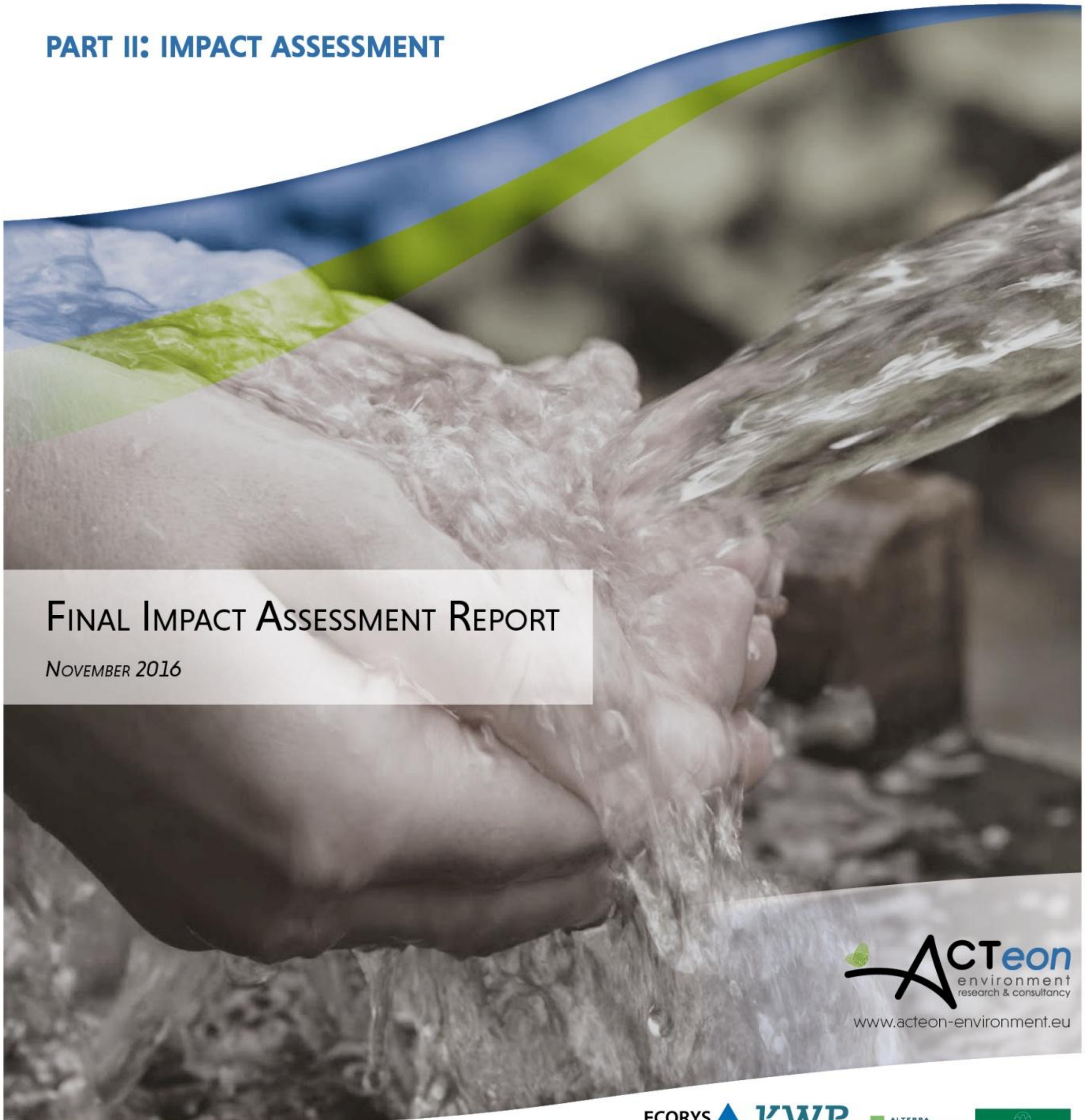
European Commission

STUDY SUPPORTING THE REVISION OF THE EU DRINKING WATER DIRECTIVE

PART II: IMPACT ASSESSMENT



FINAL IMPACT ASSESSMENT REPORT

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GLOSSARY OF TERMS & ABBREVIATIONS

EC: European Commission

EU: European Union

DWD: Drinking Water Directive

PPHR- The indicator Population Potentially at Health Risk refers to the part of the population that is supplied with, or has access to, a drinking water that could contain pollutants that might potentially cause health problems. In the context of the assessment of the baseline scenario and of the different Policy Options, the population supplied with drinking water that complies with the current Drinking Water Quality Standards can be part of the PPHR, in situation where pollutants of emerging concern and/or compounds not currently covered by Annex II of the DWD but that represent a health risk, are present in the drinking water. People supplied with such water are considered as potentially at health risk.

MS: Member State of the European Union

PO: Policy Options

PWS: The Public Water Supply is the water supplied by operators that are engaged in collecting, purifying and distributing water through public networks (source: Eurostat). It is complemented bu “self and other water supply” in the Eurostat typology dealing with the different types of (drinking) water supply.

RBA: Risk Based Assessment (following the definition of the WHO)

SDG: Sustainable Development Goals

WFD: Water Framework Directive

WHO: World Health Organisation

WSP: A Water Safety Plan (see also dedicated boxes in Chapter 6) is, according to the WHO definition, a plan that ensures the safety of drinking water through the application of a comprehensive risk assessment (aimed at identifying all/the main sources of pollution or pollution risk) and a risk management approach that encompasses all components of the water supply system from water resources in the catchment to the delivery to the final consumer. A WSP is a part of Water Safety Framework, which comprises of step by step activities and measures prepared by the distribution network operator in order to permanently and effectively ensure the wholesomeness, compliance and cleanliness of drinking water. The WSP is based on the identification of risks and hazardous occurrences, risk assessment, taking preventive measures in order to prevent or manage these risks, checking the effectiveness of drinking water preparation and monitoring compliance with the regulatory requirements relevant to drinking water.

WSZ: A Water Supply Zone is a geographically defined area within which water intended for human consumption comes from one or more sources and within which water quality may be considered as being approximately uniform (source: DWD).

Large water supplies (LWS) are those supplying more than 1,000 m^3 drinking water per day as an average or serving more than 5,000 persons (source: DWD)

Small water supplies (SWS) are those supplying less than 1,000 m^3 drinking water per day. Small water supply zones can be subdivided into two categories: category 1 supplying less than 100m^3/day; and category 2 supplying between 100m^3 to 1000m^3/day. Individual supply providing less than 10 m^3 a day as an average or serving fewer than 50 persons, unless the water is supplied as part of a commercial or public activity, are considered as a separate category exempted from the provisions of the DWD.

Water Supplier: A water supplier is a company (private or public) in charge of drinking water supply for general domestic water use in an agreed geographic area. This company can also be responsible for sewerage management and wastewater treatment. In most MS, the company operates under the delegation of a public authority (municipality in general). A Water operator is a synonym of Water Supplier. Water supply companies/ or water operators are part of what is defined as the water industry. They can supply water via PWS to different water supply zones (see above), or there can be several large and/or small water supply companies supplying water to one water supply zone.

WWAP: World Water Assessment Program

EXECUTIVE SUMMARY

The **European Union (EU) Drinking Water Directive (DWD)**, adopted in 1998, has been key to delivering high-quality drinking water across Europe. Despite its success illustrated by the high level of compliance to the requirements of the DWD achieved by Member States (MS), the implementation of the DWD **is facing many challenges** such as: drinking water quality problems in small Public Water Supplies (PWS) in remote and rural areas; no attention given to inhabitants not connected to PWS; a focus on a list of pollutants (parameters) that has not been up-dated since the adoption of the DWD and that does not consider emerging pollutants; monitoring provisions for these parameters that are not flexible nor cost-effective; no coherent approach to address potential contamination from materials in contact with drinking water; or, untapped potential to provide easier access to up-to-date information for consumers and citizens in general.

To address these challenges, the European Commission (EC) launched a **process for reviewing the EU DWD**. This process builds *inter alia* on a series of complementary activities such as: (a) an EU-wide consultation on the current state of the DWD implementation; (b) the *ex-post* evaluation of the current DWD to assess whether it is "fit for purpose" and achieves its objectives; (c) the identification of adaptations (or Policy Options) in the current EU drinking water policy framework that would help addressing above-mentioned challenges; and, (d) the assessment of the economic, environmental and social impacts of these Policy Options (PO).

This report presents the end-results of this process. It provides answers to the following questions that structure the report:

- Question 1 – **What is the problem** with today's implementation of the EU DWD and how it might evolve by 2050 if no further policy action is taken? And **why it is a problem**?
- Question 2 – **Why should the EU act** to address this problem?
- Question 3 – **What should be achieved** with a new EU initiative in the field of drinking water that would be proposed for addressing this problem? More specifically, what should be the objectives of this new EU initiative?
- Question 4 – **How would the problem evolve, all things being equal?** (the so-called baseline or reference scenario)
- Question 5 **– What are Policy Options** (PO) that could be proposed for achieving the objectives set for this new EU initiative?
- Question 6 – **What are the expected health, economic, environment and social impacts** of each proposed Policy Option (PO)?

- Question 7 – **How do the Policy Options (PO) compare**? And how could some of the proposed Policy Options be combined so as to achieve the set objectives in a (cost-)effective manner?

The *ex-ante* assessment has been developed mobilizing the results of the *ex-post* assessment of the DWD directive, complemented by: **stakeholder mobilization** in particular during a stakeholder workshop organized on December 8, 2015 in Brussels to make the bridge between the *ex-post* evaluation and the selection of policy options to be proposed for the *ex-ante* assessment; the **collection and analysis of all available evidence** for characterizing today's situation and future (baseline) changes, supporting assumptions in key parameters proposed for the different policy options, and assessing their likely health, social, economic and environmental impacts; the **development of Excel-based models** for quantifying the **costs** and the importance of the **population at health risk** as a result of the likely quality of their drinking water (both indicators being assessed for individual Policy Options at the level of individual EU MS).

To capture health risk issues, accounting for the uncertainty in the quality of drinking water received outside of the pollutants for which monitoring (and treatment) is compulsory, and for the potential health implications these pollutants might have, a specific indicator entitled **Population Potentially at Health Risk (PPHR)** was defined and assessed. This indicator captures the part of the population that is supplied with, or has access to, a drinking water that could contain pollutants that can potentially cause health problems. In the context of the assessment of the baseline scenario and of the different Policy Options, the population supplied with drinking water that complies with the current Drinking Water quality standards can be part of the PPHR: this is the case for example when the water supplied by the Public Water Supply (PWS) network contains pollutants of emerging concern and/or compounds not covered by Annex II of the DWD, but that represent a health risk. People supplied with such water are then considered as being potentially at health risk. To better capture the criticality of potential health risk, different levels of drinking water-related health risk (marginal, low, medium and high) have been defined depending on the type of pollutants and substances potentially present in the drinking water.

The baseline scenario (all things evolving with no change made under the current DWD) stresses that the PPHR will be slightly reduced by 2050 (20 million people) as compared to the 2015 figure (22,7 million people). However, despite an increase in the number of people with access to clean water by 2050, the population that might face potential health risk because of drinking water remains important (around 4% of 2050 EU 28 population).

Building on contributions from stakeholders, 12 different Policy Options (PO) **have been identified** to ensure **safe drinking water to all EU citizens in the long term**. They will enhance the **cost-effective implementation** of the EU drinking water policy, **strengthening its coherence** with other EU directives (in particular with the WFD) and ensuring **better informed drinking water consumers**. These Policy Options fall under 5 key areas:

- **Updating the list and limit values of parameters with 3 sub-options: PO** 1.1: Update of the parameters in Annex I according to scientific progress and following recommendations of the WHO; PO 1.2: Updating the list of parameters in the Annex I to longer list C (including all parameters potentially harmful); and PO1.3: Reduction of the number of parameters in Annex I to a minimum list, with the same limit values than those specified under the current Annex I of the DWD.

- **Promoting Risk-Based Assessment** (RBA) and the establishment of Water Safety Plans for addressing drinki g water pollution risks, with 2 sub-options: PO 2.1: compulsory implementation of RBA for all large water suppliers; and PO2.2: compulsory implementation of RBA for both large and small water suppliers.

- **Proposing EU harmonized standards for materials and products in contact with drinking water,** with two sub-options: **PO 3** that promotes an EU-wide standardisation process, and PO 3 bis that builds on the parallel standardisation processes carried out by individual MS with a recognition of each others' standards;

- **Ensuring SMART information to drinking water consumers, with** 3 sub-options: PO4.1: simplified automatic electronic reporting to EC; PO **4.2: Timely ba**sic online information to consumers about qu**ality of drin**king water; and PO4.3.: Ensuring advanced SMART access to a wider range of information related to the management and efficiency of the management and performance of drinking water operator.

- **Providing the right to safe drinking water to all EU inhabitants, with** 2 sub-options: PO5.1: All people that are not connected to PWS today will be connected to Public Water Supply networks; and PO 5.2: Providing all people not connected to PWS with the leans/self-supply systems that ensure they have access to DW.

Further assessment of the potential health, economic, social and environmental impacts of these Policy Options has been carried out for **9 of these 12 sub-options**, the assessment distinguishing impacts for three different groups: consumers, water suppliers and authorities in charge of the implementation of the DWD (or of any regulatory framework that would replace this directive). Three sub-options were excluded from the assessment: PO 1.3 narrowing down (shortening) the list of parameters, as it leads to a reduction in the level of drinking water protection currently put in place by the DWD; PO 3bis that kept an individual MS standardisation process considered as very similar to the baseline conditions; and, PO 4.1 that required automated reporting to the EC, with potential impacts being considered too marginal and limited to reduced reporting costs (this option was still integrated in the two other Policy Options dealing with SMART information to drinking water consumers).

The main outcomes of the ex-ante impact assessment are as follows:

- In terms of **potential health impacts**, the largest reduction in PPHR (without considering the population at marginal risk) by 2050 is for **PO 1.2** (establishing a wide list of parameters) followed by PO 3 (harmonizing standards for material in contact with drinking water) and PO 4.3 (SMART information to consumers).

- **In terms of costs**, **PO 5.1 (drinking water to all via PWS) and PO 1.2 (full list of parameters)** are **by far the most expensive**. At the opposite, the two Policy Options that promote a more systematic application of RBA and WSP (**PO 2.1 and PO 2.2) lead to some (although limited) benefits (cost savings)** as compared to the baseline scenario;

- **Incremental cost (cost-saving) per additional person protected (in €/person/year)** are best for the two Policy Options that promote a more systematic application of RBA (cost-saving of 61 €/additional person protected/year and 62 €/additional person protected/year for **PO 2.2 and 2.1**, respectively), then for **PO 1.1** (updated list of parameters: cost of +81 €/additional person protected/year). At the other extreme, the cost is as high as 2 007 €/additional person/year for PO 5.1 (drinking water to all via PWS).
- Overall, the Policy Options promoting the wider use of RBA and the establishment of WSP (2.1 and 2.2), along with Policy Options promoting SMART information to drinking water consumers (4.2 and 4.3), appear as providing an interesting balance between expected (positive) health impacts (reduction in the indicator PPHR) and costs (or costs savings). PO 5.1 with significantly high costs and limited improvements in the PPHR indicator appears as the least interesting Policy Option investigated in terms of impacts.

The robustness of these results was validated with a sensitivity analysis on key parameters, stressing the stability of the ranking between PO for the cost and PPHR indicators.

The combination of policy options into '**policy packages**' was also investigated. Two **policy packages in particular were investigated**:

- Policy Package 1 combining: PO1.1 (Updated list of parameters); PO2.1 (RBA for LWS); PO3.1 (harmonization of materials in contact); and PO 4.2 (basic online information for consumers)

- Policy Package 2 (providing more drastic changes as compared to the current DWD and a more ambitious level of protection) combining: PO1.2 (Updated list of parameters); PO2.1 (RBA for LWS); PO3.1 (harmonization of materials in contact); and PO 4.3 (SMART Information for consumers).

Because of the similarities between some Policy Options in terms of direct and/or indirect impacts, additional assessments were carried out for each Policy Package using the Excel model developed for PPHR and costs, stressing in particular the following:

- **Health impact of the Policy Packages**: As a result of the Policy Package 1 (PP1), PPHR (catching short and mid-term health risk related to drinking water) will decrease by 11,6 million inhabitants by 2050 as compared to the baseline, reaching 8,4 million people potentially at health risk. Policy Package 2 (PP2) will result in larger impacts, with a decrease of the PPHR by 15,3 million inhabitants to achieve the lowest level of 4.77 million people potentially at risk from all PO and Policy Packages. In addition, these Policy Packages will reduce the number of people with health potentially affected in the long-by 47 million people (PP1) and 78 million people (PP2), respectively;

- **Costs of the Policy Packages:** Policy Package 1 and Policy Package 2 will lead to an increase in set-up cost of 1 989 million Euros and 5 923 million Euros, respectively. Annual operating costs are expected to increase as compared to baseline by respectively 152 million Euros and 2 155 million Euros for Policy Package 1 and Policy Package 2, respectively. In addition, the cost of drinking bottled water will decrease by respectively 336 million Euros (PP1) and 610 million Euros (PP2);

- **Affordability:** the Policy Package 1 will increase the total cost per household by €0.4 euro. This ranges from an increase by 5 Euros for Luxembourg to a decrease by €2.70 Euros for Malta. The Policy Package 2 will increase the total cost per household by €8 Euros, ranging from + 16 Euro for Ireland to a 4 €uro for Hungary.

- **Employment** is expected to decrease by 1 460 persons as compared to the 2050 baseline for Policy Package 1. And it is expected to increase by 13 490 persons with Policy Package 2.

When looking at the cost effectiveness of the Policy Packages, they are higher for the two Policy Packages as compared to Policy Options taken individually.

1. INTRODUCTION

1.1 Context

Safe drinking water is a European heritage. Its high quality is essential for public health and human well-being. Water is not a commercial product like any other. However, it is economically important. Every citizen uses up to 150 liters of drinking water per day, and the total abstraction of freshwater for drinking water purpose across Europe is around 250 billion m^3/year. The existing drinking water supply infrastructure is also a comparative advantage that can support economic growth locally. Defects in the supply of drinking water, in terms of quality or quantity, cause high social and economic costs. To avoid such costs, the preservation and further improvement of a safe drinking water supply is of vital importance for the EU, contributing to its overall socio-economic development.

The main piece of EU legislation, the Drinking Water Directive (DWD) 98/83/EC[1], introduced in 1980 and revised in 1998, has led to the delivery of high-quality drinking water across the EU. Joint efforts from EU institutions, Member States and drinking water service providers have resulted in high compliance rates with the drinking water standards proposed by the DWD. However, the implementation of the DWD is also facing specific challenges as highlighted by the 2014 implementation report of the DWD[2]. These include: quality problems in small water supplies in remote and rural areas; inflexible and not cost-effective monitoring provisions; parameter list that has not been up-dated and capacity to consider emerging pollutants; and untapped potential to provide easier access to up-to-date information for consumers and citizens in general.

To address these different challenges, the EC launched a process for reviewing the EU DWD. This process built *inter alia* on:

- An **EU-wide public consultation** on the current state of the DWD implementation. This consultation identified issues calling upon the EC to improve or to maintain the current drinking water policy, in particular: to enhance the information to the public; to improve monitoring and control systems; or to address contamination from materials in contact with drinking water. It also raised many additional issues beyond the (health-related) scope of the drinking water policy including the question of the "human right to water" and the access to safe water and sanitation for all;

- An ***ex-post* evaluation of the EU DWD**. The *ex-post* evaluation of the DWD was carried out in 2015 to assess whether the legislation is "fit for purpose" and achieves its objectives. This *ex-post* evaluation covered the key performance dimensions of a public policy evaluation, including: effectiveness, efficiency, EU value added, coherence and relevance. It built on available evidence

[1] Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, OJ L 330, 05/12/1998, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31998L0083

[2] The final report of the *ex-post* evaluation study is available at: http://www.safe2drink.eu/dwd-evaluation/

(in particular in terms of water quality and compliance levels), the results of the EU-wide public consultation, interviews with a wide range of drinking water stakeholders and the organization of a stakeholder workshop[3] for collating input and feedbacks on the main components of the *ex-post* evaluation.

As a result of the review process, the EC decided to embark on the *ex-ante* assessment of policy options proposed for strengthening the current EU drinking water policy. The *ex-ante* assessment is the focus of the present report.

1.2 The objectives of the report

The main objective of the report is **to present the results of the ex-ante assessment of policy options proposed for addressing current challenges in achieving the objectives of the EU DWD**, i.e. safe drinking water to EU citizens.

The report is structured along the following series of questions:

- **Question 1 – What is the problem - and why it is a problem?** Presenting the main challenges currently faced by the EU DWD, and how these might evolve over time by 2050 if no additional policy action is taken (the so-called baseline scenario) ➡ ***Chapter 2***
- **Question 2 – Why should the EU act?** ➡ ***Chapter 3***
- **Question 3 – What should be achieved?** And what should be the objectives of this new EU initiative? ➡ ***Chapter 4***
- **Question 4 - How would the problem evolve, all things being equal?** ➡ ***Chapter 5***
- **Question 5 - What are the proposed options** to achieve the objectives? ➡ ***Chapter 6***
- **Question 6 – What are the expected impacts** of the proposed options? ➡ ***Chapter 7***
- **Question 7 – How do the options compare?** ➡ ***Chapter 8***

The report ends with a **conclusion** (***Chapter 8***) summarizing the main sources of uncertainties, and discussing the possible combination of policy options for achieving set objectives.

[3] Organised in Brussels in May 2015

1.3 Selected methodological aspects

The *ex-ante* assessment of policy options proposed as alternatives to the current DWD included the following steps; development of the baseline scenario; identification and selection of policy options that might address current and future challenges with the supply of clean drinking water, building on the outcome of the *ex-post* evaluation of the DWD and contributions from stakeholders; analyzing the impacts of the proposed policy options. More practically, the *ex-ante* assessment built on the following tasks and activities:

- **Collection of evidence** (statistics, study reports, scientific publications….) for characterizing today's situation and future (baseline) changes, supporting assumptions in key parameters proposed for characterizing different policy options, and for estimating their expected health, social, economic and environmental impacts;

- **Stakeholder mobilization** in particular during a stakeholder workshop organized on December 8, 2015 in Brussels to identify possible Policy Options that could be proposed for the ex-ante assessment, on the basis of the results of the *ex-post* evaluation (see Annex 1)[4];

- The development of a **specific approach to address health issues** in relation to drinking water (quality), as a result of the limited evidence on health-related impacts available and presented in the *ex-post* evaluation report. A specific indicator named **Population Potentially at Health Risk (or PPHR)** was defined to capture the part of the population that has access to drinking water that might contain substances that can *potentially* cause health problems. Indeed, even though a given drinking water can be compliant with the current DWD standards, it can possibly contain new substances or substances of emerging concern (but not included in the current list of substances requiring monitoring under the DWD) which intake could have health implications for the population drinking this water. The term "Potential" refers to the fact that, even if there are harmful substances in the water, the risk of any individual falling sick is potential (unknown) – as the individual may drink the water or not (or use bottled water instead) and may get sick or not. This indicator was further disaggregated into 4 different potential risk levels– marginal, low, medium and high, with the low, medium and high risk categories being combined into a single PPHR indicator analysed separately from the marginal risk one;

- The development of **Excel-based models** for quantifying at the level of individual MS the likely impacts of individual policy options on key parameters (direct costs, PPHR and population at marginal health risk related to drinking water – see below). These Excel-based models were also

[4] The workshop was attended by 60 participants from different EU MS representing a wide range of stakeholders. The workshop agenda and synthesis is available at http://www.safe2drink.eu. The workshop addressed the following questions: (1) Which areas of current DWD are in need of improvement?; (2) How are drinking water quality, the implementation of the DWD and the drinking water system likely to evolve in the future? And, (3) **What could be changed – and how?** Identifying different areas for improvements (or policy options).

used to perform the sensitivity analysis on key assumptions to assess the robustness of the results obtained, in particular in terms of ranking of Policy Options. The Excel models were built to assess health and direct economic impacts, supporting also the assessment of the social, environmental and other economic impacts that were mainly analyzed separately in qualitative and quantitative terms on the basis of the evidence available in the literature. Figure 1 below presents in a schematic manner how the two indicators PPHR and direct costs are calculated in the Excel model under the current situation, the baseline scenario and for each individual policy option.

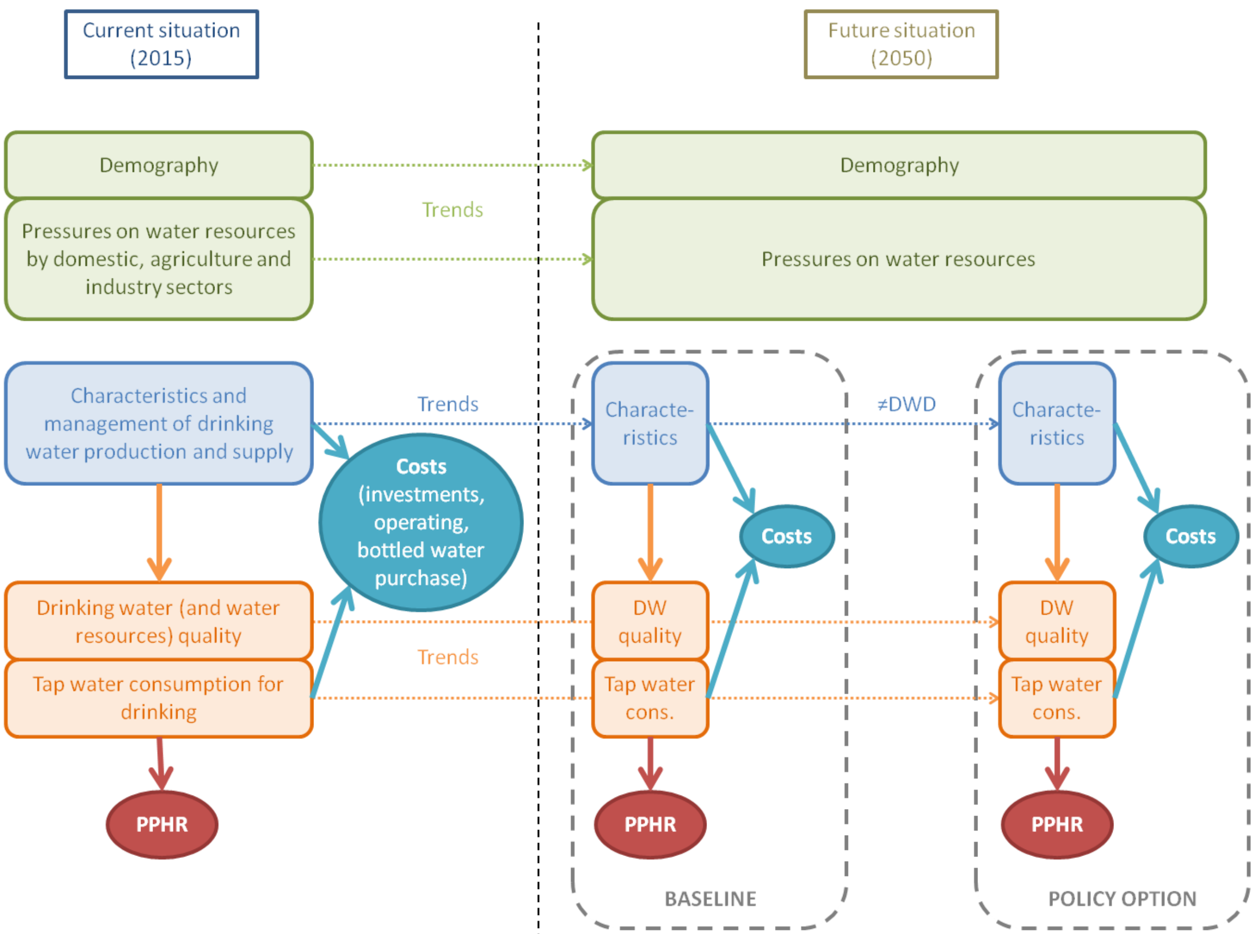

Figure 1. Schematic presentation of how the PPHR and costs are calculated in the models

The PPHR indicator was calculated first for the current situation (2015) - using latest data available on demography, pressures on water resources, water quality, etc.. It was then estimated for the future situation where no action is taken (baseline) and under each proposed policy option for 2030 and 2050 at the level of the population of each individual MS and at the European scale. The comparison between the PPHR values estimated under different policy options with the PPHR value under the baseline scenario helped quantifying the part of the population that would be 'protected' from potential adverse effects by effective monitoring of substances, the implementation of measures taken to limit drinking water contamination, or by providing better information to consumers. Section 6 of the present report summarize the key factors and assumptions used for estimating the impact of individual policy options on the indicator PPHR and on implementation costs at the MS level (the results being then aggregated at the scale of EU 28 for obtaining EU estimates). Those assumptions were based on the available literature and expert opinions. The excel model set provided also the possibility to estimate intermediary or final indicators such as (fresh or drinking) water quality, consumption of bottled water, operating costs and setting-up costs, etc[5].

The PPHR indicator (combining the low, medium and high risk categories) and the population marginally at health risk were estimated on the basis of assumptions for the shares of the population exposed to different risk factors among which: being connected to a PWS or not, drinking bottled-water or not, being supplied by a water operator applying RBA or not, having access to water potentially contaminated by different types of pollutants, etc.. Depending on their exposure to different risk factors, the percentage of the population under each risk category (marginal, low, medium and high) was estimated as summarized in Figure 2.

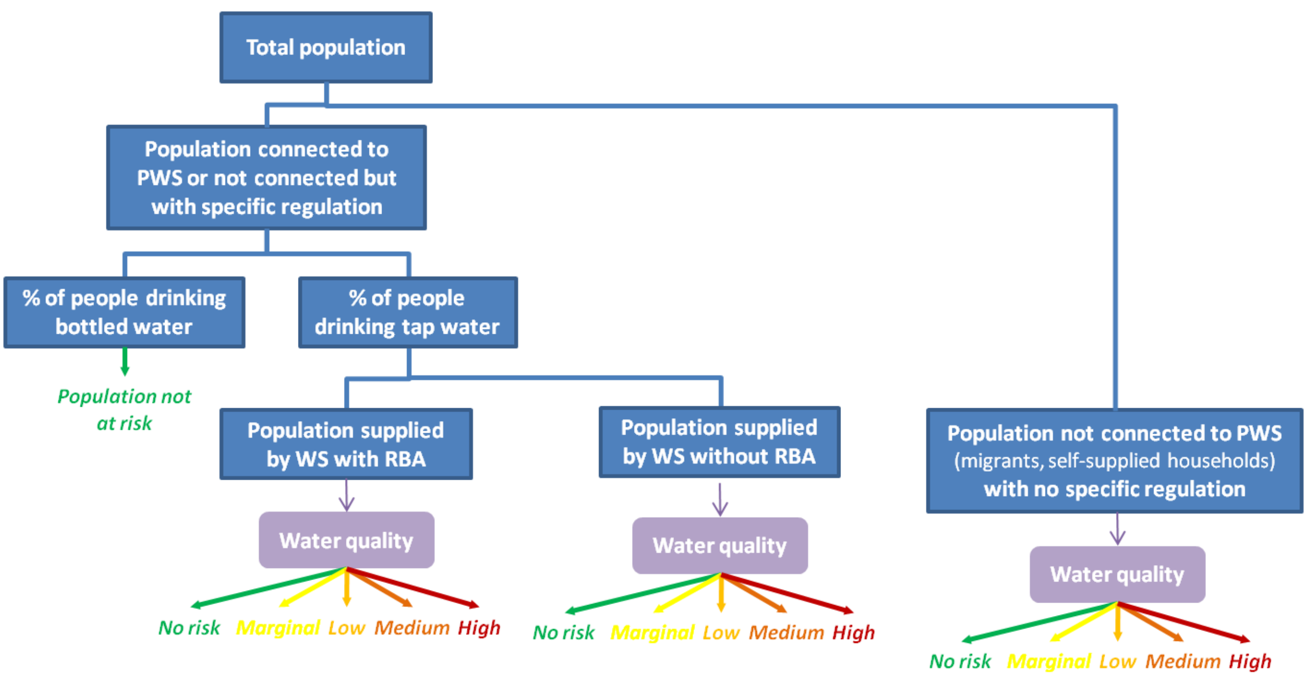

Figure 2. Estimating the relative importance of different levels of risks on the basis of exposure to different factors (note: the low, medium and high risk categories are then aggregated as the PPHR indicator).

The table below presents how the population is split between different levels of potential health risk depending on water quality. The level of risk depends on the combination of pollution from different

[5] To better understand the assessment carried out, it is important to remember that the DWD covers water supplied by networks for household uses, including: the 2 liters of water drank per person every day; water used for cooking; water used for the other domestic activities.

groups of substances at different concentration (i.e. the higher the number of contaminations sources, the higher is the risk).

Table 1. Different levels potential health risk depending on the presence of different pollutants in drinking water

Population supplied with drinking water containing…												
List A substances	No				Intermediate				Yes			
New list B substances	No[6]		Yes		No		Yes		No		Yes	
Supplementary list C substances	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Population at…	**no risk**	**marg. risk**	**marg. risk**	**low risk**	**marg. risk**	**low risk**	**low risk**	**med. risk**	**low risk**	**med. risk**	**med. risk**	**high risk**

For this categorization, the different groups of substances and different concentration that have been considered are the following:

- Contamination by substances from the list in annex I of the current DWD - called **list A substances -** with 2 different thresholds of concentration[7], resulting in three categories of contamination[8] : no contamination; intermediate contamination; and clear contamination.

- Contamination by some substances that are currently not listed in Annex I of DWD but that would be added if a simple scientific update of the list would be performed defined as **list B**), with threshold values being also defined through this update[9].

- Contamination by some substances that are currently not listed in Annex I of the DWD but that correspond to all potentially harmful substances not listed that could be found in drinking water (this theoretical list being defined as **list C**) and not yet included in list B, and at a concentration defined according to scientific knowledge[10].

[6] In this table, the "Yes or No" contamination by list B and list C substances has to be understood has: 'Yes' it exists a contamination above concentration defined as parametric thresholds and 'No' there is no contamination above concentration defined as parametric values.

[7] Those two thresholds are: the concentrations defined as parametric values in the current annex I of DWD and that are similar to WHO guideline values; and (only for some parameters) lower concentrations defined according to precautionary principle that we've called precautionary values. Those "precautionary values" have not been settled here but in this approach they are considered as a concept that would need more insight from the upcoming EC/WHO study. For more information on precautionary principle generally speaking, please refer to the dedicated literature.

[8] In details: 'no contamination' corresponds to a contamination below "precautionary values", 'intermediate contamination' corresponds to a contamination at a concentration between WHO guideline values and above precautionary values; and 'contamination' corresponds to a contamination above WHO guideline values.

[9] For some indications on which substances might be considered in this list, please refer to the forthcoming results of the ongoing WHO/EC project.

[10] For some indications on what would be those substances could be, please refer also to the forthcoming results of the ongoing WHO/EC study.

To account for the main health risks, it was decided not to account for population that might be marginally at health risk (i.e. facing potentially the presence of a single pollutant with limited or no chance of falling sick or of being impacted). Thus, only the **low, medium and high levels of risk were accounting for, and combined, into the PPHR indicator**. The population marginally at risk was still considered in parallel as a proxy of the slight or long-term health effects that could be related to drinking water intake[11].

Box 1. **The different levels of drinking water-related health risk**

The risk approach that is proposed here is based on a probabilistic approach capturing the risk to face one or several sources of contaminations from the drinking water that might be drunk. As this study is not a health study, the approach does not attempt to describe and assess the potential level of severity of health effects potentially caused by each kind of substance that might contaminate drinking water. And the different types of contaminants considered (lists A, B and C – see above) are treated alike as potentially source of health risk.

The **PPHR** that capture the population potentially at health risk combines three different levels of health risk:

- **High risk -** corresponding to a potential exposure to the presence of the three categories of substances in drinking water (list A with substances with concentrations above the WHO guideline values, list B and List C);
- **Medium risk -** corresponding to a potential exposure to the three categories of substances in drinking water and with list A substances in intermediate concentrations, or a potential exposure to list A substances above WHO guideline concentrations combined with exposure to substances of list B or substances of list C;
- **Low risk -** corresponding to a potential exposure to two categories of substances in drinking water with list A substances being in intermediate concentrations, or an exposure to list A substances above WHO guideline concentrations without exposure to substances of list B and of list C.

As indicated above, the marginal risk category is considered separately. This category corresponds to a potential exposure to only one category of substances in drinking water with list A substances being in intermediate concentrations. Overall, this implies a low probability of negative health effects (likely to be of limited to marginal importance). Thus, this indicator is used as a proxy to the potential slight and long-term health effects that might result from drinking water

People supplied by water potentially containing harmful substances as described above can have potentially health impacts. However, translating directly the indicator PPHR and the access to, and consumption of, this water into health impacts (number of sick people, illness levels, etc.) **is out of the scope of the PPHR indicator.** Some attempts to translate the PPHR indicator into **"health impacts" and "health costs" were made in separate analyses** which results fed the *ex-ante* impact assessment, as indicated in Annex 2 to the present report.

[11] It is important to stress that the zero risk does not exist. In consequence, the population not at risk in the assessment is in fact a population at very marginal risk according to the health risk assessment framework that has been developed for this study.

2 WHAT IS THE PROBLEM AND WHY IS IT A PROBLEM?

2.1. What did we learn from the *ex-post* evaluation of the DWD?

As indicated in the *ex-post* evaluation report of the DWD[12], the Directive has been very effective in achieving high compliance rates for the water quality parameters set in the Directive. But there is no convincing evidence that the DWD induced increase in compliance for several agriculture and/or catchment related parameters. And the water quality in small water supply zones is today of not so good quality than that in large water supply zones. While there is agreement that the Directive's provisions for setting parameters, monitoring and remedial action had been effective for the protection of human health, there are many issues raised in relation to these same provisions, in particular with regards to: (1) updating the list of parameters in Annex I; (2) enhancing the quality of monitoring in some MS (with insufficient insight into the quality of drinking water in small supply zones); (3) regulating (and harmonising) materials and substances in contact with drinking water which; (4) low and/or variable quality of the information available on water quality, leading to low consumer satisfaction and challenging policy monitoring by the Commission.

Question 1 - Are we achieving our "health" objective?

The EU DWD defines minimum requirements for the sanitary quality of drinking water within the EU. The directive lists in its Annex I 48 microbiological and chemical parameters which should be monitored regularly. The limit values listed in the directive are based on the guidelines of the World Health Organisation [WHO 2004]. EU Member States must comply with the parametric proposed by the directive, with the possibility to set additional (stricter) national regulations.

The **compliance to the set DWD standards has significantly increased** since the adoption of the directive. The analysis of compliance data reported by MS highlight that exceedance of drinking water quality higher than these standards decreased between 2005 and 2013 for microbial, chemical, and indicator parameters[13]. Improvements were the most significant for parameters such as E. coli, Cl. perfringens and Atrazine, the compliance for all other parameters increasing from ca. 95% to nearly 100%.

In spite of this positive development, **concerns remain on parameters not included in the DWD** which are potentially a threat to human health (e.g. emerging substances including endocrine disrupting compounds). Some individual MS have already added other parameters to the list in Annex I such as: virus, parasites (e.g. legionella), calcium and magnesium, chlorophenols, cadmium, trihalomethanes, microcystin, uranium and chlorite. Today, there is wide agreement among MS and stakeholders of the drinking water community on the **outdated character of the Annex I** list that has not been amended in

[12] http://www.safe2drink.eu/wp-content/uploads/2016/07/DWD-evaluation-report-Main.pdf

[1] The analysis was carried out over the period 2005-2013 for 10 parameters representing the four main groups: microbial parameters (Escherichia.coli), chemical parameters (arsenic, nitrate, lead, copper), indicator parameters (Cl. Perfringens) and other parameters (atrazin, desethylatrazine, terbutylatrazine, Bentazon)

line with the latest scientific developments and evidence. In addition to some of the parameters already considered in individual MS, suggestions for additional parameters that might pose risk to human health include: consumer products, pharmaceuticals and endocrine disrupting substances, chromiumVI, perfluorinated substances and nanoparticles. Some of these concerns have been partially addressed in the current revision of Annex II of the DWD (dealing with monitoring) that offers the possibility for MS to decide, on the basis of a **sound risk assessment**, which parameters to monitor[14]. On the basis of this risk-assessment, water suppliers can then develop Water Safety Plans defining actions for addressing drinking water pollution problems. And this is expected to lower the risk of contamination[15]. This approach is today already implemented by some water suppliers and MS[16].

The overall high compliance rates achieved by EU MS hide a **diversity of situations within MS**. In particular, the issue of small Water Supply Zones (WSZ) has long been perceived as a potential risk to consumers, around 65.5 million people (or 13% of the EU population) being served by drinking water abstracted from small WSZs. According to a report on the quality of water in small WSZ[17], 40% of these small WSZ (representing a population of over 11.5 Million people) were not in compliance with the DWD regulations, and 19% were not monitored in accordance with the DWD requirements[18].

The **frequency of monitoring**, as stipulated in Annex II to the Directive, is also an issue of concerns. This Annex has been recently amended providing flexibility in the overall approach to monitoring, allowing in particular MS to decide, on the basis of a sound risk assessment, which parameters to monitor. For small WSZs, the revised Annex II and III now prescribe a minimum frequency of monitoring of once per year. Although this change might lead to marginal improvements only in the knowledge base on small WSZ, it illustrates the importance of monitoring requirements as an essential element to safeguard drinking water quality for all European citizens. Indeed, low quality monitoring can have two negative consequences: i) a weak or absent bases to act on cases which require remedial action (thus potentially impacting on human health); and ii) a weak basis for (re-) designing policies, both at local, national and international (EU) level. Whether frequencies of monitoring mentioned in Annex II are sufficient to safeguard the quality of drinking water year-round remains an issue, some experts[19] favouring a more frequent monitoring than currently specified in Annex II.

Finally, **not all EU citizens** fall under the regulatory requirements of the DWD, as these apply only to citizens connected to Public Water Supply systems. Thus, there is high uncertainty on the quality of the drinking water for **citizens not connected to PWS systems** (using wells, cisterns, direct connection to sources, etc.) that represent 23 million people or 4.5% of the total EU population[20] .

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[14] The amendment to Annexes II and III allows MS to derogate from the monitoring programmes they have established, provided they perform credible risk assessments which may be based on the WHO Guidelines for Drinking Water Quality and should take into account the monitoring carried out under Article 8 of Directive 2000/60/EC.

[15] The application of risk assessment and the development of Water Safety Plans will also enable water companies to learn more about their drinking water sources and the different factors that influence their quality and status.

[16] In particular: Belgium, the Netherlands, Sweden and the United-Kingdom.

[17] Add reference

[18] Small water supply zones in the EU – Reporting year 2010" report (dated 26 March 2013)

[19] Contacted during the *ex-post* evaluation of the DWD

[20] Eurostat - Data from env_wat_pop - mean on the 2009-2013 period.

Using available data on population and PWS (sources: Eurostat) complemented by assumptions on the type and level of contaminants in water resources (see Box 1[21]), the indicator PPHR was estimated for aggregating the overall impact of these different elements on today's population potentially at health risk. It is estimated that there are **22,7 million inhabitants (or 4% of the EU 28 population)** who are potentially at health risk today because of potential contamination in water resources and drinking water.

Box 2. Today's situation with regards to basic parameters used to estimate PPHR

- 508 223 624 inhabitants (EU 28)
- With 95% connected to PWS
- Each inhabitant drinks on average 106 liters of bottled water per person and per year – with 3 845 liters of tap water being used per person and per year
- It is assumed that 47% of (large) PWS are applying already a RBA.
- It is assumed that current tap water quality is affected by contamination as follows:
    - 7% contaminated by list A substances with concentration above the WHO parametric values, i.e. not complying with the current DWD standards
    - 11% contaminated by list A substances with concentration below the WHO parametric values but, above "precautionary" limit values
    - 4% contaminated by substances from the list B among water distributed by water suppliers who apply an RBA; and 8% among water distributed by water suppliers who do not apply a RBA
    - 7% contaminated by supplementary substances from the list C
- It is assumed that raw water (used for self-water supply in particular) is affected by contamination as follows:
    - 9% contaminated by list A substances with concentration above the WHO parametric values, i.e. not compliant with the current DWD standards
    - 11% contaminated by list A substances with concentration below the WHO parametric values but above "precautionary" limit values
    - 10% contaminated by substances from the new list B
    - 11% contaminated by supplementary substances from the list C.

> Overall, current drinking water quality in Europe reaches the targets set by the DWD in the majority of cases. But there are clear concerns on: (1) the targets themselves, and on the risk parameters currently not monitored by the DWD might pose risk to human health; (2) with small WSZ that remain less well monitored (despite recent changes in monitoring obligations) and with potentially higher risk than for large WSZ; and, (3) for population non connected to PWS systems. The indicator PPHR is estimated at 22.7 Million inhabitants for today's situation.

[21] For sources of data presented in Box 1, see chapter 2 for details on sources. Data on contamination come from: DWD reports, Waterbase database (EEA) and estimations by the contractor. The description of the different assumptions is further described in Chapter 5 (baseline) and in chapter 6.

Question 2 - Are we responding to today consumers' and citizens' demands?

Receiving safe drinking water is a basic demand of all citizens and drinking water consumers. Despite the current level of compliance with the DWD standards, **many customers do not trust tap water** and rely partially or exclusively on more expensive bottled water for drinking (average of 106 l/capita/year of bottled water purchased in the EU, up to 170 to 180 l/capita/year for MS like Germany, Italy and Malta[22]).

There are many reasons explaining that some consumers do not drink tap water (including smell, taste, social status...). **Confidence** in the quality of tap water is one of these reasons, linked in particular to the information consumers receive or do not receive on the quality of the water they receive. According to Article 13 of the DWD, MS are to provide adequate and up-to-date information on water quality for human consumption to consumers. Most national authorities do indeed provide information on the quality of the drinking water through various means (consumer leaflets, websites, etc.). Often, the reports national authorities submit to the Commission are also made available to the public.[23] However, a 51% of consumers who responded to the stakeholder survey carried out in 2015 in the context of the *ex-post* evaluation study of the DWD[24] stressed that the **inadequacy of current information provisions**. In particular: i) information on the quality of water is difficult to find – and potentially to understand; and ii) it is unclear what is being paid for via the water bill – a wider issue linked to the management of drinking water services. Overall, higher transparency is seen as an important element in maintaining and improving public confidence in the quality of drinking water. Consumers are in particular demanding more information and transparency on insecurities (risk communication). Providing insufficient information to consumers may turn them to other water resources than DWD protected drinking water as highlighted by the current purchases of bottled water by households.

In addition to enhanced transparency, there is a growing (societal) demand for expanding the obligations of the DWD from people connected to PWS to all citizens. Indeed, as indicated above, the DWD does not include an obligation to supply safe water to any citizen. This has been one of the key issues highlighted by the first European Citizen Initiative "Right to Water" which urges EU institutions and Member States "to ensure that all **inhabitants enjoy the right to water** and sanitation".

> There is a clear demand from drinking water customers for "better information" as compared to the current provisions of the DWD, in particular on the quality of the water they receive and on potential risks. In addition, initiatives are taken throughout Europe to widen the scope of the DWD from people connected to PWS to all inhabitants.

[22] Data from Canadean Wisdom 2016 Annual Cycle available on Unesda website - Data for the year 2015.
[23] The latest DWD synthesis report made available by the Commission refers to the period 2011-2013.
[24] Add reference

Question 3 - Are we cost-effective in achieving the set objectives?

Different concerns are raised with regards to the efforts that are required by water suppliers for achieving the objectives of the DWD, which were described above.

The costs of **monitoring** required for assessing if drinking water is safe has been an issue for discussion. Indeed, under the current DWD provisions, drinking water suppliers might require monitoring pollutants that have no chance of being present in the water bodies from which they abstract water, because of the absence of possible sources of pollutants in these water bodies. These concerns are partially considered with the recent amendment of Annex II, the risk assessment carried out helping to focus monitoring on the parameters that are necessary to monitor and potentially reducing monitoring costs[25].

The way in which drinking water quality problems are addressed, raises also cost-effectiveness issues. Despite clear changes in the philosophy of water management and policy in recent years, in particular with the adoption of the EU Water Framework Directive, pollution and pollution risks are often addressed with mitigation and remediation actions, such as: (1) the displacement of drinking water wells to non-polluted zones; (2) the connection to neighbouring water supply networks with better quality (allowing in particular to mix waters and achieve set standards); (3) the installation of treatment plants to clean water prior to distribution. It is estimated that annual drinking water treatment costs amount to 8 billion €/year[26], an amount that is directly translated into water tariffs and water bills. And these measures can be more expensive than **actions that aim at addressing pollution at source** (e.g. changing in farm practices in water catchments)

The issue of cost-effectiveness has also been raised with regards to the mechanism for **addressing possible sources of pollution from materials and substances in contact with drinking water**. Article 10 of the DWD regulates the impact of materials and substances in contact with drinking water to ensure that MS take the necessary measures to prevent hazardous concentrations of substances and materials from ending up in the drinking water as a result of treatment, equipment and materials used. The article covers: (1) 'substances' such as chemicals used in the production and distribution of drinking water; and, (2) materials used for new installations. Chemicals used in the treatment of drinking water are generally (but not always) of certified quality. But even when quality has been checked, they should not be used in such a way that they can cause impact on water quality. The implementation of Art. 10 has caused many discussions as the DWD does not give guidance on the outline and the operation of a system for the assessment and the approval of chemicals and materials in contact with drinking water. Furthermore, the reference to the Construction Products Directive (89/106/EEC), and Regulation 305/2011 which replaced this Directive has not solved the issue of harmonized product standards before industry is able to identify compliance. Given the number of substances and the complexity of test and field conditions, leaving the implementation to individual MS has turned out to be a challenging, laborious and time-taking task, which is also seen as an obstacle to free trade within Europe.

[25] Note that the cost of reporting of the DWD by MS to the European Commission is not seen as an issue today which reduction could help MS to re-allocate budget and financial resources allocated to reporting to other more priority tasks and challenges.

[26] Amount estimated as equal to 18% of total operating costs in each Member State - Ecorys (2016), Study supporting the revision of the EU Drinking Water Directive. Chapter 3.1

Ensuring a cost-effective implementation of the DWD remains a challenge, in particular with regards to: (1) targeting the monitoring of substances that matter most; (2) the selection of actions for addressing pollution problems, in particular the role actions for reducing pollution at source can play; and, (3) how to address in a more coherent and collective manner the issue of materials and substances in contact with drinking water.

2.2 Summarizing the current problem

Building on the outcome of the *ex-post* evaluation, the following diagram summarises: (a) the main problems faced by, and shortcomings of, the current drinking water regulatory framework; (b) the direct effects and wider impacts that results from these problems, including in terms of health risk for EU population and implications for the wider socio-economic development of Europe.

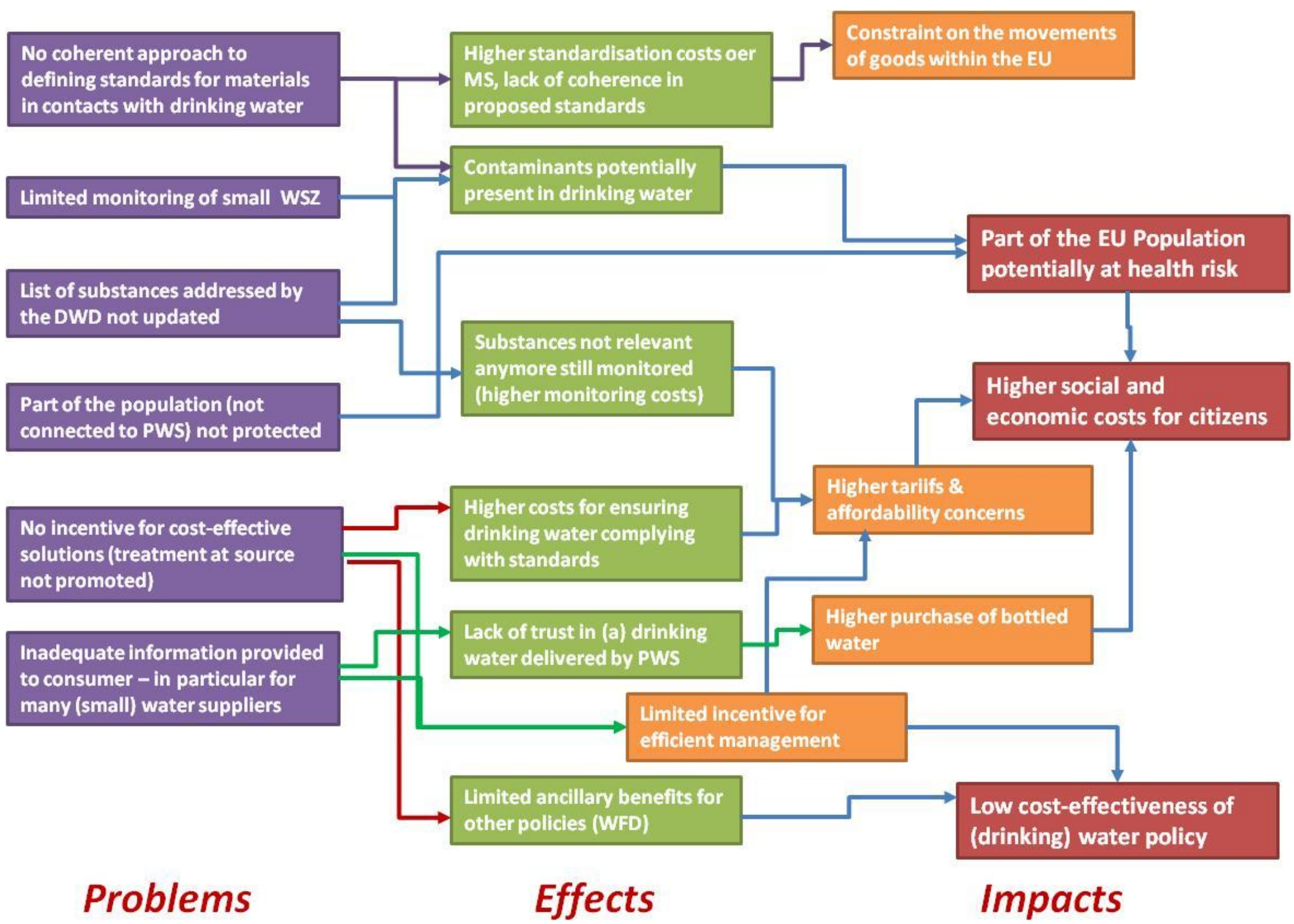


Figure 3. What are the problems? and why they are problems? A summary

3 WHY SHOULD THE EU ACT?

Despite a gradual improvement in compliance in all MS since the adoption of the DWD, EU citizens from different MS are still facing different levels of protection. The current short-comings of the EU DWD are recognised by many local, national and EU stakeholders involved in the regulation and management of drinking water. More specifically, a more dynamic (e.g. ensuring regular update in line with the emergence of new pollutants and related socio-economic & technological developments) and targeted (e.g. putting efforts where problems are – and addressing pollution at source) is necessary today for addressing EU drinking water challenges.

There are different reasons that explain **why the EU should act** and pursue its action in ensuring the delivery of safe drinking water to EU citizens.

- This current situation contradicts the principle of an **equal level of health protection** from the adverse effects of any contamination of water intended for human consumption for all EU citizens and in all EU MS. The EU only can play a role in delivering this equal level of health protection throughout Europe. This is essential from an **equity** point of view. It is also required that **EU citizens travelling throughout Europe** (in particular tourists, professionals, migrant populations) can **benefit from the same level of health protection whoever and wherever they are**. Ensuring access to the same level of safety that can be trusted wherever you are (along similar lines as the quality of the bathing water) is likely to be a positive factor facilitating intra-European travel and the development of the European tourism sector;

- The EU can also contribute to achieving **high level of protection at lower costs** than what individual MS would deliver. Cost savings and economies of scale are in particular important for: (a) identifying new pollutants (develop knowledge and apply sound health risk tests and procedures) that would need to be monitored and addressed throughout Europe; or (b) develop standards for materials in contact with drinking water that would then be applied throughout the EU[27];

- An EU led initiative will contribute **to the smooth functioning of the internal market**. Different standards for materials in contact with drinking water developed by individual MS will limit the movement of products within the EU (constraints and market fragmentation for these products), or add additional costs to the industry producing materials[28]. Although marginally, this could have negative socio-economic impacts;

[27] Strong collaboration between MS developing their own standards could also potentially deliver common standards for materials in contact with drinking water at least for several MS. However, it is expected that this will entail transaction costs higher than those of an EU wide process.

[28] Facing the need to develop different products responding to these (MS-based) standards or deciding not to access some MS markets (an option likely to reduce opportunities for economics of scale, higher production costs and potential impact on competitiveness including in international markets)

- A strong EU role in renewing the European drinking water policy so it responds to new and future challenges will enhance the **cost-effectiveness and coherence of the wider EU water policy** – in particular ensuring drinking water policy is well articulated and coherent with the EU WFD, the corner stone of EU water policy with common objectives, coherent approaches and tools including in European transboundary river basins such as the Danube, the Rhine or the Elbe. Leaving the definition of a new drinking water policy to individual MS could make the WFD implementation less coherent and more challenging

- A strong involvement of the EU is also essential on **wider political grounds**: all stakeholders that have been involved in EC WG and events dealing with drinking water, including events organised in the context of the *ex-post* evaluation of the DWD, recognise the success of the DWD thanks to the lead role and added value of the EU. They **expect the EU to remain involved in, committed to**, addressing current and future drinking water challenges. Pursuing the *status quo* with the current DWD and its short-comings, requiring MS to take actions individually, could contribute negatively to the views actors active in this field have on the legitimacy of the EU as a whole and on its lead role in water policy.

- Finally, **protecting human health** is specified as one of the competencies of the EU and objectives of a common EU environmental policy (reference to TFEU 191). As an EU wide initiative bringing a fresh dynamics in the field of drinking water policy will not address (a) provisions of a fiscal nature, (b) measures concerning town and country planning and (c) measures significantly affecting a Member State's energy supply, a possible regulatory initiative in this field would not require unanimity for adoption – a context likely to reduce policy development transaction costs if a regulatory option would emerge as the best option for addressing the challenges identified above.

Launching an EU initiative promoting the achievement of safer drinking water to all EU citizens will also deliver ancillary benefits thanks to its contribution to the achievement of the objectives of other key EU policies. In particular:

- **Enhanced policy coherence** between: (a) the EU drinking water regulatory framework and other EU water policies, in particular the EU WFD, an area where the EU is playing a determinant role to ensure improvements in the status of aquatic ecosystems; and (b) the EU drinking water and the food quality regulatory frameworks when dealing with quality requirements of products in contacts with drinking water;

- Contributing to the **better functioning of the EU Single Market**, facilitating in particular the move of products in contact with drinking water within the EU, offering opportunities for European businesses and lower prices for drinking water consumer;

- Making the **EU regulatory framework simpler while reducing regulatory costs**, two pillars of the European Commission's Regulatory Fitness and Performance (REFIT) programme adopted in

2015[29] that aims at contributing to a clear, stable and predictable regulatory framework supporting growth and jobs.

- **More resource efficient implementation**, in line with the EU 2020 strategy and its flagship initiative for a resource-efficient Europe[30], that results from enhanced policy coherence and from the prioritised allocation of available financial resources in particular for reducing pollution at source.

- Better **transparency and access to information**, in line with the principles and objectives of the Aarhus Convention to which the EU is committed;

This added-value of a renewed EU policy initiative to ensure safe drinking water to all EU citizens is not in contradiction with the **subsidiarity principle** that will ensure a cost-effectiveness policy overall. Indeed, specific (operational) measures that will address current drinking water challenges will be defined at the MS scale (or below) in line with the subsidiarity principle accounting for the water and socio-economic context of individual MS, the structure and organisation of their water industry and their institutional framework for water services and for water resources. Subsidiarity will in particular be relevant to:

- The types of **pollutants** that need to be monitored (accounting for risks and pollutants that are relevant to a given drinking water supply system in particular), and how to monitor them (in particular: which method and monitoring device to apply);

- The **actions** that are selected for addressing pollution and ensuring healthy drinking water to EU citizens, their implementation and the recovery of their costs (accounting for basic principles such as the polluter-pays principle and the cost-recovery principles promoted by the EU WFD);

- The innovative tools that can be developed and implemented for ensuring high-quality relevant and timely **information** to drinking water consumers;

- More generally, the overall **governance and organisation** of the drinking water sector including the expected roles and responsibilities of drinking water consumers and the integration of the drinking water governance in the wider water resource governance and institutions, different areas that are fully under the responsibility of individual MS.

[29] See http://ec.europa.eu/smart-regulation/refit/index_en.htm
[30] See http://ec.europa.eu/europe2020/index_en.htm

4 WHAT SHOULD BE ACHIEVED?

A new EU initiative is needed today for addressing more comprehensively the current and future challenges linked to the delivery of safe drinking water to EU citizens. This initiative will be the **direct continuation of the EU DWD** that is a success story in EU policy making, providing it a new impetus so it responds cost-effectively to today's and tomorrow's challenges.

In line with the objectives of the present EU DWD and to address the problems identified above, the primary objective of this initiative will be **to ensure safe and affordable drinking water to all EU citizens** so as to **minimize potential health risks** in the **long term**

As compared to the current EU DWD, this (new) initiative will be more:

- **Efficient** in minimizing health risks, providing safe drinking water to a larger share of the EU population while providing sufficient adaptive capacity to address emerging contaminants, and related health risk that might arise due to the combination between contaminants;

- T**argeted to what really matters**, focusing on contaminants present in the aquatic environment and that present clear health risk;

- **Cost-effective and coherent with the wider EU water regulatory framework,** , favouring actions that address contamination at source, providing a coherent approach to the standardisation of materials in contact with drinking water, and modernising reporting to the EC so it delivers safe drinking water to all citizens at lower (regulatory, monitoring and action) costs while contributing to the achievement of the objectives of other EU water directives (in particular the WFD);

- **Transparent**, ensuring better information (the right information at the right time to the right person) is provided to drinking water consumer so they are: (1) informed in a timely manner of the performance of drinking water suppliers in delivering safe drinking water – and can act accordingly; and (2) can critically assess the actions taken to deliver safe drinking water that they have to pay via their water bill and influence water suppliers to operate more efficiently and lower their ecological footprint; (3) take voluntary actions to reduce their own water consumption and lower their environmental impact of drinking water consumption. In turn, this will increase drinking water consumers' trust in the quality of their drinking water.

The following figure summarises how these objectives, translated in operational terms, will contribute to addressing the problems identified above in the delivery of safe drinking water in Europe.

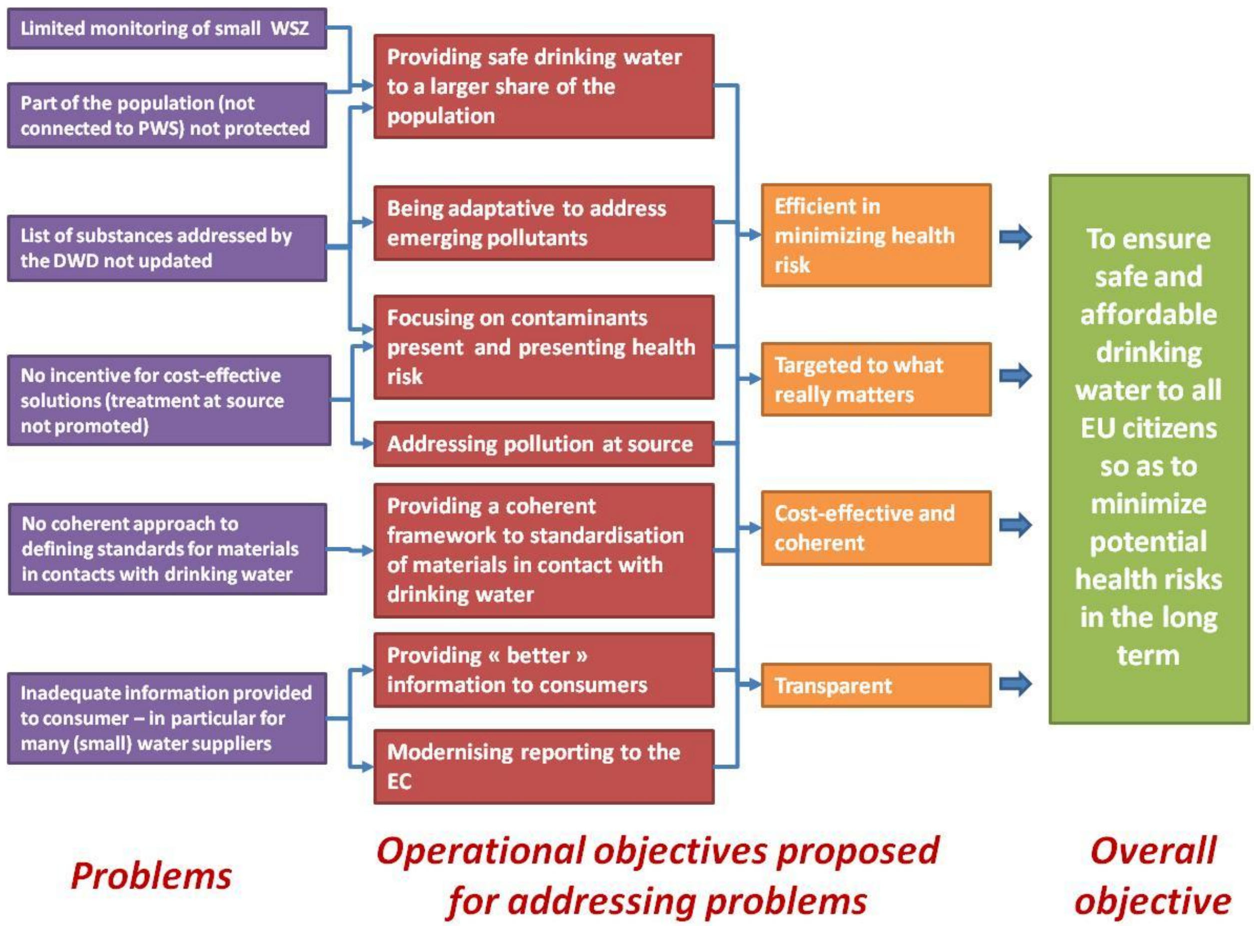


Figure 4. Defining overall and operational objectives for addressing problems

5 HOW WOULD THE PROBLEM EVOLVE? (BASELINE)

Many changes will take place in Europe between today and 2050, be it linked to climate change, general socio-economic development, the uptake of innovations, or migrations linked in particular to changes in the political situations of countries that are (geographically or economically) connected to the EU. Only some of these changes, however, will affect directly or indirectly the functioning of the "drinking water system" (see Figure 5 below) and thus the access to, and the delivery of, safe drinking water to EU populations.

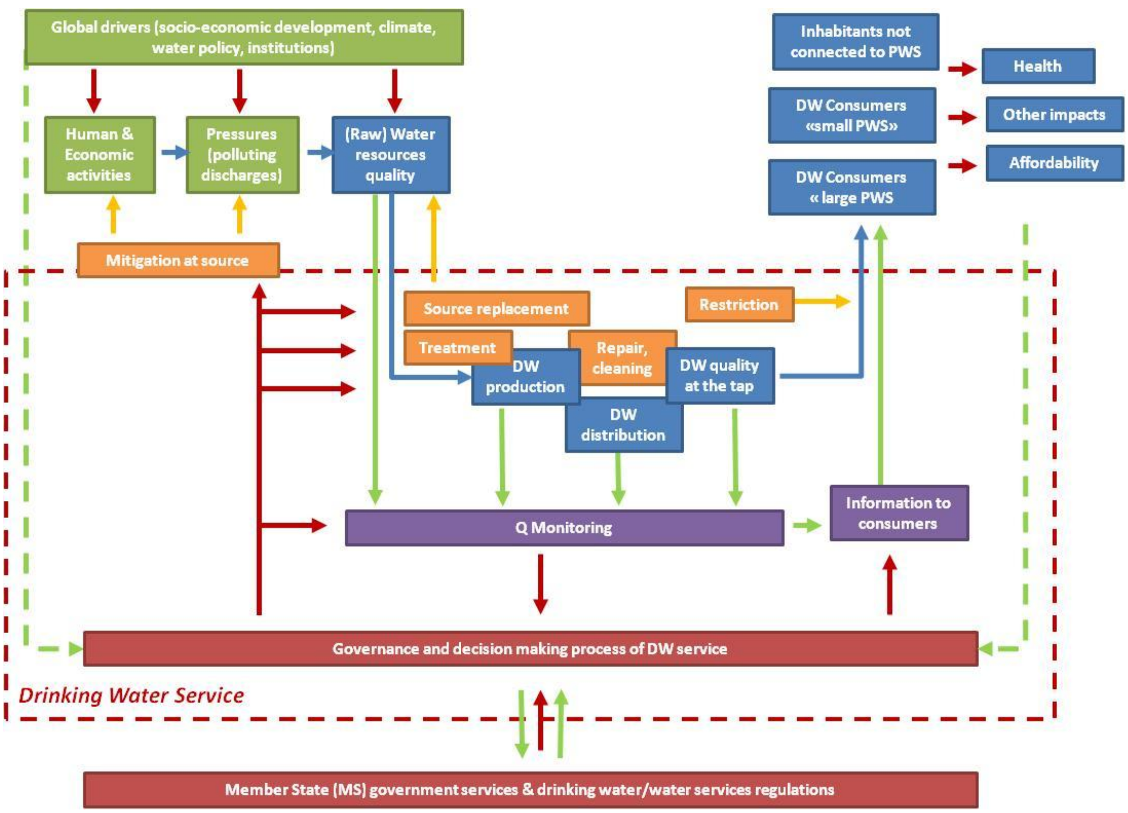


Figure 5. A schematic representation of the drinking water system

The following paragraphs describe the main changes that are expected in key parameters and variables affecting the drinking water system between now and 2050, the intermediary date of 2030 being described to better capture the dynamics of the system over time.

5.1. What are expected changes in key components of the drinking water system by 2050?

Expected changes in the quality of raw water resources

The quality of raw water resources in Europe will evolve based on changes in emissions of polluting substances and on the level of actions taken for addressing water quality issues, in particular in the context of the implementation of the EU WFD.

The **emission of emerging substances by the domestic sector** (the parameters of the list C[31]) is expected to could be approximated by the consumption of pharmaceuticals by the population. Indeed, pharmaceuticals contain chemicals that end-up in rivers and water bodies because the majority of existing waste water treatment processes do not treat such substances[32,33]. Because of too high costs (and their direct impacts on water tariffs and affordability issues), it is unlikely that the level of treatment will be significantly upgraded to deal with such substances, if no additional (policy) incentive is made. It is assumed that the pharmaceuticals consumption in the EU will follow the trend in the share of population above 65. The share of the population above 65 will increase from today's 19% of inhabitants (EU 28) up to 24% and 28% in 2030 and 2050, respectively[34]. As a consequence, while the current total pharmaceutical products consumption expenditure for the EU28 is equal to 9 030 PPS (Purchasing Power Standards)[35], pharmaceuticals consumption (and expenditure) is expected to increase by 31% by 2030 and by 57% by 2050 (reaching then 14 204 PPS).

There are many "basic measures" for addressing diffuse pollution and reducing polluting pressures from slurry, manure, livestock… that will be implemented in the context of the WFD and in line with the greening of the CAP. However, these improvements are expected to be counterbalanced by the effect of climate change and the intensification of agriculture in some rural areas (resulting partly from increase in temperature) that will lead to a **global increase of N losses to groundwater and surface water**. With an average for EU 28 of 13.9 kg N/ha in 2010, this ratio will increase up to 15.7 kg N/ha in 2030 and up to 18.1 kg N/ha in 2050, i.e. an increase of 30% by 2050[36].

Point source pollution in water bodies is mainly the fact of industrial activities. It is complex to predict the evolution of point source pollution by 2050. Many new compounds will be used by the industry in its

[31] Defined in the earlier section

[32] Following advances in the sensitivity of analytical methods for the measurement of these chemicals at very low concentrations, a number of studies found trace concentrations of pharmaceuticals in wastewater, various water sources and some drinking-waters. Concentrations in surface waters, groundwater and partially treated water were typically less than 0.1 µg/l (or 100 ng/l), whereas concentrations in treated water were generally below 0.05 µg/l (or 50 ng/l). These investigations suggested that pharmaceuticals are present, albeit at trace concentrations, in many water sources receiving wastewater effluents

[33] However, this depends on the substances. Some of the non-soluble substances are very well treated and other partially treated. With the improvement of the UWWTP treatments in Europe it will contribute to reduce the quantity discharges. See page 73 of this document: http://projetamperes.cemagref.fr/illustrations/63-77-SOULIER.pdf

[34] Eurostat - source

[35] Eurostat - source

[36] As a result of climate change and improved technology and farm management, crop yields will increase in 2050. To produce those higher yields more nitrogen fertilizers are required, which in turn result in higher losses. Assumption based on Wolf, J., A. Kanellopoulos, J. Kros, H. Webber, G. Zhao, W. Britz, G.J. Reinds, F. Ewert en W. de Vries, 2015. Combined analysis of climate, technological and price changes on future arable farming systems in Europe. Agricultural Systems 140, 56-73.

processes and for producing new materials. And these new compounds and related substances entering the environment (whether directly from the industrial plants, or indirectly from disposal including in the sewage system by consumers) with many of which being potentially harmful to human health (in the long term). It is for instance expected that the use of rare earth metals will grow, being essential for the production of advanced electronics equipment – mobile phones, tablets, batteries, plasma screens, as well as they form a part of the 'green' technology revolution as components in hybrid cars, wind turbines, etc. However, industrial emissions and industries economic growth will be more and more decoupled (but with large difference among MS[37]). As a result, it is assumed that point source pollution will remain stable in all MS by 2030 and 2050 as compared to 2015 (the increase of pollutants used by manufacturing industries being counterbalanced by the relative decoupling with environmental impacts).

The quality of fresh water body is expected to continue improving, as a result of the **implementation of the EU WFD**. The percentage of water bodies achieving good water status was expected to improve from 43% to 53% between 2009 and 2015. Following this trend, it is assumed that the chemical status of surface and ground water bodies will keep on improving by 10% by 2050 for all water bodies, and by 20% points for water bodies used as a source of drinking water by water suppliers which implemented RBA (as a result of the priority given to actions that treat water pollution at source)[38].

Expected changes in the management of drinking water services

The first main change that could the impact of drinking water management on the delivery of safe drinking water is the **increasing application of Risk-Based Assessments (RBA) in Europe** (see Boxes in section 6.1 for more information on RBA and water suppliers). Until October 2015 (when Directive 2015/1787 on the amended Annex II and III was adopted), there was no incentive in the DWD to adopt RBA for the water sector in the national regulations. However, some water suppliers had already taken step in implementing RBA and developing Water Safety Plans (WSP). Depending on the MS, the population is today partially, fully or not at all connected to water suppliers applying RBA. As the implementation of RBA and the creation of a WSP is a long and costly process, implementation is considered easier for large water suppliers as compared to smaller water suppliers.

Even without a new incentive at the EU level to implement RBA, **the number of water suppliers implementing RBA will likely continue to increase** with the combination of national (MS) and water suppliers' initiatives. It is assumed that large water suppliers are more inclined to voluntarily implement RBA rather than the smaller water suppliers. It is assumed that the percentage of population connected to water suppliers applying RBA for a given year (2030 or 2050) and a given MS is influenced by: the

[37] According to EEA, discharges of pollutants from point sources have decreased significantly over the past 30 years due to improved treatment of urban wastewater and reduced industrial discharges to water. In Western European countries, tertiary treatments are effective and Eastern European countries are following a similar development. However, pollution caused by inadequately treated wastewater is still an important source of pollution in some areas. Emissions of pollutants by industry have decreased since 1990, while the productive capacity of the industry sector — in terms of gross value added (GVA) — has increased. However, emissions from industry are not fully decoupled from economic activity: for most pollutants, there was a significant decrease in emissions in 2009 corresponding to the global economic downturn that year.

[38] Assumption made considering that improvement of fresh water bodies quality will continue but slower than during the previous years (10% or 20% in 35 years vs. 10% in 6 years in the past) because bodies that have not attain good status yet are those were more efforts need to be done and because the expected improvement of 10% during the 6 previous years was an expectation and not a reality.

relative importance of large and small water suppliers in the MS; and, the percentage of the population already connected to water suppliers applying RBA in 2015.

The following assumptions were made to estimate the population supplied by water suppliers with RBA in 2030 and 2050 in Baseline scenario[39]:

Table 2. Population supplied by water suppliers which implemented RBA

Population supplied by water suppliers which implemented RBA in …				
% of the MS population already supplied by water suppliers applying RBA in 2015	% of the MS population supplied by water suppliers applying RBA in 2030		% of MS population supplied by water suppliers applying RBA in 2050	
	Large water suppliers	Small water suppliers	Large water suppliers	Small water suppliers
0%	25%	0%	50%	25%
<50%	50%	25%	75%	50%
<90%	75%	50%	90%	75%
>90%	95%	95%	95%	95%

Example to read this table: if in 2015 in a given MS, 48% of the population if supplied by water suppliers applying an RBA (detail of percentage applying RBA among large and small water suppliers is not available for 2015 data), we will assume in baseline that by 2050, 75% of large water suppliers will have adopt a RBA and 50% of small water suppliers (share of water services between large and small water suppliers is available and trends have been estimated by 2050).

Here it is assumed that in the MS were compulsory RBA implementation has been adopted and translated into national legislation and all population is covered by water suppliers who implement RBA this coverage will remain the same in 2030 and 2050. In the other case, where there is only partial implementation of RBA / or none[40], we assume that a higher percentage of large water suppliers will have implemented RBA 2050 than small water suppliers, resulting in 2050 to 50-90% for large suppliers and 25-75% of small water suppliers.

A trend towards an **optimization of monitoring and data management** currently exists and will continue in the future, either on the own initiative of water suppliers, or pushed by Member States themselves. As a consequence, it will be easier for water suppliers to provide **up-to-date information on water quality in a timely manner to consumers** (thanks to the use of smart phone apps in particular) or to a regional/national database that will make it available to consumers. This information diffusion is easier to implement for large water suppliers and it will benefit from the widening use of information technologies, social media and connected appliances. It is assumed that an additional 20% of the population supplied by large water suppliers in 2050 will also profit from access to smart- information on water quality. The information, however, will be mainly limited to quality parameters. Despite the technological improvements leading to better access to information by consumers, reporting to the EC,

[39] Those assumptions were made based on the collective expertise and knowledge of the context of the authors of this report.
[40] Answers given by MS corresponds to the question “Is RBA implemented at a national scale?” were chosen between No / Partially / Fully.

which is often pointed out as a constraining and time-consuming process for MS, will continue to take place as under the current DWD (same reporting obligations and format).

With regards to the **standards for materials and products in contact with drinking water**, the current situation with MS developing different standards that are difficult to harmonize will continue. Even if some MS are working together towards the harmonization of their approval systems (e.g. NL, DE, FR and UK), it seems too complex to assume that this effort will be expanded in the next decades if no new regulation is introduced in DWD. So it has been assumed, that no new member states would change their regulation on standards for materials and products in contact with drinking water by 2050.

It is important to stress that many changes might take place in the management of drinking water services, **independently of the implementation of the DWD and of drinking water issues**.

- Because of the aging of the drinking water infrastructure, some basic efforts will be made by drinking water suppliers to replace old pipes and infrastructure. Additional efforts in replacing aging infrastructure will take place for water suppliers implementing RBA when aging infrastructure is found to be the main source of pollution and health risk. However, it is expected that most efforts for replacing aging infrastructure will be taken on the basis of water losses and (resource – water and energy) efficiency.

- Also, dual water supply systems, with high potable water and lower-quality/grey water, will be more commonly used in new developments and in urban regeneration projects. And new optimal ways of using low-quality local sources such as rainwater, grey-water or water contained in Sustainable Urban Drainage Systems (SUDS) will be developed by water service operators. This trend will be driven partly by energy efficiency/CO2 emission reduction objectives: to make a large reduction in carbon use associated with water, it will be necessary to lower the quality of water used for non-potable applications. Some water service operators will then treat water to a lower "general use" quality (lowering their energy use and CO2 emissions) combined to additional "end of tap" treatment (at household or group of households levels) that will ensure high drinking water quality for potable water use.

However, it is assumed that both changes will not affect in the long-term the delivery of safe cleaning water to water consumers.

Expected changes in population: total population and population connected to PWS

The 2015 **EU28 population** (equal to 508.2 million inhabitants) will grow to 518.5 million people and to 525.5 million people by 2030 and 2050, respectively[41]. Although the EU-28 population is expected to increase, some MS will see their population decrease by 2050.

It is assumed that rural exodus will continue in the coming decades but at a slightly lower rate as in recent years to account for the renewal of some rural areas. Today, 43% of the **population is living in urban areas** and 35% in intermediate areas close to urban centers, the remaining living in rural areas –

[41] Eurostat

with differences in the relative importance of rural population being significant between MS. By 2050, 86% of the European inhabitants will live in urban or intermediate areas[42]. The population will become older on average, with the number of inhabitants above 65 increasing from 19% to 24% and 28% by 2030 and 2050, respectively.

The percentage of **inhabitants connected to PWS** is not expected to change over time over the next decades. Overall, 96% of the population is connected today to PWS networks, with connection rates among MS ranging from 57% (Romania) to 100% (Belgium, the Netherlands and the United-Kingdom). And this proportion of the population connected to PWS is expected to be stable over time because of: (1) their living conditions life that does not allow a connection to PWS (homeless and itinerant population); (2) the (isolated) location of their home that would imply too high connection costs[43]. Combining a stable percentage of the population connected to PWS with the increase in the total population, the total number of inhabitants connected to PWS (as well as the number of inhabitants not connected to PWS) is expected to increase in EU28.

People connected to PWS are supplied by **large water suppliers**[44] or **small water suppliers**[45]. Large water suppliers mainly manage larger urban areas (or areas with high population densities), while rural areas are mainly supplied by small water suppliers. In 2015, 80% of the total population is supplied by large water suppliers[46]. It is assumed that the share of population connected to large water suppliers will increase in each MS along the increase of population living in urban and intermediate areas, resulting in a population supplied by large water suppliers estimated equal to 86% in 2050. Note that the source of water for population connected to PWS is expected to remain constant as compared to today situation (i.e. 58% of the EU 28 population connected to PWS supplied by water abstracted from groundwater sources)[47].

Population not connected to PWS is mainly composed of homeless people, nomads and travelers and people living in remote rural areas, the relative importance of each category being different proportions in individual MS. People in rural areas are often equipped with wells or cisterns that allow them to have access to water with its quality depending on the quality of the freshwater resource they use. Among the other categories of people not connected to PWS, some categories could also benefit from an access to drinking water from PWS, as a result of their access to public water points or because of their (temporary) stay at public accommodations (homeless people for example). It is assumed that 50% of people not connected to PWS are already equipped with alternative water supply devices. Some MS

[42] Forecast on percentage of increase of population in urban and intermediate areas from UN 2014 ESA report.

[43] The authors of the report are aware that this assumption could seem a bit strong for some MS, e.g. Romania where the current connection rate to PWS is rather low with 57% of inhabitants supplied by water networks. However, the development of assumptions MS by MS would have been a too complex process regarding that several parameters could influence the extension of a PWS network in a given country. For this reason, the authors made the choice to set one assumption for all MS - which in the case of an ex-ante assessment, that is not a prediction exercise, seems a valid approach.

[44] According to definition in DWD, large water supplies are those supplying more than 1,000 m³ drinking water per day as an average or serving more than 5,000 persons.

[45] Small water supplies supply less than 1,000 m³ drinking water per day. Small water supply zones can be subdivided into two more categories: category 1 supplying less than 100m³/day; and category 2 supplying 100m³ to 1000m³/day. Individual supply providing less than 10 m³ a day as an average or serving fewer than 50 persons, unless the water is supplied as part of a commercial or public activity are considered apart and exempted from the provisions of DWD.

[46] From the DWD technical reports by each MS.

[47] Eurostat

have also specific regulations to guarantee to those not connected people an access to safe drinking water. Belgium, France[48], Ireland, Italy, Spain and United Kingdom have a regulation specifying that "specific measures in the water sector are taken in favor of vulnerable groups such as travelers (gypsies and others), minorities (indigenous peoples, first peoples, etc.), illegal immigrants, and the homeless"[49]. Available information shows that the measures required for ensuring safe drinking water to these populations are not always effective. But there is no data on the share of people not connected to PWS with access to wholesome drinking water. It is assumed that this situation will continue to exist in the future, with no new MS adopting specific regulation to give the right to the access to safe drinking water to its entire population and to currently non-connected inhabitants.

Expected changes in the behaviour of drinking water consumers

As indicated above, water suppliers are expected to provide up-to-date information on water quality in a timely manner to consumers, as a result of the wider use of information technologies, social media and connected appliances. Along with the access to smart-information on water quality and water tariffs, consumers may be willing to have the possibility / the power to influence water suppliers' decisions that determine drinking water quality (treatments or measures at source). As it is assumed that information to consumers will remain restricted to water quality information, no change in the influence of drinking water consumers on drinking water operators and on their decisions is expected in the baseline scenario.

In parallel to the information technology change, the overall awareness of population on environmental concerns is expected to continue to increase. It is assumed that the purchase of bottled-water will decrease as: (1) the overall awareness of population on environmental concerns (including on plastics/microplastics and their impacts on ecosystems) will continue to increase; and, (2) because the information on drinking water quality will become more updated, timely and transparent. As a consequence, the confidence of consumers towards tap water will improve, with more consumers deciding to drink tap water versus bottled-water. The average consumption of bottled-water in EU28 will decrease from 106 litres per capita and per year today[50] to 100 l/capita/year in 2050[51]).

Expected changes in actions and measures aimed at providing safe drinking water to consumers

Overall, water suppliers who do not implement RBA and develop WSP will continue to **monitor the parameters from the list established in Annex I** of the current DWD, applying the same limit values. Water suppliers implementing RBA will adapt their monitoring slightly, adding parameters that have been identified as source of problems in the RBA or deciding to stop the monitoring of other parameters

[48] For example in France "Since 1990 all sizable municipalities (of more than 5,000 inhabitants) have to provide parking areas for camping cars and caravans of nomads and to provide water and toilets in these areas" (Law N°2000-614 of 5 July 2000 pertaining to the reception and accommodation of travelers. Decree N°2001569)

[49] References:

- Henri Smets. Implementing the right to water in France. Paper prepared for the workshop entitled 'Legal Aspects of Water Sector Reforms' to be organized in Geneva from 20 to 21 April 2007.
- Académie de l'eau, 2011. Le droit à l'eau potable et à l'assainissement, sa mise en œuvre en Europe. Rapport préparé pour le 6ème Forum Mondial de l'Eau, Marseille, 2012.
- Email exchange with Henri Smets.

[50] UNESDA

[51] Based on the current trend of a slow decrease in bottled water consumption - Unesda data).

that are not present in their catchments. For large water suppliers, the adoption of a RBA generally leads to a small reduction of monitoring effort/cost, mainly because of an improvement of monitoring process[52]. This reduction is estimated at 5% of the costs of monitoring before RBA implementation. As technologies for monitoring new pollutants take time to develop and might be expensive during some period, it is assumed that monitoring technology will not drastically change over time. This implies that pollution by emerging pollutants in areas with intensive economic activity (agriculture, industry) and population density will take time to be identified, posing potential health risk to local population.

As a result of the implementation of the WFD, the increase application of RBA and the increasing size of drinking water service operators, it is expected that efforts will be made to implement actions that reduce or suppress pollution at source (i.e. measures that promote farm practices with no or limited use of inputs). This in turn will reduce the reliance on drinking water treatment. It is assumed that water suppliers will replace 5% and 10% of their current treatments (costs) by measures addressing pollution at source for those not implementing RBA and for those implementing RBA, respectively[53]. The positive effect of implementing measures addressing pollution at source on raw water quality (especially for groundwater) is delayed in time after the adoption of these measures. However, it is considered that if measures addressing pollution at source are adopted from 2020, effects would be effective in 2030 - and similarly for 2050. With regards to the level of water treatment, parameters and limit values to comply with will remain unchanged (or slightly adapted for water suppliers with RBA as indicated above). As a result, treatment required for any given quality of (raw) freshwater during the process of drinking water production will remain unchanged (including for water suppliers applying RBA, as some pollutants will be replaced by others).

In case of incident/accidental pollution, water services have to react quickly to reestablish a wholesome water quality and limit health impacts. As Water Safety Plans anticipate the risk of accidental pollution, and thus organize the intervention program in case of incident, it is expected that water suppliers implementing RBA will react faster with more efficient reaction in case of an accidental pollution of water resources used for drinking water production. Also, water suppliers and water authorities will be able to inform consumers more rapidly in case of an accidental pollution of tap water because of better information technology. As a consequence, consumers will stop drinking tap water and thus limit risk of sickness under the baseline scenario.

In summary

The following table summarizes qualitatively the main changes in key variables and factors that are expected to influence the achievement and performance of the EU DWD in the future.

[52] WHO report

[53] Those assumptions were made based on the collective expertise and knowledge of the context of the authors of this report. In an impacts analyse approach, different from a prediction exercise, this seems a valid assumption.

Table 3. Summarizing trends in key components of the drinking water system

Key factors	Current situation (2015)	Likely future trends in drivers and factors expected to affect the challenge/outcome	Resulting challenge or outcome by 2050
Quality of water resources	Water quality problematic for many water bodies in Europe for a wide range of pollutants	Increasing pollution from all sources, including domestic sources (pharmaceuticals). Efforts made for addressing pollution in the context of the WFD and also as a result of (local) actions for mitigating pollution at source.	Water quality improved, but remain problematic in many water bodies.
Application of RBA and development of water safety plans	The Annex I list of the DWD has not been updated. Thus, some new substances that can cause health risk are not covered. And there is no mechanism for addressing emerging substances. To address this issue, RBA and the establishment of WSP is applied in some MS and by large water suppliers.	Progressive uptake of RBA by water suppliers as MS progressively adapt their own national regulation. But progress is slow and it takes 35 years for seen wide application. Consolidation of water supply operators contributes to accelerating the adoption process of RBA.	Population connected to water suppliers applying RBA is better protected because of the possibility to address substances of emerging concern.
Information to consumers and citizens	Information to consumers and citizens is of inadequate quality and not timely. There are first experiences in using social media/apps/modern information technology by large water suppliers to share timely information with their customers. But these remain limited. Overall, confidence of customers in drinking water quality is low.	Widening use of information technologies/social media/connected appliances in all parts of society. Additional information efforts made by large water suppliers. But information provided to customers remains limited to water quality parameters.	Timely and better information provided to customers of drinking (mainly large) water companies in.
Reporting to the EC	Reporting in line with the obligations of the DWD, with some challenges in the use of the information as monitoring remains problematic for small water supply zones.	No change expected in reporting to the EC apart for some improvements in the quality of monitoring data from small water supply zones.	Slight improvement in the quality of reporting to the EC.
Contamination from materials in contact with drinking water	No common approach to materials in contact with drinking water in Europe => different protocols put in place in some MS leading to high costs to industry producing materials.	Increasing number of materials and products, no harmonized approach developed on the basis of MS initiatives, despite efforts of some MS	No change in the challenge
Population connected/not connected to PWS	Challenges in ensuring adequate monitoring water quality in small water supply zones. No specific regulation for ensuring safe drinking water to not-connected people, apart for a limited number of MS.	Continued population increase, with migration to urban areas leading to a reduction in the population leaving in small settlements connected to small water supply zones. "Consolidation" of drinking water services with better management of existing services – in particular when large agglomerations having the capacity to "control" quality for large catchments. Percentage of non-connected inhabitants expected to remain constant with no additional regulation proposed for addressing safe drinking water issues for them.	Problem of quality of drinking water in small settlements (remote and rural areas) decreasing but remaining an issue. Supply of safe drinking water to non-connected people remaining similar as today.
Behaviour of drinking water consumers	Low confidence in the quality of tap water, resulting in purchase of bottled water for many inhabitants. Limited influence in the management of water supply operators.	Better information on water quality, combined with increasing awareness on environmental issues will lead to better confidence in the quality of tap water and to reduced purchases of bottled water. As information provided to consumers remain limited to drinking water quality, the role of consumers in influencing the management of water operators is not expected to change.	Increase use of tap water connected consumers.
Monitoring of water quality parameters	The directive's parameter list is not up-to-date. And there is no capacity to consider and address new and emerging pollutants apart in areas where RBA is already implemented and for countries that have mechanisms for adapting their parameter lists. There are problems with the quality of monitoring in small	No changes in monitoring technologies or very marginally, nor of monitoring costs. Expected improvements in monitoring in small water supply zones as a result of recent amendment in the directive, but frequency of monitoring considered too low for ensuring monitoring capture all water quality issues effectively.	Marginal change in monitoring (strategy, costs) with improvements in the quality of monitoring in small water supply zones=> slight contribution to reducing health risks in

Key factors	Current situation (2015)	Likely future trends in drivers and factors expected to affect the challenge/outcome	Resulting challenge or outcome by 2050
	water supply zones.		these areas.
Measures for addressing pollution	Large reliance on "treatment" technologies for ensuring safe drinking water quality at tap. Treatment at source, in particular when agriculture responsible for pollution, remains limited – despite regulatory framework, financial incentives and the willingness of some local authorities/water suppliers.	Further application of cost-effectiveness analysis as part of the WFD and increasing number of MS making RBA mandatory, combined with an increasing number of large water suppliers as a result of consolidation, Wider application of RBA.	Larger application of cost-effective measures for treating pollution at source Faster and more effective reaction to accidental pollution for areas with RBA.

5.2. How do these changes affect the delivery of safe drinking water to EU citizens by 2050?

The trends expected under the baseline scenario will affect the performance of EU drinking water policy, particularly in regards of the achievement of its "health" objective, responses to consumers' and citizens' demands, and cost-effectiveness in achieving set objectives. Table 4 summarises the main differences between the actual situation and the baseline (2050) for key parameters that affect the population potentially at health risk (PPHR indicator), as well as the costs of delivering the obligations of the current DWD[54].

Table 4. Summary of the main elements of 2015 and baseline 2050[55]

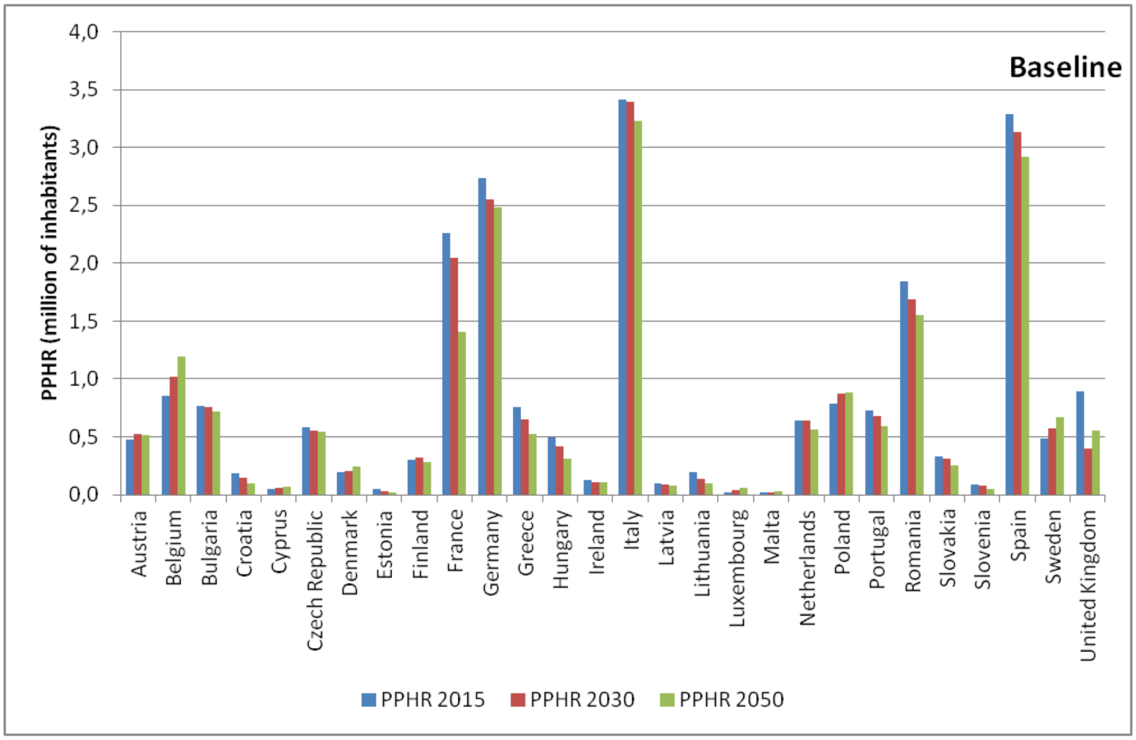
Characteristics of demography and pressures on water resources	Current situation (2015)	Baseline (2050) & all POs (2050)
Demography	508.2 millions of inhabitants (Eurostat)	525.5 millions of inhabitants, - decreasing in some MS (Eurostat)
Distribution of population between urban / rural areas	43% in urban areas; 35% in intermediate areas; 22% in rural areas (Eurostat)	47% in urban areas; 38% in intermediate areas; 15% in rural areas (UN trends)
Population above 65	19% (Eurostat)	28% (Eurostat)
Pharmaceuticals products consumption expenditure	9 030 PPS (Eurostat)	14 204 PPS (increase proportional to the number of inhabitants above 65)
N losses to surface and ground water	13.9 kg N/ha (Eurostat)	18.1 kg N/ha (Wolf et al., 2015)
Surface water bodies subject to point source pollution	37.5% (Waterbase, EEA) - with large disparities between MS	37.5% (stable, as decoupling of industrial emissions and economic growth)
Percentage of PWS water coming from groundwater sources	58% (Eurostat)	58% (stable)
Average consumption of drinking water per person (tap + bottles)	3 950 liters per year and per person (Eurostat, Unesda)	3 950 l/y/p (stable)
Large water suppliers (among population connected to PWS)	80% of the EU28 population (Eurostat)	86% of the EU28 population (increase proportionally to the population in urban and intermediate areas)

[54] All assumptions made in for estimating the changes in the PPHR and cost indicators are summarized again in the assumptions tables presented in section 6.2, and further described in annexes of the present report.

[55] All assumptions made in the Baseline are summarized again in section 6.2, and are described in details in annexes.

Expected impacts on health risk

As indicated above, the PPHR indicator in 2015 is estimated at 22,7 million people potentially at health risk. Using the Excel-based PPHR model accounting for the assumptions made for the changes in key parameters by 2050, the number of people potentially at health risk is expected to decrease in 2050. However, as a result of the EU population increase, the number of people that might face potential health risks will remain important: overall **20 million of people** will remain potentially at health risk to (drinking) water quality problems, equivalent to 4% of EU 28 population in 2050. Furthermore (see Figure 6), while the large majority of MS will see their situation improved in terms of the PPHR indicator, some MS will record marginal improvements, no improvement or even a /degradation of their health risk situation (e.g. Bulgaria, Greece, Lithuania…), a group of MS which Gross Development Product (GDP) is among the lowest in Europe. In relative terms, all MS are expected to record decrease in the percentage of inhabitants potentially facing the risk of drinking water supplied from water resources with inadequate water quality.



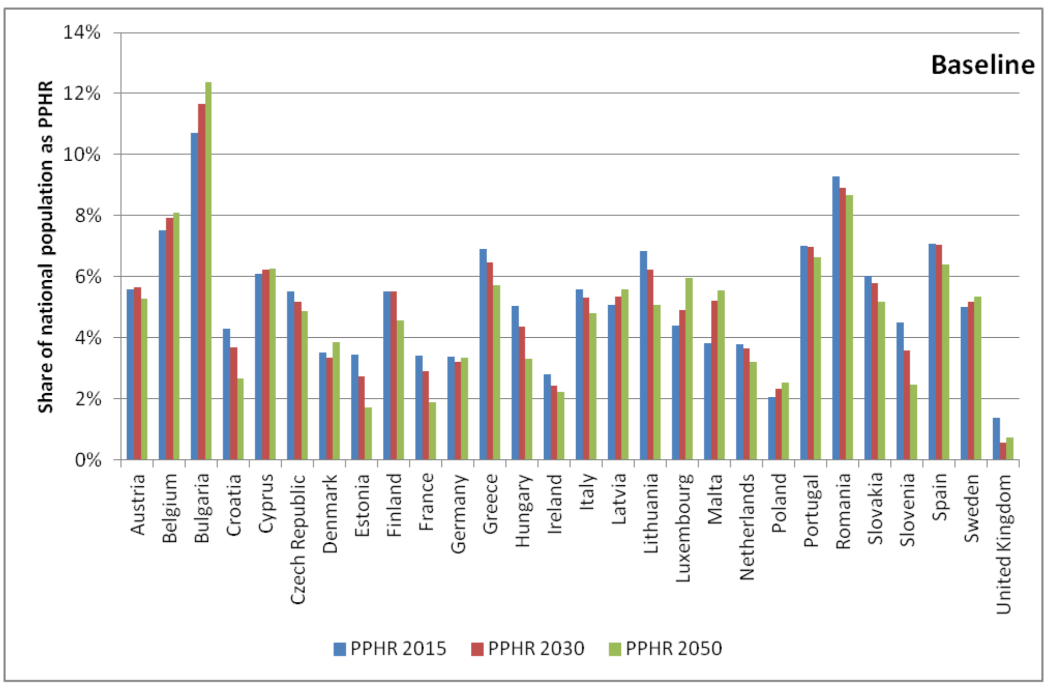
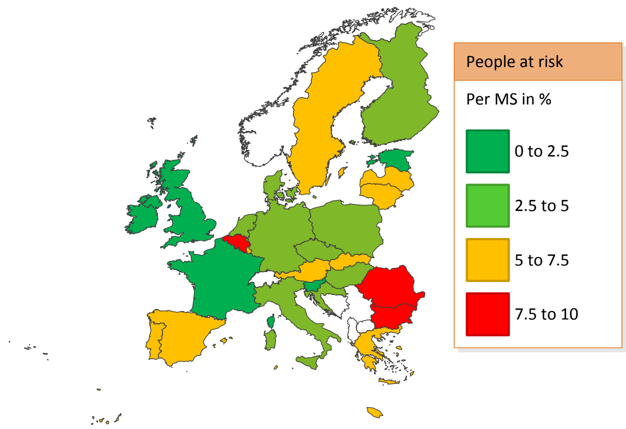


Figure 6. Expected trend in the Population Potentially at Drinking Water Health Risk (in absolute and relative terms, 2015, 2030 and 2050)

In the baseline (Map 1), the three most affected countries regarding the share of their national population potentially exposed to potential health risk related to drinking water are Bulgaria (12%), Romania (9%) and Belgium (8%). But in terms of number of inhabitants facing a potential health risk those countries do not represent the highest results - more inhabitants are concerned in Italy, Spain and Germany (with more than 8.6 million inhabitants as PPHR summed up in those 3 MS). At the opposite, Estonia, France, Ireland, Slovenia and United Kingdom have PPHR representing less than 2% of their national population.

Map 1. PPHR in baseline 2050 per MS (in % of the national population)



Expected impacts on costs

In general terms, the **cost-effectiveness in achieving the set objectives of the current DWD** will improve in the longer term in as a result of the progressive application of RBA and the development of WSP. Indeed, these will ensure more targeted monitoring and support the selection of (more cost-effective) measures that address pollution at source. However, it will take 35 years for such changes to take place – a very long time scale as compared to the need to address drinking water challenges today!

Specific assessments were made for estimating the specific costs linked to the drinking water sector and thus to the DWD - either operating costs (monitor and treatment of drinking water, reporting to EC…), investment/setting-up costs annualized (voluntary application of a RBA by some operators, voluntary development of information systems on water quality…), bottled-water purchase costs. It is important to stress that all operating costs of water services are not impacted by the DWD, a specific "other operating costs" category being created for stressing the presence of operating costs not affected by baseline assumptions: it is assumed that these other operating costs evolve proportionally to the population increase/decrease in each MS[56].

[56] Total operating costs of water services by member state available in the *ex-post* assessment report.

Table 5. Expected trends over time of the implementation costs of the current DWD (2015, 2030 and 2050)

Costs (M€)	Costs 2015	Costs 2030	Costs 2050
Cost of monitoring (M€/yr)	1 574	1 560	1 481
Cost of treatments (M€/yr)	8 327	8 103	8 190
Cost of measures at source (M€/yr)	0*	46	54
Cost of information and reporting (M€/yr)	4	5	5
Other costs impacted (M€/yr)	0	0	0
Total operating costs (M€/yr)	46 261	47 085	47 892
Setting-Up costs (M€)	0,0	5,6	19,6
Setting-Up costs (M€/yr)	0,0	0,6	2,0
Cost of bottled water purchase (M€/yr)	5 371	5 345	5 254

*Measures at source are considered to be '0' in 2015 because no data was available. This has insignificant effect on our analysis, as the costs in the impacts assessment will focus on the difference with baseline 2050 and not 2015.

The figures presented in this table require some explanations:

- The costs of monitoring are expected to decrease from 2015 to 2030 and 2050 as a result of the wider RBA voluntary application by MS and/or water services in the baseline scenario, combined with lower unitary monitoring cost (expressed in euros by person connected to PWS) for large water suppliers which apply RBA as compared to large water suppliers which do not[57].

- The costs of treatments are expected to decrease by 2030 and then to increase again by 2050 because of the combination of two trends: (1) the substitution of some curative treatments during the process of potabilization by actions addressing pollution at source (preventive measures) that is expected to continue leading to a reduction of the unitary treatment costs by 10% for water suppliers that apply RBA and by 5% for water suppliers which do not apply a RBA. This results in a decreasing global trend in the unitary treatment cost; (2) the regular increase in the EU28 population from 2015 to 2030 to 2050. Overall, the reduction of the mean unitary treatment cost between 2030 and 2050 thanks to the voluntary adoption of RBA does not compensate for the increase in population connected to PWS as it does between 2015 and 2030.

[57] According to WHO report on RBA and Water Safety Plan.

6. WHAT ARE POLICY OPTIONS THAT CAN CONTRIBUTE TO THE ACHIEVEMENT OF PROPOSED OBJECTIVES?

To address the problems identified and contribute to the achievements of the objectives set above different Policy Options (PO) have been identified building on the contributions from stakeholders during the different consultation workshops organised by the EC to support the revision of the DWD. These initial options were pre-screened with 5 policy options and 12 sub-options (see figure below), 9 of them been then selected for further Impact Assessment (IA).

The different PO are presented and described in the following templates, the assumptions specifying the implication of each PO for the different parameters that will impact in particular health risk (the PPHR indicator), costs, water tariffs and affordability issues... being presented in the following 3 tables[58]. The following figure summarises out the proposed Policy Options contribute to the achievement of the operational objectives specified above, stressing in particular the possible contribution of individual options (and sub-options) to more than one operational objective.

[58] Note that some differences in the implementation of the options (for example difference in implementation (costs) for the options 2.1 and 2.2 targeting small and large water suppliers, or the costs of automated reporting to the EC, are taken in account (and shown in the economic part of the Analysis of impacts part), but are not considered in the full Impact Assessment.

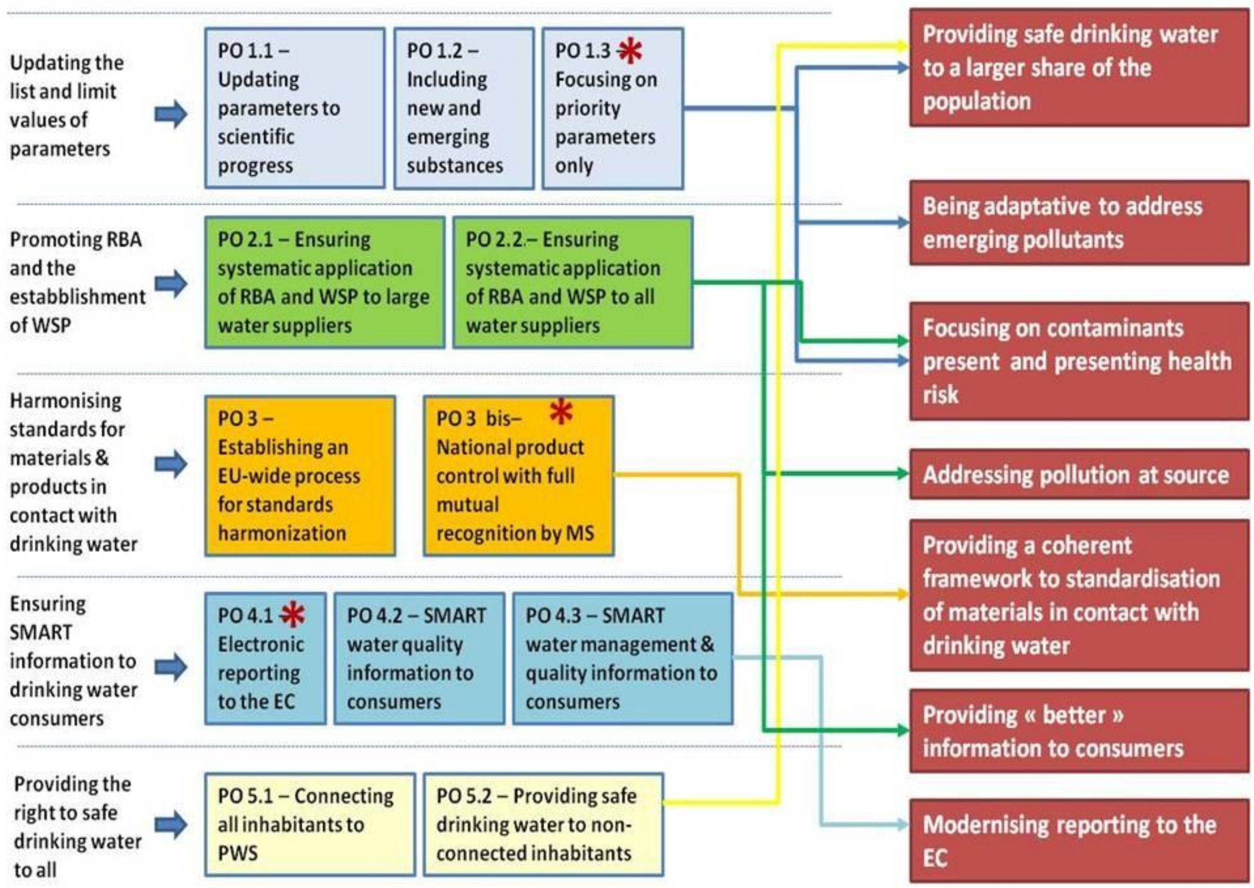


Figure 7. The Policy Options and sub-options proposed for addressing proposed operational objectives

When looking at the baseline scenario and to well capture the implications of the Policy Options described below descriptions, two concepts need more particular attention as they are common to the baseline and to all proposed Policy Options: (1) the Risk Based Approach and its related process; (2) the water supply zones and the water suppliers and their respective meanings. These two concepts are explained in the following boxes as preparatory information to the understanding of the Policy Options' descriptions that follows.

Box 3. Risk based approach and Water Safety Plan

According to Guidelines for Drinking-water Quality by WHO *(2004), "the most cost-effective and protective means of consistently assuring a supply of acceptable drinking-water is the application of some form of risk management based on sound science and supported by appropriate monitoring... It is important that risk management is inclusive and, therefore, needs to cover the whole system from catchment to consumer." In its guide "Water Safety Plan: Managing drinking-water quality from catchment", WHO (2005) give this introduction to the risk based approach or risk management process in water services. The approach proposed by WHO is largely based upon HACCP (Hazard Analysis and Critical Control Point). "The principles of HACCP (which is a preventive risk management system that has been used in the food manufacturing industry for a number of decades) are based on developing an understanding of the system, prioritising risks and ensuring that appropriate control measures are in place to reduce risks to an acceptable level...The experience of the application of HACCP by water utilities has informed the development of the water safety plan approach."*

Still according to this document, "the objectives of a water safety plan are to ensure safe drinking-water through good water supply practice, that is: to prevent contamination of source waters; to treat the water to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets; and to prevent re-contamination during storage, distribution and handling of drinking-water." Also, the RBA approach considers much wider and enhanced cooperation of all stakeholders.

For more details on the development and implementation of water safety plans to be used by the water supplier, please refer to the document that provides guidance on how water safety plans can be developed for a range of water supply types. This document stresses also the importance of stakeholder mobilisation for supporting the risk-based approach and the development of water safety plans. It is important to stress that the RBA implies obligations and actions for the water supplier, but also for the MS authorities that need to review and approve RBAs/WSPs, (e.g. via a national or regional WSP committee or programme) and ensure the link to the WFD, agriculture, urban planning etc..

Often the control of water sources/catchment measures is under different responsibilities and linked to WFD Article 7, what predominantly should remain with the MS, but that in WHO terminology the utilities play the most important role, and in one of the policy options (option 2- on RBA) it is considered that the Directive may require to address operators/suppliers directly, and that they get the responsibility for applying the RBA/WSP.

Box 4. Water Supply Zones (WSZ) and water suppliers

In the current Drinking Water Directive, obligations are relied on and at the scale of Water Supply Zones (WSZ). A supply zone is a geographically defined area within which water intended for human consumption comes from one or more sources and within which water quality may be considered as being approximately uniform (source: DWD). However, in this context it is complex to clearly identify who (or which organism) is responsible of implementing regulations or potential changes in DWD. Indeed, generally a large water supply zone is managed by one water supplier[59], but a small water supply zone can be either managed by one small water supplier or by a large water supplier that would manage several small WSZ under his control. To simplify those aspects and to allow us to describe the feasibility of the proposed policy options, the present report consider mainly drinking water management and quality at the scale of water supplier's perimeter and thus the water supplier is indicated as the body in charge of implementing new regulations or new treatments - even though in concerned MS, the municipalities or the MS is still the competent authorities to guarantee that laws and regulations are respected. This switch from a text based on water supply zones management (current DWD) to a text based on water suppliers is an important change in the conception of the Directive and would need further development during the writing of any future regulatory text. Note that although there is some uncertainty in the links between WSZ and water suppliers, it is expected that the current WSZ figures provide a reliable proxy to the population of water suppliers[60].

6.1. Description of the individual policy options

Policy Option 1: Updated list of parameters

Why this option?

Where does this option stem from and why did exactly this option emerge?

The EU DWD defines the minimum requirements of the sanitary quality of drinking water within the EU.

[59] Companies (private or public) in charge of drinking water supply for general domestic use (those companies can also be responsible of sewerage management) in an agreed geographical region, and in most MS under the delegation of a public service authority (municipality, etc.). Synonym is Water operator.

[60] This aspect can be further investigated in sensitivity analysis.

The directive lists 48 microbiological and chemical parameters in its Annex I, which should be monitored regularly and gives parametric values to comply with in drinking water for each parameter monitored. The limit values listed in the directive are generally based on the guidelines of World Health Organization [WHO 2004]. EU MS must adhere to at least the same demands and recommendations as in the directive but they can also set additional national regulations. Even though compliance rates are today rather high (more than 95% in all MS), there is a risk that some harmful substances that are not monitored pose health risks for population. The current directive has been reviewed regularly and plans to update parameters and limit values based on technical progress every 5 years. But this has never been done since the adoption of the DWD and the start of its implementation. *Ex-post* evaluation study of the current directive noted a general agreement among MS respondents contacted to amend the list of parameters of Annex I in line with latest scientific and technical developments and evidence. There is in particular agreement that substances used in consumer products, pharmaceuticals and endocrine disrupting substances should be included. Additional parameters that are currently discussed as posing risks to human health include chromiumVI, perfluorinated substances and nanoparticles. Moreover a study is currently conducted by the WHO on the update of the parameters in DWD, and at the end it should propose a list of substances to remove and to add to the regulatory list in DWD.

Short description of the option

This option will address the problem raised above by amending Annex I of the directive. There are 3 sub-options that have been proposed and defined via desk research and consultations with the stakeholders. These represent different levels of ambition concerning substances to monitor and parametric values to comply with. This option does not include any modification of the directive on the incitation/obligation to apply RBA.

What is the purpose of this option for IA?

Analyzing this option in IA allows assessing whether a longer/updated list of parameters or some lower parametric values to comply with would bring additional benefits.

During the Stakeholder workshop this option and its sub-options were chosen to be a priority for proposed revision.

Description of sub-options and their assumptions:

Sub-Option 1.1: Update of the parameters in Annex I according to scientific progress and following recommendations of WHO

This sub-option will consist in an update of the Annex I based on scientific and technical progress. This update would lead to the removal of some substances that are outdated (ie that do not represent a source of contamination with potential health effects anymore), and the addition of the most priority substances that are considered of emerging concern regarding their potential harmful health effects. Parametric values for those new substances would be settled according to WHO guidelines. The parametric values for substances that are already included in annex I would stay unchanged (including pesticides for which the threshold level remains at 0.1 microgram/liter). This theoretical updated list of parameters to monitor and to comply with has been called **list B**. It is assumed, however, that the total number of substances to be monitored would remain more or less stable (i.e. around 48). The upcoming study of the WHO on the subject will bring more details and suggestions on the content of this theoretical list B.

Main assumptions

- **Parameters**: around 48 parameters to monitor and to comply with in drinking water, corresponding to list B - defined as an update of the current list in annex I according to scientific and technical progress.

- This sub-option would require **some investments to equip monitoring labs and treatment facilities for making water potable,** with new technologies machines in order to be able to monitor and treat the new substances added to annex I list.
- This sub-option would require the **application of more treatments** on water during the potabilization process as compared to baseline (+5% in annual treatment costs[61]).
- It would lead to a **change in the drinking water quality** as some more parameters will be monitored and taken into consideration:
  - We assumed that contamination by new list B substances above defined parametric values would be reduced as compared to baseline as those substances would be regulatory monitored and treated - contamination rates would be equal to list A non-compliance rates during the previous period[62]. We also assumed that water suppliers which apply a RBA would even more reduce this contamination, consistently with the assumptions in baseline (i.e. that contamination rates are twice lower for water suppliers which apply RBA as compared to those which do not apply RBA.
  - We assumed that contamination of drinking water by list A substances and by supplementary list C substances are similar as in baseline.
- We assumed that contamination of raw water used for individual supply would be similar as in baseline.

Sub-Option 1.2: Updating the list of parameters in the Annex I to list C (including all parameters potentially harmful)

Description of the sub-option

This sub-option will consist in an update of the parameters in Annex I following scientific and technical progress, plus the addition of even more potential harmful substances following the precautionary principle. Parametric values would be settled either equal to current ones or to WHO guidelines for some parameters/substances, either to a lower level for the most harmful contaminants and with regard to the precautionary principle. This theoretical list of parameters has been called list C, and it includes all potentially harmful substances that could be found in drinking water. The upcoming study of the WHO on the subject will bring more details and suggestions on the content of this theoretical list C.

Main assumptions

- **Parameters**: more than 48 parameters to monitor and to comply with in drinking water, defined as the whole list of substances representing a potential harm for human health and with parametric values settled according to the precautionary principle.
- This sub-option would require **some investments to equip monitoring labs and potabilization plants** with new technologies machines in order to be able to monitor and treat the new substances added to annex I list. Investments needed are considered 3 times higher than in sub-option 1.1.
- This sub-option would require an increased monitoring effort during the drinking water production process as compared to baseline (+15% in annual monitoring costs[63]).

[61] This increase in treatment costs could also correspond to a change of supply and an abandon of “critical” raw water sources if treatments are too expensive. This assumption was based on an estimate by the authors of this report, which relies on a collective expertise..

[62] Ie 2015 for contamination rates in 2030 and 2030 for 2050 contamination rates in 2050. This assumption was based on an estimate by the authors of this report, which relies on a collective expertise..

[63] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

- This sub-option would require the **application of more treatments** on water during the potabilization process as compared to baseline (+30% in annual treatment costs[64]).
- It would lead to a **change in the drinking water quality** as some more parameters will be monitored and taken into consideration:
  - We assumed that contamination by list A substances would be on average at lower concentration in drinking water as compared to the baseline. Overall, the compliance rates with current DWD parametric values would remain similar to the baseline. But more drinking water will contain list A substances at concentration below precautionary limit values: as a result, contamination rates above precautionary limit values are assumed to be equal to the non-compliance rates assessed during the previous DWD reporting period[65].
  - We assumed that the contamination by new list B substances above defined parametric values would be reduced as compared to baseline as those substances would be regulatory monitored and treated - new contamination rates would be equal to list A compliance rates during the previous period[66]. We also assumed that water suppliers which apply a RBA would even more reduce this contamination, consistently with the assumptions in baseline (i.e. that contamination rates are twice lower for water suppliers which apply RBA as compared to those which do not apply RBA.
  - We assumed that the contamination of drinking water by supplementary list C substances above defined parametric values would be reduced as compared to baseline and to sub-option 1.1. Contamination rates are assumed equal to ¾ of contaminations rates[67] in baseline for both water suppliers applying RBA and those not applying RBA.
- We assumed that contamination of raw water used for individual supply would be similar as in baseline.

Sub-Option 1.3: Reduction of the number of parameters in Annex I to a minimum list, with the same limit values than those required in the current Annex I.

This option has been designed to simplify the requirements in terms of quality standards for drinking water. The list of parameters to comply with in annex I will only keep the most potentially harmful parameters already listed, and each MS will be responsible to eventually set additional regulations for other substances.

Main assumptions

- **Parameters:** less than 48 parameters to monitor and to comply with in drinking water, corresponding to the current list in annex I with only the most potentially harmful substances kept.
- This sub-option would lead to a reduced monitoring effort during the drinking water production process as compared to baseline (-15% in annual monitoring costs[68]).
- This sub-option would lead to the **application of less treatments** on water during the potabilization process as compared to baseline (-10% in annual treatment costs[69]).
- It would lead to a **change in the drinking water quality** as some less parameters will be monitored and taken into consideration:
  - We assumed that contamination by list A substances remains stable as compared to 2015, which

[64] This increase in treatment costs, could also correspond to a change of supply and an abandon of "critical" raw water sources if treatments are too expensive.
[65] Ie 2015 for contamination rates in 2030 and 2030 for 2050 contamination rates in 2050.
[66] Ie 2015 for contamination rates in 2030 and 2030 for 2050 contamination rates in 2050.
[67] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[68] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[69] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

means would be higher than in baseline where an improvement is assumed.

- We assumed that contamination of drinking water by new list B substances and by supplementary list C substances are similar to the baseline.

- We assumed that contamination of raw water used for individual supply would be similar as in baseline.

This sub-option has been excluded from the full IA, as it is obviously leads to a worse situation than today in terms of achieving the set health objective.

Policy Option 2. Ensuring a systematic application of Risk Based Assessment (RBA)

Why this option?

Where does this option stem from and why did exactly this option emerge?

Several problems with the quality of raw water used for drinking water purposes take place within the catchment. The implementation of water policy in general, and of the EU Water Framework Directive (WFD) in particular, has an impact on the quality of raw water, which in turn has an effect on health risks. Today, there is no sufficient coherence between the EU WFD and the DWD, in particular when considering Article 7 of the WFD. Thus, there is a need to have a different mechanism that triggers an action beyond "compliance at the tap".

Monitoring differs between MS and sometimes between different Water Supply Zones (WSZ) of the same MS. This results in different levels and availability of monitoring data. As the frequency of monitoring is stipulated in Annex II of the DWD, there was no incentive for MS to adapt monitoring. With the recently adapted amendment to the DWD, the overall approach to monitoring has become more flexible, allowing MS to decide, on the basis of a risk assessment, which parameters to monitor. For small WSZs, the revised Annexes II and III prescribe now a minimum frequency of monitoring (once per year). Until October 2015, there was no incentive to adopt RBA (Risk Based Assessment) for the water sector within the DWD implementation framework, be it at the national level or by individual water suppliers. But some water suppliers have already started to implemented RBA (see description of the baseline) in a search for optimized management and reduced costs or because some (very few) MS have included RBA in their national legislation. RBA is seen as a way to improve, optimize and adapt to each context the detection and the treatment of potentially harmful substances in drinking water.

Integrating specific requirements for RBA in the DWD is an approach that has been welcomed by many stakeholders in both consultations and expert workshops.

Short description of the option

To address the issue of implementation of RBA principles, which can provide cost effective solutions for ensuring water quality, the proposed policy option is designed so that specific provisions for compulsory RBA are integrated in MS national legislation, providing some degree of flexibility in RBA implementation requirements to distinguish between large and small water suppliers.

As a difference with baseline where some WS or MS can integrate a voluntary RBA process, RBA here is mandatory and with the same "format" and ambition across all MS.

What is the purpose of this option for IA?

To assess whether the obligation to implement RBA (for large and small water suppliers) in the national legislation will bring additional benefits, who will be affected and how (supplier/authority/consumers).

Description of the sub-options

Sub-option 2.1: compulsory implementation of RBA for all large water suppliers

The current DWD can be amended by an article in which Member States can ensure that **all large water suppliers** (supplying more than 1,000 cubic meters per day or serving more than 5,000 people) have the obligation to apply a RBA and to develop and implement a Water Safety Plan (WSP). The water suppliers shall demonstrate that a WSP and a system for implementing it have been put in place and are operational.

This option will enable water companies and communities to learn more about sources of pollution of their drinking water sources, monitor right parameters (including ones not listed in the current annex I) and thus to target measures to reduce pollution at source.

Main assumptions

- **RBA application:** We assumed that 98% of large water suppliers would indeed apply a RBA and have implemented a WSP by 2050[70]. Concerning small water suppliers, voluntary application of RBA would be similar as in baseline. In total, it would result in 86% of the population connected to PWS concerned by a RBA in 2050 (vs. 74% in baseline). **Cost of mandatory RBA implementation** (per person supplied and per year) is assumed to be higher (by 10%)[71] than for the "voluntary" RBA considered in baseline as the regulation would impose a stricter process of implementation and of WSP writing.
- **Parameters:** As currently and as in baseline, a list of parameters to monitor and to comply with will be annexed to the DWD - and with (as currently) the possibility for water suppliers which apply a RBA (so in theory all large water suppliers at least) to derogate to part of this list in terms of monitoring and/or treatment. In this sub-option as more water suppliers would apply an RBA as compared to baseline, we can assume that more water suppliers would monitor less (and sometimes more) parameters.
- **Monitoring and treatment efforts** (and thus unitary costs) are impacted by the application of an RBA. Assumptions on those impacts are common with baseline and are described in details in the regarding section. It is important to stress that monitoring obligations shift from a pure monitoring of the quality of drinking water supplied to consumers to monitoring the wider water resources, including the quality of raw water in catchments[72].
- The obligation to apply RBA would have **consequences on the drinking water quality.** Although the impacts of a RBA application on supplied drinking water's contamination by all categories of substances considered (list A, list B and list C) are similar than in baseline regarding to contamination percentage[73], more water (and more persons) would be concerned by the lower

[70] It seemed to the authors that a full application of the RBA requirement would not be realistic, and in consequence an assumption of a 98% rate of application was made.

[71] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

[72] That helps inter alia to assess the effectiveness of measures proposed for reducing the release of polluting substances at source.

[73] See baseline description.

rates defined for water suppliers applying RBA. As a result, drinking water quality would be globally improved for list A and the new list B substances (those concerned by a difference in contamination if an RBA is applied).

- The obligation to apply RBA would also have **consequences on the quality of raw water** used for individual supply by the persons not connected to PWS. Indeed, a higher number of water suppliers applying RBA would lead to more actions addressing contamination at source implemented – with ancillary benefits for those persons with self-supplies/self-abstractions in water bodies benefiting from these actions. However, this improvement is small and only concerns list A substances.

Sub-option 2.2: Compulsory implementation of RBA for both large and small water suppliers

In this sub-option, in addition to the sub-option 2.1 **small water suppliers will also be obliged to develop and implement a simplified water safety plan.** Indeed the WSP shall **be proportionate** to the size of the water supply and to possible hazards that could deteriorate water quality, following the process and guides developed by WHO, including a simplified WSP process for small communities[74,75].

Main assumptions

- **RBA application:** We assumed that 98% of large water suppliers would indeed apply a RBA and have implemented a WSP by 2050, and 95% of small water suppliers[76]. In total, it would result in 95% of the population connected to PWS concerned by a RBA in 2050 (vs. 74% in baseline). **Cost of mandatory RBA implementation** (per person supplied and per year) is assumed to be higher (by 10%) than for the "voluntary" RBA considered in baseline as the regulation would impose stricter process of implementation and of WSP writing.
- **Parameters:** As currently and as in baseline, a list of parameters to monitor and to comply with will be annexed to the DWD - and with (as currently) the possibility for water suppliers which apply a RBA (so in theory all large water suppliers at least) to derogate to part of this list in terms of monitoring and/or treatment. In this sub-option, as more water suppliers would apply an RBA as compared to baseline, we can assume that more water suppliers would monitor less (and sometimes more) parameters.
- **Monitoring and treatment efforts** (and thus unitary costs) are impacted by the application of an RBA. Assumptions on those impacts are common with baseline and are described in details in the regarding section.
- The obligation to apply RBA would have **consequences on the drinking water quality.** Although the impacts of a RBA application on supplied drinking water's contamination by all categories of substances considered (list A, list B and list C) are similar than in baseline regarding the contamination percentage[77], more water (and more persons) would be concerned by the lower rates defined for water suppliers applying RBA. As a result, drinking water quality would be globally improved for list A and the new list B substances (those concerned by a difference in contamination if an RBA is applied).

[74] Towards a Guidance Document for the implementation of a Risk Assessment for small water supplies in the European Union Overview of best practices, 2011 KWR.
[75] Water safety plan: a field guide to improving drinking-water safety in small communities. Bettina Rickert, Oliver Schmoll, Angella Rinehold and Eva Barrenberg, 2014.
[76] It seemed to the authors that a full application of the RBA requirement would not be realistic, and in consequence an assumption of a 98% for LWS and 95% for SWS rates of application was made.
[77] See baseline description.

- The obligation to apply RBA would also have **consequences on the quality of raw water** used for individual supply by the persons not connected to PWS. Indeed, a higher number of water suppliers applying RBA would lead to more actions addressing contamination at source implemented. However, this improvement is small and only concerns list A substances.

Policy Option 3: Materials and products in contact with drinking water - harmonization of the system

Why this option?

Where does this option stem from and why did exactly this option emerges?

In the drinking water production and supply process, a variety of materials and products - such as plastics and metals for pipes, sealing materials and valves - are used and might be partially released into the water and, in doing so, affect its quality and characteristics. Organic substances in particular can also encourage the growth of bacteria and lead to the microbial contamination of drinking water.

Article 10 of the DWD regulates the impact of materials and substances in contact with drinking water to ensure that MS take the necessary measures to prevent hazardous concentrations of substances from materials contaminating drinking water as a result of treatment, equipment and materials used in the general drinking water system. This article covers 'substances' such as chemicals used in the production and distribution of drinking water, and in materials used for new installations. Chemicals used in the treatment of drinking water are generally (but not always) of certified quality.

The implementation of Article 10 has received much attention, as the DWD does not give guidance on the outline and the operation of a system for the assessment and the approval of chemicals and materials in contact with drinking water.

Furthermore, the reference to the Construction Products Directive (89/106/EEC), and to Regulation 305/2011 which replaced this Directive, has not solved the issue of harmonized product standards before industry is able to identify compliance. The implementation has been left to the MS. Today, there is no common system for dealing with these products and materials, only various national requirements and regulations are in place. In total, 12 EU MS have today mandatory and voluntary requirements on materials in contact with drinking water (including The Netherlands, United Kingdom, Germany and France[78]) which work together on a step-by-step harmonization of their national systems.

A recurring element in the discussions with stakeholders in the Netherlands and Europe concerns the economic impact of the lack of European harmonization of hygienic requirements for producers of materials and products used in the drinking water supply chain from source to tap. In the stakeholder and expert workshops and consultation papers this option was given positive reaction and further research is needed on what additional benefits/costs it will bring and how it will affect the health.

Short description of the option

This option will oblige all MS to develop product requirements and harmonization of standards to ensure that materials and products, which come in contact with drinking water, comply with them.

What is the purpose of this option for IA?

[78] http://www.umweltbundesamt.de/en/topics/water/drinking-water/distributing-drinking-water/approval-harmonization-4ms-initiative

To assess whether introduction of an article which implies harmonization of standards for material and products that come in contact with DW brings additional benefits. Who will be mainly affected?

Description of the sub-options

Sub-option 3 The harmonization of standards on materials and products in contact with drinking water

This sub-option proposes to harmonize standards of the product requirements for the materials and products that come in contact with drinking water. Compliance with the requirements can be demonstrated through the issue of a certificate from a certifying authority accredited for the drinking water field. This policy option will commit water suppliers in MS to provide the documents that set out their agreed policies and practices public when they are fully agreed.

This option will affect in particular the MS which do not have today voluntary labeling and control, and where product manufacturers face challenging situations with aging equipment, as well as countries that have a large share of small water suppliers.

Main assumptions

- The harmonization of standards on materials and products in contact with drinking water would have consequences on **drinking water quality:**
  - We assumed that contamination by new list B substances and by supplementary list C substances above defined parametric values would be reduced as compared to baseline as those pollutants partly come from materials and products used during the drinking water production process - this reduction is assumed to be of 5%[79] as compared to contamination in baseline.
  - We assumed that contamination of drinking water by list A substances is similar as in baseline as those pollutants are assumed to not be coming from materials and products in contact with drinking water.
- This option would also lead to an improvement of organoleptic characteristics of drinking water (such as odor and taste of water). Thus we assumed that those among the population supplied by PWS but drinking bottled-water would partly switch to tap water for their consumption. This reduction of bottled water consumption is assumed to 10% (vs. 4% in baseline)[80].

Sub option 3 bis.2 National Product Control and Full Mutual Recognition among MS

As regards to materials and products in contact with drinking water, the second sub-option builds on the expansion of the current practice, with National Product Control mechanisms established for deriving standards, and a Full Mutual Recognition between MS of the standards approved by national approval systems. It is expected that this approach can progressively lead to some level of (step-by-step) harmonization of national systems, but not covering the EU28 and with a very slow implementation process[81].

This sub-option has been excluded from the full IA, as it is obviously leads to a situation very similar to the baseline conditions with marginal impacts as compared to baseline.

[79] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[80] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[81] As indicated above, this sub-option that is considered very close to the actual (baseline) situation is not further investigated in the impact assessment.

Policy option 4: SMART information to drinking water consumers

Why this option?

Where does this option stem from and why did exactly this option emerge?

According to Article 13 of the DWD, MS are to provide adequate and up-to-date information on water quality for human consumption to drinking water consumers connected to PWS. Most national authorities and water suppliers do provide information on drinking water quality through various means (consumer leaflets, websites, etc.), this information presenting details on, and explanations of, measured water quality for key parameters. Often, the reports submitted by national authorities to the European Commission are made publicly available. However, 51% of the consumers who responded to the stakeholder survey carried out in 2015 in the context of the *ex-post* evaluation study of the DWD stressed that the information provision is inadequate, with information on the quality of water being: (i) difficult to find; and (ii) not sufficiently transparent to understand what consumers pay for. The survey stressed that consumers in so-called "old" (EU-15) MS are somewhat more satisfied (17% of the total number of respondents) than those in "new" MS (only 10%). These results are coherent with the results of the Flash Eurobarometer on consumer satisfaction with 37% of the respondents feeling well or very well informed on water-related issues. In addition to information on (drinking) water quality, consumers are interested in information on the source of water, pricing, options for lowering water bills, water (and potentially energy) footprint, and on the cost-effectiveness of technologies used.

Lack of available timely information can cause a lag in the time of reaction in case of accidental pollution to prevent population drinking contaminated water. Moreover, providing insufficient information to consumers may turn them away from tap water to other sources of drinking water.

Need to provide useful understandable information was expressed at various consultation workshops as well as in expert meetings and positions papers of stakeholders. Better information can empower citizens by allowing them to follow and participate more actively in water management decisions that are - for the most part - taken at national, regional or local level and influence water suppliers to become more efficient in terms of water and energy savings technologies, or to apply newer and better monitoring.

Short description of the option:

This option proposes via several sub-options to improve the information that is provided about to consumers and administrations on drinking water quality.

What is the purpose of this option for IA?

To assess whether the better information provided to consumers can bring additional benefits? Who will receive these additional benefits?

Description of the sub-options

Sub-option 4.1 simplified automatic electronic reporting to EC

This sub-option will ensure that the information which has to be provided to the public will be used by MS for complying with the automated electronic reporting to the European Commission, beginning from 2020. It is assumed that automatic reporting will allow a reduction of the reporting cost of individual MS (although this cost is currently limited).

At the moment, there are on-going initiatives to address the need for robust and effective reporting whilst minimizing the administrative burden associated with it. The fitness check has been launched to ensure that environmental reporting is fit-for-purpose and to allow for the identification of concrete actions towards a streamlined, low burden, high effects monitoring and reporting in the context of environmental legislation[82].

Main assumptions

- The implementation of an automatized reporting process would need the development of national informatics systems gathering information from water suppliers on drinking water quality and water services characteristics. This represents a small **investment** corresponding to some time of work of some dedicated persons across MS.
- Once the automatized reporting system implemented, the process dedicated to the production of the report that needs to be sent to the EC each year would be simplified - and thus the corresponding **annual costs** would be reduced (by 15% as an assumption)[83].

This sub-option will mainly have (limited) cost implications for MS and will help to lessen the burden of reporting to the EC. As this option does not affect health, social, or environmental impacts, it has been discarded from the full analysis of impacts. Still, the (budgetary) cost savings that result from the implementation of this option have been estimated and are presented in the section presenting the economic impacts of Policy Options.

Sub-option 4.2 Timely basic online information to consumers about quality of drinking water

In order to improve information diffusion and quality provided to citizens, this option proposes to put specific requirements for water suppliers to provide updated, timely, transparent, understandable, local and useful information to consumers using SMART (electronic/web) systems. MS shall ensure that all water suppliers provide the updated information (to be defined in details in a specific Annex of the DWD), and facilitate its (electronic) access via in particular internet servers, phone applications and portals.

In case of major changes and (investments, management) decision to be taken by water suppliers, the public will be informed with specific public consultations. Member States shall ensure that the public is given early and effective opportunities to participate in decisions related to changes in water abstraction, treatment, distribution of water and ultimately costs and water tariffs.

For small water service suppliers, information will be collected and presented at an aggregated (e.g. regional – to be defined by individual MS based on the organization of the drinking water sector) level. As in sub-option 4.1, reporting to the EC will be based on automatized electronic reporting. The information that will be provided (further defined in a specific Annex to the DWD) will address in particular: which water sources are used (categories of waters, characteristics, quantities per category); monitoring (frequency, location); results of monitoring in terms of drinking water quality (including also information on odor, taste) with explanations of what it means for human health and the actions taken; incidents and interruption of services (and how long they last) and measures taken to restore the service;[84] timeliness and adequacy of responses to problems. Updated information will be available online and sent to consumers with the same frequency as water bills as a means to limit administrative cost increases and also put online on water services website and/or water authorities

[82] http://ec.europa.eu/environment/legal/reporting/fc_overview_en.htm

[83] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

[84] Can be based on the information extracted from current Article 8(3) and (7)

websites.

Main assumptions

- Same **investment and same cost reduction for reporting** would happen in this sub-option as in sub-option 4.1 as a consequence of an automatized reporting process.
- Even if the smart-information on water quality would theoretically be provided to all persons connected to PWS, we assumed that in fact **only 95%**[85] of them would have access to this smart-information.
- The implementation of a system that allows the collection of data from water suppliers, the organization of a national database and the development of websites and applications would require an initial **investment** corresponding to sometime of work by some persons dedicated to this task in each MS and in the EC. Once this system is developed, the provision of smart-information would be more costly than the current **annual cost of providing information** and supported by water suppliers (4.75 times higher than the current unitary cost per person connected to PWS and per year)[86].
- As a consequence of the possibility of consumers to give their feedback on water quality and to participate to consultations on water quality and water services decisions, population would have the "power" to influence drinking water suppliers so they will improve drinking water quality by applying more treatments. We assumed that **treatments** would be increased by 10% as compared to baseline[87].
- And as more treatments would be applied, **drinking water quality** would be improved:
  - We assumed that contamination by list A substances would be in average at lower concentration in drinking water. Globally compliance rates with current parametric values would remain similar as in baseline, but more drinking water will contain list A substances at concentration below precautionary limit values - and as a result contamination rates above precautionary limit values would be reduced by 10% as compared to baseline[88].
  - We assumed that contamination of drinking water by new list B substances and by supplementary list C substances are similar as in baseline.
- We assumed that contamination of **raw water** used for individual supply would be of similar quality than in baseline.
- This option would also lead to an improvement of trust in drinking water quality and thus we assumed that those among population supplied by PWS but drinking **bottled-water** would partly switch to tap water for their consumption. This reduction of bottled water consumption is assumed to 10% by 2050 (vs. 4% in baseline)[89].

Sub-option 4.3. Ensuring advanced SMART access to a wider range of information.

In addition to the provision of a smart-information on water quality as defined in sub-option 4.2, this sub-option includes the provision of information also on performance and water pricing in order to allow citizens to change their behaviour (bottled water consumption) and to allow water suppliers to aim at better performance (through the possibility of benchmarking at the level of regions, MS or EU).

[85] It seemed to the authors that a full implementation of the required access to smart-info would not be realistic, and in consequence an assumption of a 95% rate of access was made.

[86] This assumption was based on the unitary cost dedicated to information diffusion calculated in MS which already give access to information on drinking water quality to all consumers.

[87] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

[88] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

[89] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

The sub-option 4.3 is thus a link to solving affordability issues (as defined by SDG 6 1).

This sub-option will require water service operators to provide information on the management of the drinking water systems in terms of: the water sources, the water quantity, the water price and components of water pricing; the overall performance of the system, in terms of efficiency, leakage rates, energy use, etc.; impacts of measures previously taken for improving performance; measures and actions proposed for improving performance (e.g. proposed investments for leakage rate reductions); additional tips and advices on how to reduce consumption can be provided depending on local conditions. The information will be accessible in a timely manner (and regularly updated) via innovative SMART information systems to all drinking water consumers.

The access to this type of information will help consumers to influence water suppliers to become more efficient in terms of water and energy savings technologies, to apply newer and better monitoring which can lead to better water quality, and to adopt more cost-effective measures to address pollution at source instead of treating polluted water.

SMART information systems including components of SMART monitoring systems would allow for timely information on exceeding parameters or identifying outbreaks which would permit suitable interventions and therefore removing potential risks for the environment.

Main assumptions

- Same **investment and same cost reduction for reporting** would happen in this sub-option as in sub-option 4.1 as a consequence of an automatized reporting process.
- Even if the smart-information on water quality would theoretically be provided to all persons connected to PWS, we assumed that in fact **only 95%** of them would have access to this smart-information[90].
- The implementation of a system that allows the collection of data from water suppliers, the organization of a national database and the development of websites and applications would require an initial **investment** (higher than for sub-option 4.2) corresponding to sometime of work by some persons dedicated to this task in each MS and in the EC. Once this system is developed, the provision of SMART-information would be more costly than the current **annual cost of providing information** and supported by water suppliers (9.5 times higher than the current unitary cost per person connected to PWS and per year)[91].
- As a consequence of the possibility of consumers to give their feedback on water quality and to participate in public consultations on water quality and water services decisions, population would have the “power” to influence drinking water suppliers so they will improve drinking water quality by applying more treatments. We assumed that **treatments** would be increased by 10% as compared to baseline (as in sub option 4.2)[92].
- And as more treatments would be applied, **drinking water quality** would be improved as in sub-option 4.2. :
  - We assumed that contamination by list A substances would be in average at lower concentration in drinking water. Globally compliance rates with current parametric values would remain similar as in baseline, but more drinking water will contain list A substances at

[90] It seemed to the authors that a full implementation of the required access to smart-info would not be realistic, and in consequence an assumption of a 95% rate of access was made.

[91] This assumption was based on the unitary cost dedicated to information diffusion calculated in MS which already give access to information on drinking water quality and other water services characteristics to all consumers.

[92] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

concentration below precautionary limit values - and as a result contamination rates above precautionary limit values would be reduced by 10% as compared to baseline[93].
    - We assumed that contamination by new list B substances would be reduced as compared to baseline (by 15%)[94].
    - We assumed that contamination of drinking water by supplementary list C substances is similar as in baseline.
- In addition to more treatments, citizens would also have the "power" to make water suppliers implement more **measures addressing pollution at source** instead of treatment. We assumed that 5 additional percent of treatments would be replaced by measures at source as compared to baseline[95].
- And as a consequence, we assumed that contamination of **raw water** used for individual supply would be improved as compared to baseline:
    - We assumed that contamination by list A substances and by new list B substances would be reduced as compared to baseline (by 10%)[96].
    - We assumed that contamination by new list B substances would be reduced as compared to baseline (by 15%)[97].
    - We assumed that contamination of drinking water by supplementary list C substances is similar as in baseline.
- This option would also lead to an improvement of trust in drinking water quality and thus we assumed that those among the population supplied by PWS but drinking **bottled-water** would partly switch to tap water for their consumption. This reduction of bottled water consumption is assumed to 15% by 2050 (vs. 4% in baseline)[98].

Policy Option 5: Access to safe drinking water for all

Why this option?

Where does this option stem from and why did exactly this option emerge?

According to the Right for Water initiative (http://www.right2water.eu/): "Water and sanitation are a human right! Water is a public good, not a commodity". The UN Sustainable Development Goals (in particular SDG6) includes the goal of ensuring "availability and sustainable management of water and sanitation for all', universal and equitable access to safe and affordable drinking water being proposed as target for all by 2030. In the EU-28 more than 1 million people still lack access to a safe and clean drinking water supply and nearly 2 % of the population lack access to sanitation, according to the World Water Assessment Programme (WWAP) (EP Boylan Report Sept 2015, Resolution Nr 17).

The current DWD is focused only on ensuring the quality of the drinking water for people connected to PWS, but does not ensure that all EU inhabitants have access to drinking water (those that are not connected to PWS because living in very remote areas, homeless, migrants).

To reach the SDG for drinking water, efforts would be different among MS, as there are significant differences in PWS connection rates between MS (between 99% and 57%)[99]. Moreover, some MS, for

[93] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[94] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[95] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[96] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[97] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[98] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[99] Eurostat data

example Belgium, France, Ireland, Italy, Spain and United Kingdom have put regulation in place proposing “specific measures in the water sector…. in favor of vulnerable groups such as travelers (gypsies and others), minorities (indigenous peoples, first peoples, etc.), illegal immigrants, and the homeless”. In France, for example, “Since 1990, all sizable municipalities (of more than 5,000 inhabitants) have to provide parking areas for camping cars and caravans of nomads and to provide water and toilets in these areas” (Law N°2000-614 of 5 July 2000 pertaining to the reception and accommodation of travelers. Decree N°2001569). However, in the MS where the connection rates to PWS are low and no specific regulation exists the problem remains unsolved.

Short description of the option

This option aims at exploring two solutions that would ensure the access to a wholesome drinking water to all EU28 citizens: extending PWS everywhere (which is a rather theoretical option as technical impossibilities would exist); or providing individual supply systems to citizens not connected to PWS and that are not equipped yet and assuring the monitoring and treatment of this raw water used for self-supply.

What is the purpose of this option for IA?

To assess what would be the benefits of a new obligation of extending the right to have access to wholesome drinking water to the people who currently do not have access to PWS.

Description of the sub-options

Sub-option 5.1 - All people that are not connected to PWS today will be connected to Public Water Supply networks

This option will address the issues described above by amending the current DWD with the obligation to provide drinking water through PWS networks to all citizens, expanding the drinking water quality standards of the current DWD to all small communities and any person living in Europe (including Roma populations and migrants). This option addresses two different issues: first, the access to water being considered as a human right; and, second guaranteeing safe drinking water quality for small water supplies.

Main assumptions

- We assumed **that 100% of the population** in all MS would be connected to PWS by 2030 - even though this assumption is purely theoretical due to technical infeasibilities (see sensitivity analysis). Investments would be necessary to extend the drinking water networks (abstraction points, pipes, treatment plants, etc.), and the unitary cost to connect one person has been assumed higher for rural population than for urban population, and even higher for rural population beyond a connection rate of 95% than for other rural populations[100].
- As a consequence of the increase of the population connected to PWS, all operating costs of water services would be proportionally higher as compared to baseline **(monitoring, treatments, measures at source, information, reporting…).**
- And as people that do not get wholesome drinking water today and so drink bottled-water would get suitable tap water instead, the average consumption of **bottled-water** will decrease. This

[100] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

decrease would be marginal as compared to baseline at EU28 scale because of the already high average rate of connection to PWS (99 l/pers/yr vs. 100 lpers/yr in baseline)[101].

Sub-option 5.2 – Providing all people (not connected to PWS) with the leans (self-supply systemsà to ensure they have access to DW

This option is aiming to reach the same objective as policy option 5.1 but instead of connecting people to the PWS, it ensures access to drinking water and quality of drinking water via self-supplied systems. To guarantee the right to all to benefit from an access to safe drinking water, the DWD will include a new obligation that would have to be swiftly transposed into national laws and then fully implemented in EU28 by 2030. It is proposed that this sub-option is rather a soft-law sub-option (includes guidance, funding etc.), and the implementation/ensuring is left to the MS.

Among people not connected to PWS today, some are already equipped with self-supply systems (wells or cisterns for example) - assumed equal to 50% of the population not connected to PWS today. All those who are not connected to PWS and not equipped with self-supply systems yet, will have to get access to self-supply systems (investment or other mechanism, by eventually water suppliers or MS giving subsidies for households equipment). Then, all water suppliers (or water authorities) will have to ensure to all not connected people, a quality of water close to PWS drinking water quality (e.g. by implementing measures at source to improve fresh water quality or by distributing UV treatment devices).

Main assumptions

- We assumed that 100% of the population not connected to PWS network would be equipped with individual supply systems, as compared to only 50% today and in baseline - even though this assumption is theoretical and not really feasible. This would require some investments that would be supported either by population concern or by water suppliers or MS, or both.
- **Monitoring:** We assumed that raw water used for self-supply will have its quality analyzed once a year (taking water samples from wells or from cisterns) - with costs supported by population concerned and/or water suppliers and MS.
- **Treatments and measures at source:** When raw water used by people not connected to PWS is unsuitable for human consumption (according to the parameters of the current Annex I that would remain unchanged), additional treatments (e.g. with UV treatment devices for cisterns) and measures for addressing pollution at source will have to be implemented. The share between treatments and measures at source is assumed to be half-half for each[102] - with corresponding unitary costs taken into consideration.
- As a consequence of treatments and measures at source applied on fresh water used for self-supply, **raw water quality** will change. We assumed that contamination of raw water by list A substances would be reduced (but only in areas where water is used for self-supply) - until reaching approximately the same rate of compliance with current annex I standards than drinking water from PWS in 2015[103].
- Drinking water in PWS networks will remain at a similar quality as in baseline.
- And as people that do not get wholesome drinking water today and so drink bottled-water would get suitable tap water instead, the average consumption of **bottled-water** will decrease. This

[101] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[102] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[103] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.

decrease would be marginal as compared to baseline at EU28 scale because of the already high average rate of connection to PWS (98 l/pers/yr vs. 100 lpers/yr in baseline)[104].

6.2. Summary of the proposed options and of their key assumptions

As indicated above, the proposed policy options tackle different problems identified in the current DWD, some problems being addressed by different options and some options addressing different problems simultaneously. The main assumptions in changes in key parameters of the drinking water system that will affect its functioning and the achievement of the proposed objectives, as compared to the baseline situation, are summarized below and in the following summary tables[105]:

- Policy option 1 (all sub-options) differ from the baseline scenario in terms of water quality and operational actions required for ensuring drinkable water;

- Policy option 2 implies that philosophy of the RBA itself impacts the compounds to be monitored, the types of measures implementing for ensuring drinkable water (with priority given to measures addressing pollution at source), the possibility of drinking water consumers to influence decisions based on their access to information, etc.

- Policy Option 3 has limited differences as compared to the baseline scenario. Apart from changes that result from the definition of the option itself, the main difference lies with the intensity of water treatment, cost of certification and harmonization.

- Although focused on enhancing information to drinking water consumers, Policy Option 4 has indirect impacts on many other parameters and factors, such as the intensity of water treatment and the importance of measures addressing pollution at source.

- The Policy Option 5 is very similar in terms of "drinking water quality philosophy" to the baseline scenario and the actual DWD. Its main difference relates to the widening of the scope of the DWD to the entire population of Europe (and not to the sole citizens connected to PWS).

Table 6. Summary of the assumptions made for key parameters of the drinking water system for the baseline scenario and for each individual policy option

In the following tables, "=" means no change as compared to the 2015 situation and "= BL" means that assumptions are similar to baseline.

[104] This assumption was based on an estimate by the authors of this report, which relies on a collective expertise.
[105] Note that these assumptions are presented in a more exhaustive manner in annexes too.

	2015	BL 2050	PO 1.1	PO 1.2	PO 2.1	PO 2.2	PO 3.1	PO 4.2	PO 4.3	PO 5.1	PO 5.2
Connection to PWS	95% in average in EU28	=	=	=	=	=	=	=	=	100%	=
Individual systems	50% of those not connected are equipped	=	=	=	=	=	=	=	=	=	100%
Water for all	Few MS include it in their regulation	=	=	=	=	=	=	=	=	Mandatory in all MS	Mandatory in all MS
RBA regulation and effective application (% of population connected to PWS)	Not mandatory - 47% of population is concerned because of voluntary application or national regulation	Trend to voluntary increase (will reach 74% of population connected to PWS)	=BL	=BL	Mandatory for LWS (will reach 92% of population connected to PWS)	Mandatory for all WS (will reach 97% of population connected to PWS)	=BL	=BL	=BL	=BL	=BL
Smart info (% of population)	50% in average in EU28	Trend to increase (up to an average of 64%)	=BL	=BL	=BL	=BL	=BL	Mandatory (will reach 95% in all MS)	Mandatory with also info on performances (will reach 95% in all MS)	=BL	=BL
Reporting	Constraignant process	=	=	=	=	=	=	Automatized process	Automatized process	=	=
Standards materials	Unharmonized	=	=	=	=	=	Harmonized accross all MS	=	=	=	=
Nb of par. & Limit values	48 parameters with derogation if RBA conducted + limit values set according to WHO guidelines	=	Update of the list ⇒approximately the same number of parameters ⇒limit values set according to WHO guidelines	Update and application of the precautionnary principle ⇒higher nb of parameters ⇒some limit values set to stricter thresholds than WHO guidelines	=	=	=	=	=	=	=

	2015	BL 2050	PO 1.1	PO 1.2	PO 2.1	PO 2.2	PO 3	PO 4.2	PO 4.3	PO 5.1	PO 5.2
Average consumption of bottled water (liters per person and per year)	106 l/p/y in EU28	100 l/p/y bcse of the increase of smart info diffusion	=BL	=BL	=BL	=BL	94 l/p/y bcse of the improvment of organoleptic characteristics of drinking water	94 l/p/y bcse of the increase of smart info diffusion	88 l/p/y bcse of the increase of smart info diffusion	99 l/p/y bcse of PWS extension	98 l/p/y bcse of the equipment of not-connected to PWS households with self-supply systems
Possibility for consumers to influence WS decisions	No	=	=	=	=	=	=	Yes, toward more treatments	Yes, toward more treatments and preventive emasures	=	=

	2015	BL 2050	PO 1.1	PO 1.2	PO 2.1	PO 2.2	PO 3	PO 4.2	PO 4.3	PO 5.1	PO 5.2
List A sub. in DW • > WHO guidelines * • > stricter limits	7 % 18 %	4 % =	=BL =BL	=BL 5 %	=BL =BL	=BL =BL	=BL =BL	=BL 10 %	=BL 10%	=BL =BL	=BL =BL
New list B sub. in DW • without RBA • with RBA	7,5 % 4 %	10,3 % 5,2 %	1,2 % 0,6 %	1,2 % 0,6 %	=BL =BL	=BL =BL	9,8 % 4,9 %	=BL =BL	8,8 % 4,4 %	=BL =BL	=BL =BL
Supplementary list C sub. in DW • without RBA • with RBA	7,3 % 7,3 %	11,2 % 11,2 %	=BL =BL	8,4 % 8,4 %	=BL =BL	=BL =BL	10,6 % 10,6 %	=BL =BL	=BL =BL	=BL =BL	=BL =BL
List A sub. in RW • > WHO guidelines • > stricter limits	9,4 % 20,2 %	8,6 % 20,2 %	=BL =BL	=BL =BL	8,5 % =BL	8,4 % =BL	=BL =BL	=BL =BL	8,3 % 18%	/ /	5 % =BL
New list B sub. in RW	10 %	16%	=BL	=BL	=BL	=BL	=BL	=BL	9%	/	=BL
Supplementary list C sub. in RW	11 %	18%	=BL	=BL	=BL	=BL	=BL	=BL	=BL	/	=BL
Comments (in POs: description of the situation as compared to baseline)	See text above and ex-post assesment for explanations beyond those figures.	Contamination by list A substances above WHO guidelines decreases bcse of the trend effort of WS to comply with DWD. Contamination by new list B and supplementary list C substances increases bcse of emergent pollutants.	Contamination by list B substances in DW decreases bcse annex I will include list B substances.	Contamination by list B and C substances in DW decreases bcse annex I will include list B and C substances.	No change in average water quality bcse RBA despite improving WS efficiency will not automatically lead to reducing contamination of water – except for RW that will benefit from more measures addressing pollution at source by list A substances (annex I).		Contamination of DW by list B and C substances will be slightly reduced bcse some of those contaminations come from materials and products in contact with DW.	Contamination of DW by list A substances under stricter limit values will decrease bcse consumers will be able to influence WS so they apply more treatments.	Contamination of DW by list A substances under stricter limit values and by list B substances will decrease bcse consumers will be able to influence WS so they apply more treatments and for more pollutants. Contamination of RW decreases because consumers will be able to influence WS so they apply more measures addressing pollution at source.	More people will benefit from a safe DW but the average contamination of drinking water from PWS will not change.	Requirements for drinking water in PWS will not change, but contamination of RW by list A substances (annex I) will decrease bcse RW will be under the requirements of DWD.

	2015	BL 2050	PO 1.1	PO 1.2	PO 2.1	PO 2.2	PO 3	PO 4.2	PO 4.3	PO 5.1	PO 5.2
Monitoring costs (average)	LWS: 2.3 €/p/yr SWS: 7 €/p/yr	LWS newly applying RBA: 2.2 €/p/yr (-5%) Other LWS: unchanged SWS: unchanged	= BL	LWS newly applying RBA: 2.6 €/p/yr Other LWS: 2.7 €/p/yr SWS: 8.1 €/p/yr ⇒All increased by 15% bcse more substances to monitor	Unitary costs similar as in BL ⇒Total lower than in BL bcse more WS apply RBA		=BL	=BL	=BL		=BL
Treatments	Different unitary costs accross MS – 17.2 €/p/yr in average	WS applying RBA: 15.4 €/p/yr (-10%) Other WS: 16.3 €/p/yr (-5%) ⇒Treatments are reduced bcse WS will partly compensate them with some preventive measures	WS applying RBA: 16.3 €/p/yr Other WS: 17.2 €/p/yr ⇒Treatments increase bcse new substances need to be treated (+5% compared to BL)	WS applying RBA: 20.6 €/p/yr Other WS: 21.5 €/p/yr ⇒Treatments increase bcse new substances need to be treated (+30% compared to BL)	Unitary costs similar as in BL ⇒Total lower than in BL bcse more WS apply RBA		=BL	WS applying RBA: 17.2 €/p/yr Other WS: 18 €/p/yr ⇒Treatments increase bcse consumers' influence (+10% compared to BL)			=BL
Measures at source	Unknown bcse not reported in within DWD	WS applying RBA: 0.17 €/p/yr Other WS: 0.09 €/p/yr ⇒Preventive measures cost 10 times less than treatments.	=BL	=BL	⇒Total higher than in BL bcse more WS apply RBA		=BL	=BL	WS applying RBA: 0.18 €/p/yr Other WS: 0.1 €/p/yr ⇒Preventive measures increase bcse of consumers' influence		Unitary costs similar as in BL for persons connected to PWS. Additionnal preventive measures are applied to improve raw water quality used for self-supply - 1.73 €/p/yr
Self-supply systems maintenance	Unknown bcse supported by households	=	=	=	=	=	=	=	=	Unitary costs similar as in BL ⇒Totals higher than in BL bcse more persons connected to PWS	Water analysis once a year: 4.7 €/p/yr Water treatment systems: 17.3 €/p/yr ⇒Difference with baseline concerns new equipped households (ie 50% of not connected to PWS)
RBA yearly audit	LWS: 0.0006 €/p/yr SWS: 0.0003 €/p/yr	=	=	=	⇒Total higher than in BL bcse more WS apply RBA		=	=	=		=
Smart-information diffusion	Average info diffusion cost: 0.004 €/p/yr	=	=	=	=	=	=	Higher cost for smart-info: 0.021 €/p/yr	Higher cost for smart-info and info on WS performances: 0.041 €/p/yr		=
Reporting to EC	Average reporting cost: 0.005 €/p/yr	=	=	=	=	=	=	Automatic reporting costs less: 0.004 €/p/yr			=
Other operating costs (other than monitoring, treatments, measures at source, self-supply systems, info, reporting)	Different unitary costs accross MS - 75 €/p/yr in average	Unitary costs similar as in 2015 ⇒Total higher than in 2015 bcse EU28 population increase	=BL	=BL	=BL	=BL	Unitary cost reduced by 1.3 €/pers as compared to BL bcse of the harmonized standards	=BL	=BL		=BL

Unitary costs (expressed per person supplied by the WS)	Life span (years)	BL 2050	PO 1.1	PO 1.2	PO 2.1	PO 2.2	PO 3	PO 4.2	PO 4.3	PO 5.1	PO 5.2
RBA implementation	10	Large WS: 0.17 €/pers Small WS: 0.09 €/pers	=BL	=BL	Increased cost for large WS than in BL bcse it is « mandatory » RBA (+10%)	Increased cost for large and small WS than in BL bcse it is « mandatory » RBA (+10%)	=BL	=BL	=BL	=BL	=BL
Materials and products certification	5	/	/	/	/	/	/	/	/	/	/
Individual supply systems equipment	3	/	/	/	/	/	/	/	/	/	130 €/pers
Smart-info and auto-reporting systems development	5	/	/	/	/	/	/	0.01 €/pers	0.01 €/pers	/	/
PWS extension	30	/	/	/	/	/	/	/	/	Urban area: 950 €/pers Rural area: 2850 €/pers Last 5% of population: 5700 €/pers	/
Monitoring and treatment machines	20	/	3.90 €/pers	11,70 €/pers	/	/	/	/	/	/	/

7. WHAT ARE THE IMPACTS OF THE DIFFERENT POLICY OPTIONS? AND WHO WILL BE AFFECTED?

The present chapter summarises the main impacts that could be expected from the implementation of individual Policy Options. In addition to health impacts which are central to achievement of the objectives of the proposed policy initiative, the options can have economic, social and environmental impacts through a variety of mechanisms. Based on desk research and interviews with stakeholders, the most significant impacts have been screened in more detail. The following table presents a synopsis of impact categories that have been screened along with the outcome of this screening process[106], the main types of expected impacts being then assessed in more detail and presented in the sections below. The assessment is based on the methodology for Impact Assessment developed by the European Commission (Toolbox for Better regulation[107]). In addition, this chapter includes a discussion on the "implementability" of the proposed policy options.

Table 7. Initial assessment (screening) of expected impacts

Impact category	Further assessment (yes/no)	Justification
Economic		
Growth and investment	No	The options will hardly affect the economic growth and investment in MS. Only two options (providing SMART information to consumers and "harmonisation of materials") will contribute to relatively small improvement in the conditions for investment and the proper functioning of the markets. These will be discussed in the context of SMEs
Sectoral competitiveness	Yes	Given that some options will have an effect on the cost of production (primarily water companies but also enterprises using drinking water as input), and others will lead to (technical) innovations, this impact category merits further investigation.
Facilitating SMEs growth	Yes	This impact category is linked to the previous one and consequences for SME growth as a result of (new) products to be developed or better quality inputs (drinking water) available, also justifies further analysis.
Achievement of the Single Market	Yes	One option (harmonisation of materials) is expected to have a positive impact on the free movement of goods (materials in contact with drinking water). This can also lead to an increase in consumer choice (and reduced prices) as enterprises producing for this market do not need to obtain approval for exporting to individual MS.
Increased innovation and research	Yes	The options which involve new technologies to detect and treat (new) substances will have a positive impact on innovation and research.
Technological development and	Yes	Some impact is to be expected from options to provide 'SMART' information to consumers.

[106] The table lists the key impacts and provides a short justification on why some need of these impacts have been investigated in more details. The justification is based on a set of questions derived from the Toolbox (Tool #16).

[107] http://ec.europa.eu/smart-regulation/guidelines/toc_tool_en.htm

digital economy		
Increased international trade and investment	No	Although an impact on the international trade of 'materials in contact with drinking water' can be expected from the option 'harmonisation of materials', this impact will be very small, and difficult to quantify as trade statistics are not available at this level of detail.
Competition	No	As none of the following questions in the 'competition checklist' is answered in the affirmative, further analysis is not needed for this impact category. Do proposed policy options have any of the following effects: i) Limit the number or range of suppliers; ii) Limit the ability of suppliers to compete; iii) Reduce the incentive of suppliers to compete; and iv) Limit the choices and information available to customers?
Energy independence	No	As impact of the options on energy use will be negligible, this category will not be further assessed.
Deeper and fairer economic monetary union	No	There will be no effect on the monetary Union, therefore this category will not be further assessed.
Social		
Employment	Yes	Each policy option will lead to an increase or decrease of employment in the sector and/ or suppliers to the sector. This category will be assessed further.
Working conditions	No	
Income distribution and social inclusion	Yes	Policy option 'Access to safe drinking water for all' would have a positive effect on social inclusion for vulnerable groups such as populations in rural, peri-urban areas or temporary settlements which currently have intermittent drinking water provision and quality.
Health and safety	Yes	As the objective of the Directive directly related to likelihood health risk, this category will be further investigated. Not only to grasp the quantitative results of the options in terms of the number of people affected or the probability of health risk, but also the financial and economic consequences of these impacts.
Social protection		
Education	No	No impact identified
Security	No	No impact identified
Governance and good administration	No	No impact identified
Preserving the cultural heritage/ multi-linguism	No	No impact identified
Crime. Terrorism and security	No	No impact identified
Social protection, health and education systems	No	No impact identified
Cultural heritage	No	No impact identified
Environmental		

Fighting climate change	Yes (minor)	A number of policy options can have a minor indirect impact on climate change. This is mainly seen through a marginal effect on energy consumption and the production of bottled water. This is further investigated in the environmental and social impact sections.
Fostering the efficient use of resources	Yes	In the option SMART' information to consumers, consumers and suppliers will be provided with incentives for implementing voluntary measures resource efficiency. Resource efficiency is in this context mainly related to water efficiency and related to energy savings as a result of more water efficient management.
Preserving the quality of natural resources/ fighting pollution	Yes	Positive impacts will derive from several policy options through improvement of water resources where waste water is discharged (following lower levels of pollutants in drinking water) and reducing pollution at source for water resources abstracted and will lead to better environmental status in water bodies. This is mainly a result of option 'Updated list of parameters' and 'Risk Based Assessment'.
Protecting biodiversity, flora, fauna and landscapes	Yes	Reducing the amounts of pollutants in drinking water and introducing more treatment at source to reduce pollution will have a positive impact. It is mainly addressed in policy option 'Risk Based Assessment'.
Reducing and managing waste	No	Some options might have a marginal impact on reducing waste, in the case of reduced levels of bottled water consumption. This is however not further explored in the report.
Minimizing environmental risks	Yes	Several of the policy options will lead to reducing the amounts of pollutants in drinking water by unlisted and emerging substances and reducing pollution at source for water resources abstracted which will lead to reduced environmental risks. This is mainly addressed through policy option 'Updated list of parameters' 'harmonisation of materials' and 'Risk Based Assessment'.
Protecting animal welfare	No	No impact identified
Other		
Economic and social cohesion	No	Policy option 'Access to safe drinking water for all' would have a positive effect on social inclusion for vulnerable groups such as populations in rural, peri-urban areas or temporary settlement which currently have intermittent drinking water provision and quality.
Impact on developing countries	No	No impact identified
Sustainable development		All suggested policy options will bring certain environmental benefits that are aligned with a sustainable development. Impacts such as limiting the amounts of pollutants in drinking water, suppressing pollution at source and improving resource efficiency will all contribute to the improvement of status of water bodies and biodiversity and support the achievement of the objectives of the WFD.
Fundamental rights	Yes	The option 'Access to safe drinking water for all' would expand DWD to include a right to safe drinking water and sanitation to all citizens, which is recognized by the UN to be a human right.

The following sections presents the main impact types investigated. As a reminder, the Policy Options (PO) analyzed and their abbreviations are as presented in the following table.

Table 7. Numbering and short names of Policy Options for which expected impacts have been assessed

Policy option	Short name
BL	Baseline
1.1	List B parameters
1.2	List C parameters
2.1	(RBA) Mandatory for large water suppliers
2.2	(RBA) Mandatory for all water suppliers
3	Harmonization of standards on materials and products in contact with drinking water
4.2	Smart-information to all on drinking water quality
4.3	Smart-information to all on drinking water quality and other characteristics and management of water services
5.1	Water for all with extension of the PWS
5.2	Water for all with equipment for not-connected population with self-supply systems

7.1 HEALTH IMPACTS[108]

7.1.1. Overview of the health impacts of the different policy options

As indicated above, health issues have been addressed through the indicator '**Population Potentially at Health Risk**' (PPHR) as desk research[109] pointed out the difficulties in establishing direct causal and statistical relations between drinking water quality and human health impacts[110]. This indicator estimates the share of the population that could potentially suffer from health problems because of the presence of contaminants in drinking water. This indicator was applied to the situation in which no action is taken (baseline), and to the situations under each proposed Policy Option (see section 1.3).

Figure 8 presents what would be the PPHR if no action is taken (baseline) and under the different policy options in 2030 and 2050. Baseline and policy options would all lead to a reduction in PPHR number over time by 2030 and by 2050 – as a result of the RBA voluntary application, an increased access to information on drinking water quality and a continuous increase in compliance with the standards as specified under the current DWD. Overall, all Policy Options would result in lower PPHR as compared to the baseline, but significant differences between Policy Options as indicated in the figure.

[108] All details on calculations (concerning PPHR and direct costs results) that are not provided in this report are available to the EC.

[109] Amongst others: Evaluation of the DWD (Ecorys, 2016) and Updated economic assessment of impacts of the revision of council directive 98/83/EC on the quality of water intended for human consumption (COWI, 2010).

[110] One of the main problems in determining whether a health impact is causal to the quality of drinking tap water is the lack of reporting on the cause of illness (e.g. when a person is taken up in a hospital the focus is on treating a disease/virus), secondly not all short –and/or long-term illness cases that could be caused through consumption of tap water are always caused by consumption of tap water (e.g. eating of infected food can also lead to sickness, see also Annex 2 for a more detailed analysis on causality between falling ill and tap water in the short run)

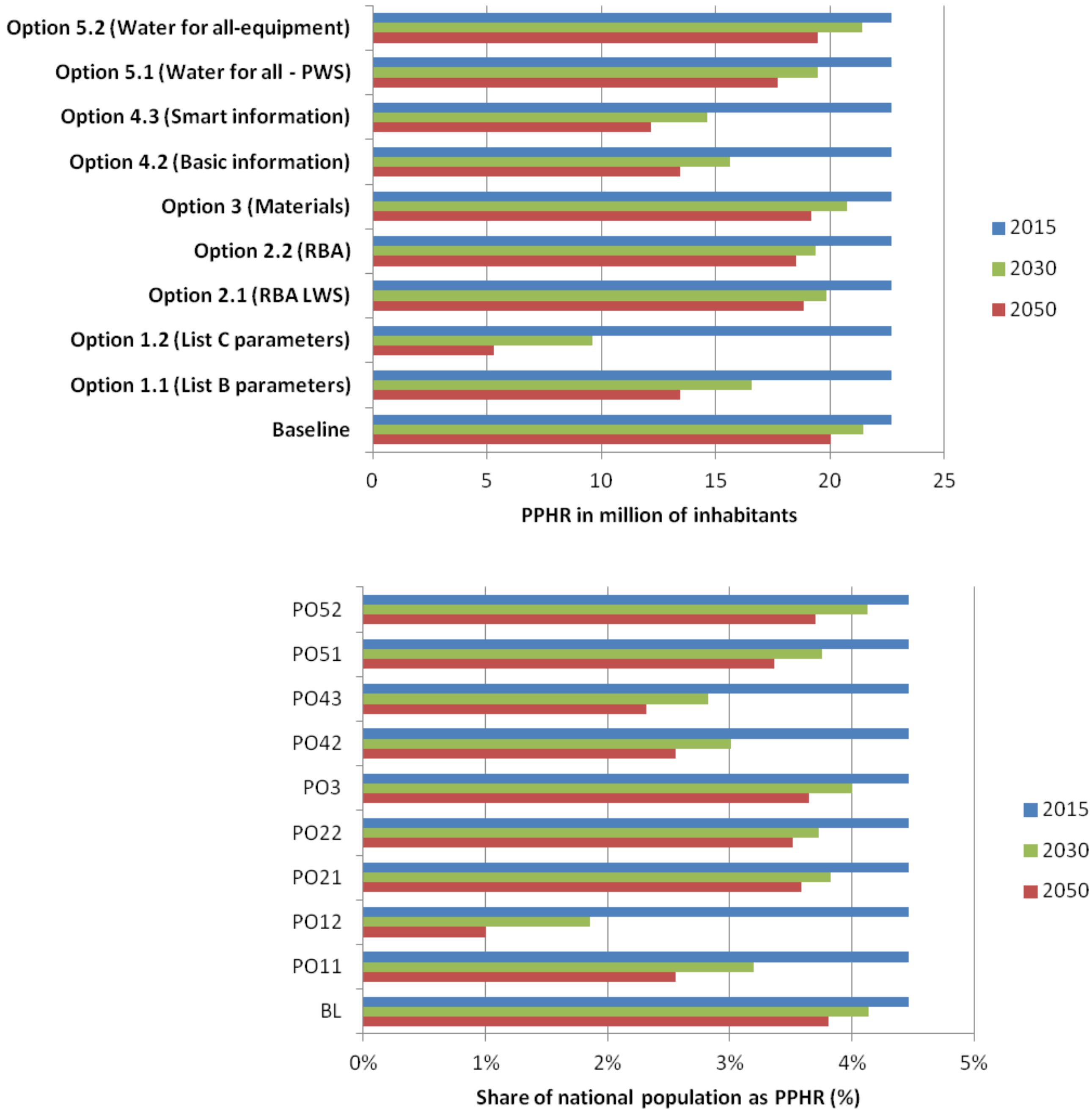


Figure 8. PPHR in baseline and policy options in 2030 and 2050 (million people and % of total EU28 population)

Considering the baseline and all policy options, PPHR in 2050 ranges from 20 million inhabitants (3.8% of EU28 population) for the maximum (Baseline) to 5.3 million inhabitants (1% of EU28 population) for Policy Option 1.2 "List C parameters".

To better capture the impact of each policy option on health risk through the PPHR indicator, it is interesting to represent directly the difference between each individual PO and the baseline in absolute value (Figure 9) or in percentage of the baseline situation (Figure 10).

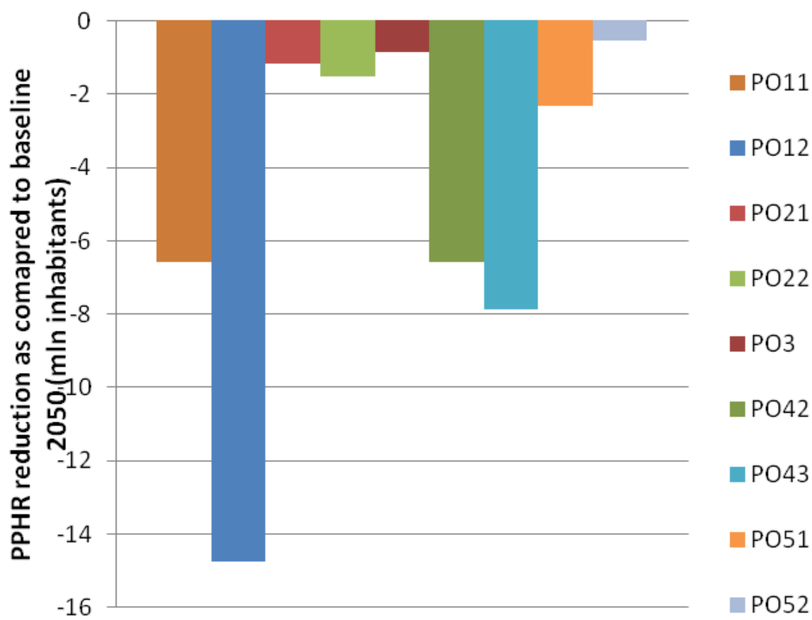


Figure 9. Difference in PPHR with baseline in 2050 (million inhabitants)

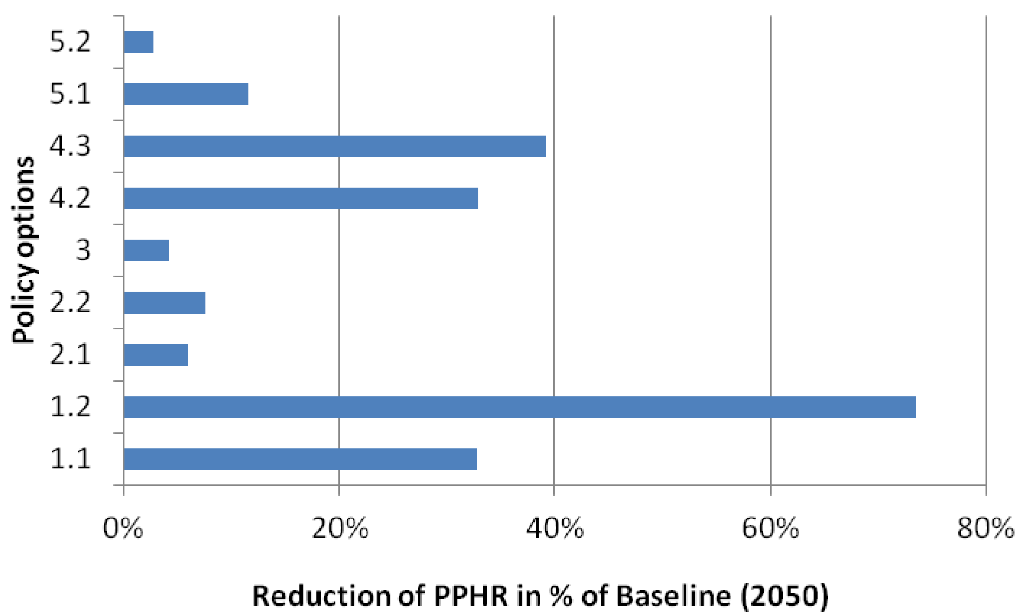


Figure 10. Difference of the PPHR as compared to the baseline (% in 2050)

The policy option with the **highest PPHR reduction as compared to baseline in 2050** is **Policy Option 1.2 ("List C parameters"),** with a reduction of approximately 15 million of inhabitants (74% of PPHR in baseline). This could be explained by the high number of substances that would be monitored and treated and thus to the significant improvement in drinking water quality that would occur under this option.

The second "most efficient" policy option to limit health impacts on populations is Policy Option 4.3, with a reduction of population accessing polluted drinking water of almost 8 million inhabitants at the EU28 scale by 2050 as compared to baseline (reduction of 39% compared to the baseline). This reduction is made possible thanks to the "power" accorded to population of influencing water suppliers decision and thus to lead to an improved water quality.

Then the third policy option with the largest positive health impact as compared to baseline is both Policy Option 4.2 and Policy Option 1.1, with a reduction of PPHR by 6.5 million of inhabitants for both (equivalent to -33% as compared to the baseline conditions). The results of Policy Option 4.2 could be explained by reasons similar (at a lower level) than for option 4.3. And the results of Policy Option 1.1 can also be explained by reasons similar (at a lower level) than for option 1.2.

At the opposite, the options with the lowest improvement in PPHR as compared to the baseline are, with approximately similar results, Policy Option 3 (standards for materials in contact with drinking water) and Policy Option 5.2 (equipment of population not connected to PWS) - with a PPHR indicator around 19.3 million inhabitants (reduced by 3 to 4% as compared to the PPHR for baseline). Low improvement with Policy Option 3 could be explained by the fact that other impacts not captured through the PPHR indicator are associated with this option - mainly impacts on organoleptic characteristics of drinking water. Concerning Policy Option 5.2, the reduction in PPHR is marginal relatively to other options (500 000 inhabitants) because: (1) "only" 0.4% of the EU28 population (2 million inhabitants) are not connected to PWS networks in the 2050 Baseline scenario[111] - among which half are assumed to be already equipped with self-supply systems and thus would be concerned by this option; (2) being equipped with an individual supply system and benefitting from actions to reduce pollution of fresh water would not completely remove all potential health risk in particular as the list of parameters taken into account would stay unchanged as compared to the present situation.

The results in PPHR for both sub-options related to mandatory RBA adoption (2.1 and 2.2) could seem surprising but they can easily be explained: (1) even though the mandatory RBA is considered as being more effective in terms of health risk reduction as compared to the "voluntary" RBA, the difference is much smaller than between no RBA and voluntary or mandatory RBA: this results from the assumption that many water suppliers (large and small ones) would already apply a RBA by 2050, resulting in a difference between Policy Options 2.1/2.2 and baseline being limited; (2) the application of a RBA is expected to improve the detection and the treatment of contaminants in drinking water. At the same

[111] There is no inconsistency between the connection rate to PWS of 95% in 2050 mention in section 5 and the 4% not connected mentioned here for the 2050 Baseline. Indeed, connection rate to PWS are assumed to be stable in each MS between 2015 and 2050, but national populations evolve differently across MS - leading to global connection rate to PWS slightly different between 2015 situation and 2050 Baseline (5% vs. 4%).

time, it will also deal with the organisation of water services. Thus, we did not assume that substances currently not listed (list B and list C) would be included in contaminants treated thanks to RBA.

Finally, Results for Policy Option 5.1 could also look surprising, as giving access to PWS water to all citizens appears as implying no health risk. Under this option, however, the list of substances monitored and treated and the drinking water quality (contamination by list A/list B/List C substances) are not assumed to change, with impacts on health risks being finally limited at the EU28 scale (see next section for details by MS) - moreover because “only” 4% of EU28 population are concerned by the improvement.

In the calculations of the PPHR indicator, differentiated levels of risk were considered - corresponding to low, medium and high risk (see section 1.3 for more explanation). Figure 11 below presents the outcome of calculations for the baseline and for all policy options for 2050 and for the different categories of risk.

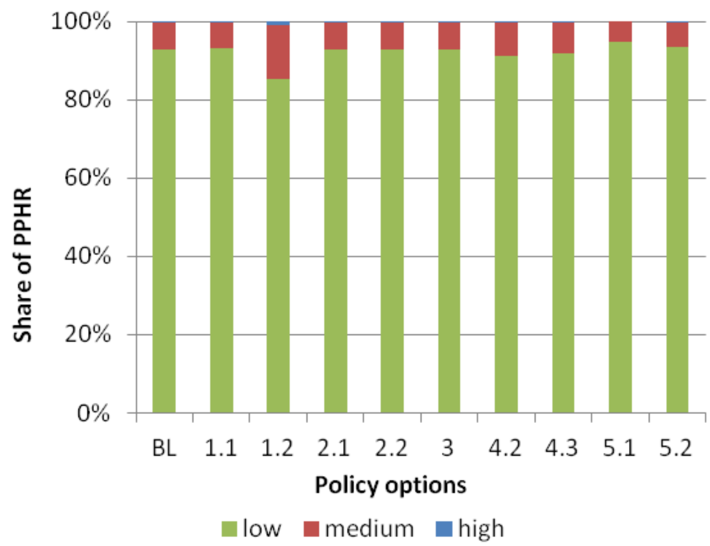


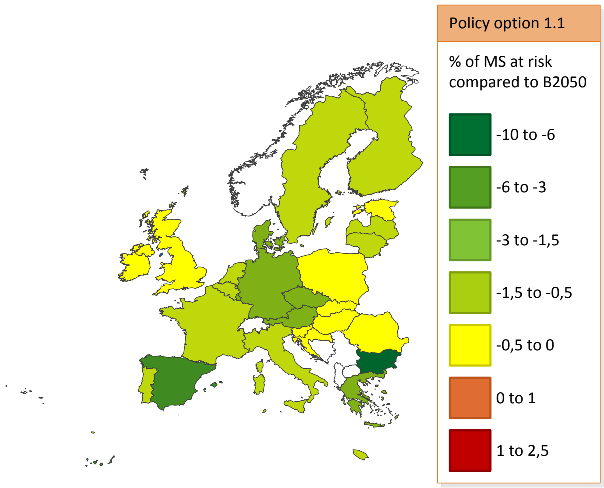
Figure 11. Share of the different levels of risk in PPHR in 2050 as percent of the total PPHR

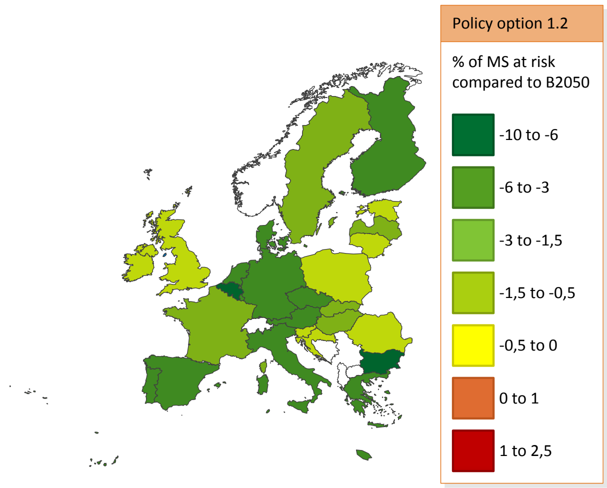
The total PPHR contains mainly population potentially facing a low potential risk related to drinking water (always more than 85% of PPHR), and very few persons facing a high risk (less than 1% of PPHR). The only policy option that differentiates from the others in terms of repartition of PPHR between the different levels of risk is PO 1.2 - which is also the one with the lowest total PPHR in absolute value. Indeed, in this option the share of PPHR facing a medium or high risk would be superior than in other policy options (15% against 7% in average in other options) - but would still be much lower in number of inhabitants (700 000 inhabitants against more than 900 000 inhabitants in all other options).

7.1.2. Variation of health impacts across MS

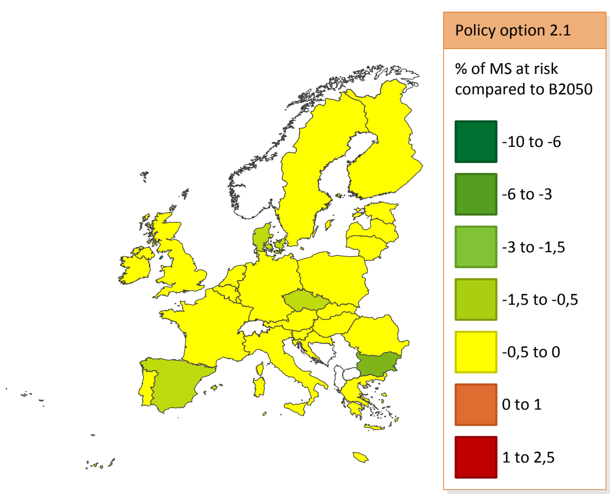
Significant differences exist among Member States in terms of levels and changes in PPHR in both absolute and relative terms, these differences depend mainly on the MS' characteristics and current situations (in terms of demography, water sector and environmental context). Annex 3 provides results on the PPHR estimated for each policy option compared to the 2050 baseline at the scale of each MS. The maps below illustrate some of the differences between MS, presenting for each policy options and MS the expected impact of a given PO in percentage of people at risk (PPHR) per MS as compared to the 2050 baseline.

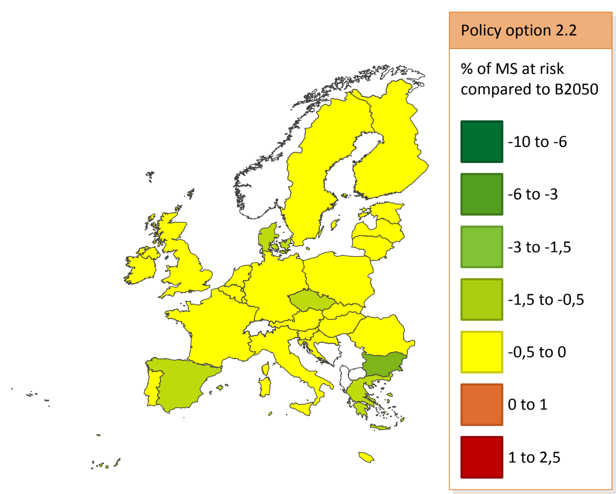
Map 2. PPHR reduction in 2050 as compared to baseline, in % of national population



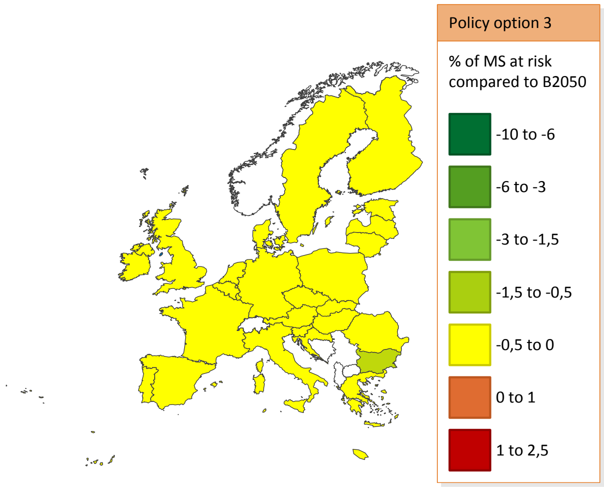


The health impact of Policy options 1.1 and 1.2 is diverse and shows a high variation across MS. Countries most affected by PO1 (both sub options) are Spain, Bulgaria, Belgium and Czech Republic. Countries that are less impacted (health wise) are Poland, Latvia and Romania. In PO1.2 all MS will have a 1.5% or higher percentage of reduction in number of people at risk (PPHR).

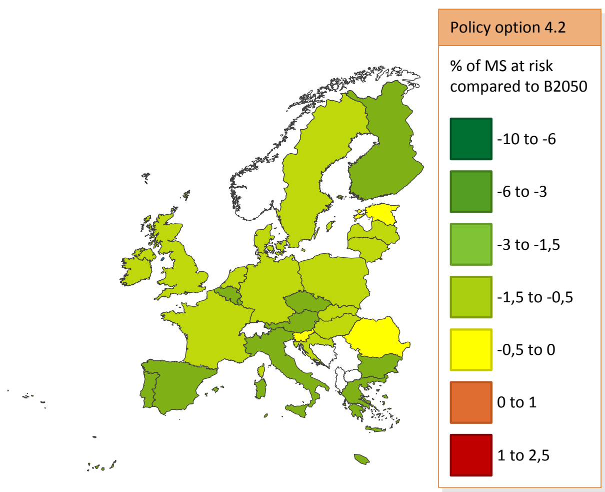


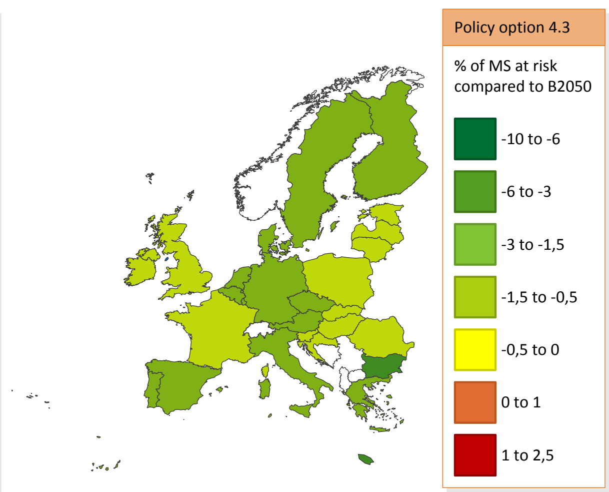


Making the RBA mandatory leads only to a minor reduction in the number of people at risk (PPHR) in PO2.1, with a slightly higher impact on Bulgaria, Spain and the Czech Republic.

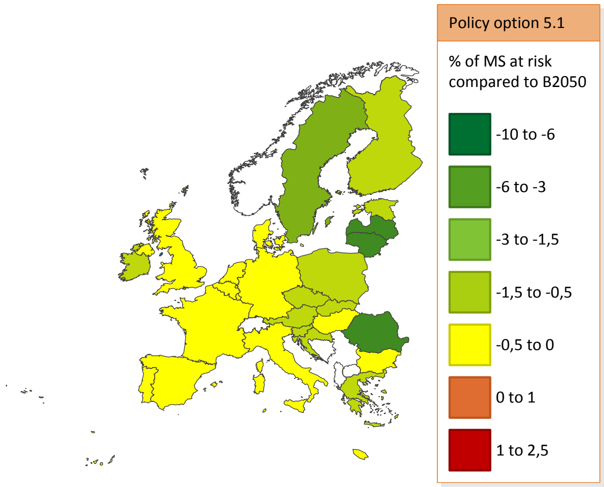


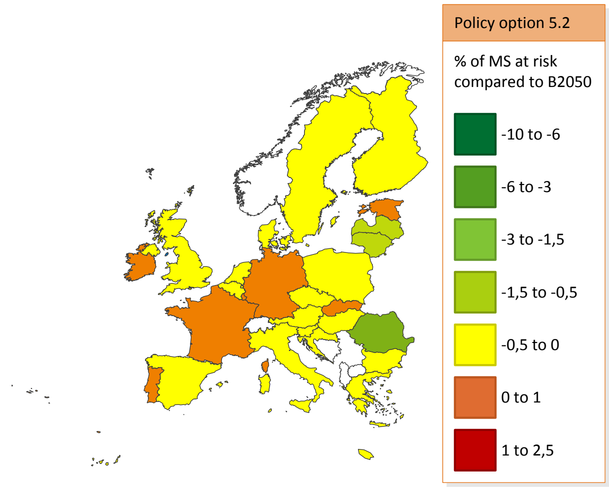
Policy option 3 has some impact on reducing the number of people at risk (PPHR) in each MS. Most notably it improves the situation in Bulgaria.





PO4.2 and PO.43 have a similar impact on each MS, although PO4.3 shows a slightly higher positive impact on the number of people at risk (PPHR) compared to option 4.2. The most positively affected MS are Cyprus, Malta, Bulgaria and Luxembourg.





When looking at the impact on specific MS, it is interesting to note that (in particular for Policy Option 5.1) benefits in terms of the reduction in the number of people at risk (PPHR) accrue mainly for Eastern European MS - with Romania, Latvia and Lithuania being the most positively impacted in terms of health impacts.

Concerning PO 5.2, some MS see their PPHR indicator increase. This can be explained by the calculations applied to estimate PPHR: very few MS have their PPHR increasing because people that were not connected or equipped by self-supply systems where assumed to mainly drink bottled-water (risk=0). Under PO 5.2, they would now drink drinking water thanks to their new individual equipment (but with a potential risk higher than 0). However, MS the more positively impacted by this option are the same than for PO 5.1.

7.1.3. Long-term health effects

In the above two sections, the approach and results on the share of people facing a potential short or mid-term health risk related to drinking water in the baseline and each policy option have been set out. Next to the short term risk and health effects of each policy option there are, however, also long-term health effects of changes to the DWD / water quality (e.g. carcinogenic and in the past lead-poisoning). Assessment of these non-acute risks is however both hard to measure and (when measurable) to causally relate back to the consumption of drinking water (e.g. the source). Notably, for some POs one can argue that all people connected to a water supplier are impacted in the long-run. Comparing of POs and the severity of the long-term impact of a PO in this instance becomes very arbitrary (if each PO has a positive long-term impact on 400+ million EU citizens, how to determine which PO should be preferred over another PO).

As said in section 1.3, the population potentially facing only a marginal risk related to drinking water has not been included in the PPHR indicator. However, it appears that if this population is probably not facing a potential health problem at mid-term (e.g. becoming sick) those people are neither facing a null risk. In consequence, it is assumed that this share of population that is potentially facing a marginal risk related to drinking water could represent the potential long-term health effects of drinking water that is not fully "inert" for human health (e.g. as a factor slightly increasing the probability of a disease). Thus, we have analyzed this share of the population (the population "marginally" at risk) separately from the other levels of risk (low, medium and high that have been combined into the PPHR indicator as explained above). In order to not count twice the short and mid-term health risks related to drinking water - included in PPHR indicator through low, medium and high risks estimations - we analyzed only the population facing a marginal risk related to drinking water to catch the potential only long-term health effects (even if people exposed to a short or mid-term risk also face a long-term risk[112]).

In the 2015 situation, the population potentially facing a long-term health risk related to drinking water (i.e. the marginal risk indicator) is estimated to be 105 million of inhabitants. In 2050, this population would increase up to 131 million of inhabitants. Compared to this baseline scenario, Figure 12 shows how policy options would impact long-term health effects.

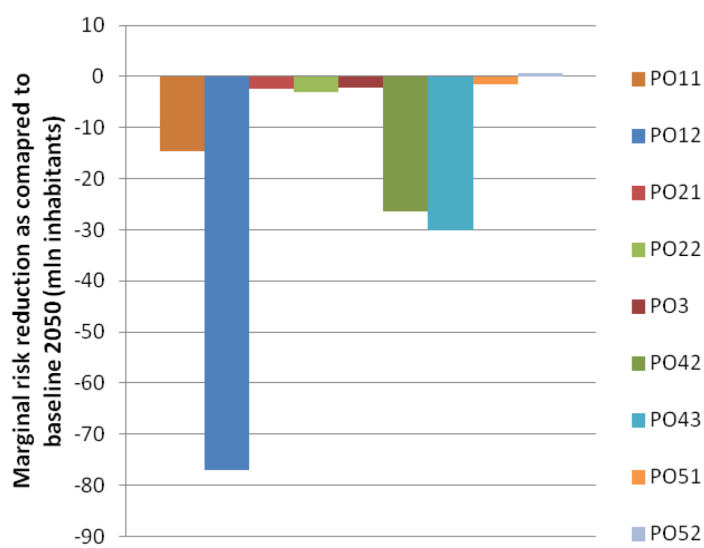


Figure 12. Difference in population facing a marginal health risk with baseline in 2050 (mln of inhabitants)

Comparing this graph with the one on figure 8 allows to see that concerning long-term health effects variations, policy options are not ranked in the exact same order than for PPHR (corresponding to short and mid-term health risk). Option 1.2 is the most effective to lead to a reduction of potential long-term health problems in the population, but policy options 1.1 would have an impact on long-term effects reduced as compared to impacts on short and mid-term risks (catch by PPHR indicator) - and this may be explained by the fact that part of those long term health effects are related to the substances that are in list C (PO 1.2) and not in list B (PO 1.1). Accordingly, policy options 4.2 and 4.3, which thanks to

[112] The authors also remind that however every person connected to PWS may be impacted by the different policy options, but what we try to catch here is how many people have the more significant impact (even if marginal) and how this differs between POs. Thus, the "not at risk" population is assumed to get a potential long-term effect that is either 1) not quantifiable ; 2) of very very low impact; or 3) leading to a difference between POs that cannot be measured and that is seen as the core of the current study.

consumers' information lead to an improvement of drinking and fresh water quality for the different categories of substances, would lead to a more effective reduction of potential long-term effects as compared to their impacts on short and mid-term risk (PPHR) - and relatively to other policy options).

At MS scale, the detailed analyze is not proposed here, but figures of long-term effect (population at marginal potential health risk) for every MS and each policy option are detailed in the annex.

7.1.4 Associated health benefits in monetary terms

This section discusses per policy and/or sub-policy option the associated health savings (or cost increase) with PPHR estimation (see 7.1.2 for PPHR estimations)[113].

Societal benefits or healthcare costs

In the 2015 scenario we calculated, when combining the results for people at high, medium or low risk (indicator PPHR), that in the EU almost 22.7 million people are at risk of potentially suffering from health problem due to drinking not 100% safe water, see Annex 2 for detailed overview of results per MS. Towards 2050 the number of people at risk is reduced to 20 million.

That these people are at potential risk does however not mean that we expect this many people to fall sick every year. Based on the 2008-2012 average number of sick cases (corrected for not reported sick cases and causality, see Annexes 2), the actual number of people falling sick related to drinking water would be only 31.500. We assumed that the societal cost of being sick (or health costs) consists of two main components, namely the hospital and / or general healthcare costs and the cost due to loss of production or productivity[114].

Then, a mathematic relation can be found between PPHR indicator and number of sick cases at EU28 scale in 2015, and thus between PPHR indicator and societal cost of being sick (i.e. a cost in euro per person in PPHR and per year). This allowed us to assess societal cost of being sick in the baseline and under all Policy Options, and to compare the impact of each option as compared to the baseline. We expect that the associated benefits or cost related to health impacts - expressed in monetary terms – could be more easily compared to other categories of (in particular economic) impacts.

For each policy option, the direct health cost change has been calculated, the graph below comparing the financial (minimum) impact per Policy Option at the EU level. The graph shows that PO1.2 will lead to the largest reduction in health costs, shortly followed by PO4.3, 4.2 and 1.1.

[113] For a detailed overview of the methodology used to assess monetary health impacts we refer to Annex 3.

[114] The costs for falling sick thus consist of salary for a replacement employee and loss of productivity. On average the cost have been estimated at € 94 - see Annex 3 for more details.

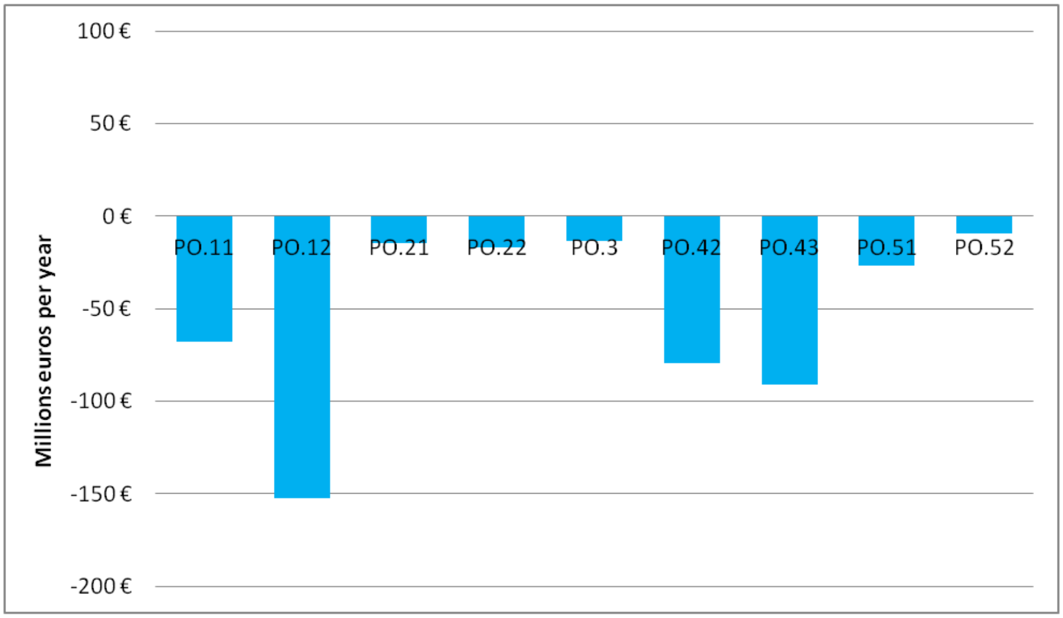


Figure 13. Annual change in health costs per policy option (in 2050 as compared to baseline)

Sub-option 1.1. If policy option 1.1 is implemented we expect, as a minimum, that this leads to a reduction of 6,5 million people at risk compared to a total of 20 million people at risk in the baseline. In monetary terms this leads to a direct societal benefit (hospital and productivity savings) of almost €46 million in 2030 and up to €69 million in 2050.

Sub- option 1.2 The implementation of policy option 1.2 will lead to a reduction of 15 million people at risk in 2050. The direct societal benefits are €153 million, making it the policy option with the highest direct health benefits.

Policy-option 2 (sub-options 2.1 and 2.2): As a result of implementing RBA by 2030 we calculated a reduction of 1.2 to 1.5 million people at risk by 2050. The mentioned health savings amounts are from €14m to €17m per year respectively for both sub options.

Sub-option 3: Presently, the product standard harmonization policy option is assumed to lead to a reduction of people at risk in 2050 by 0.9 million and in health benefits the 2050 scenario will lead to savings of near €14 million.

Sub-option 4.2: In terms of health benefits, this option is expected to decrease the number of people at risk by 6,6 million of inhabitants. In monetary values this implies a direct benefit of €80 million.

Sub-option 4.3: Policy option 4.3 reduces the number of people at risk further than PO.42 to a decrease of 7.8 million. In monetary values this implies a direct benefit of €92 million.

Policy option 5 (sub-options 5.1 and 5.2): The number of people at risk through policy option 5.1 is reduced by 2.3 million of inhabitants as compared to baseline, 26 million euros of health benefits. Health benefits of policy option 5.2 are realised for just over 550.000 people, representing a health benefit of 9 million euros.

Marginal cost of reducing health impact

Lastly, we calculated the cost for protecting one additional person from being at potential risk in each policy option. Information on direct costs (operating costs and setting up costs) associated to each option are given in the economic impacts sections 7.2.1 and 7.2.2 - but as the calculation of the marginal cost of reducing PPHR relates to health impacts, we choose to analyze this here. This analysis has been done for the persons at risk included in the PPHR indicator (i.e. potentially exposed to low, medium or high potential risk). Figure 14 shows how much need to spend to protect one additional person that was at risk for EU28.[115]

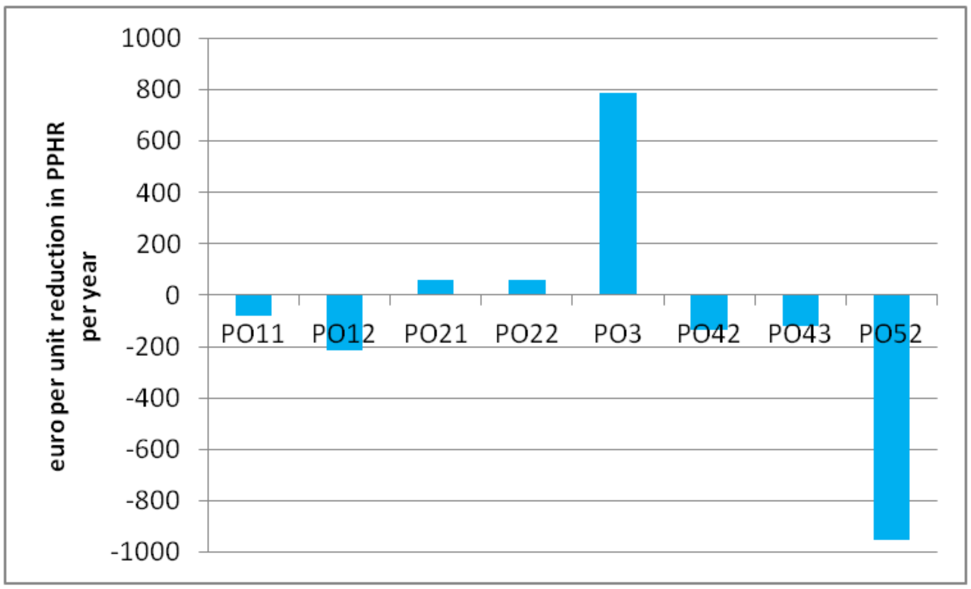


Figure 14. Marginal cost to reduce PPHR per policy option

From this figure we find that PO1.1 has the lowest cost marginal cost for reducing PPHR (81 € per unit reduction in PPHR), or the highest 'value for money'. At the opposite, and policy option 5.1 put apart because of its really high associated investment cost, PO5.2 has high marginal cost for reducing PPHR - approximately 950 € per unit reduction in PPHR. Policy options 2.1, 2.2 and 3 have a marginal "benefit" for reducing PPDWHR, which means that the global cost of those options as compared to baseline is lower.

[115] The cost per person for PO5.1 is equal to -2007 euros - it is not shown on this graph because as it is really high as compared to other POs and to better reflect the difference between other POs.

7.2 ECONOMIC IMPACTS

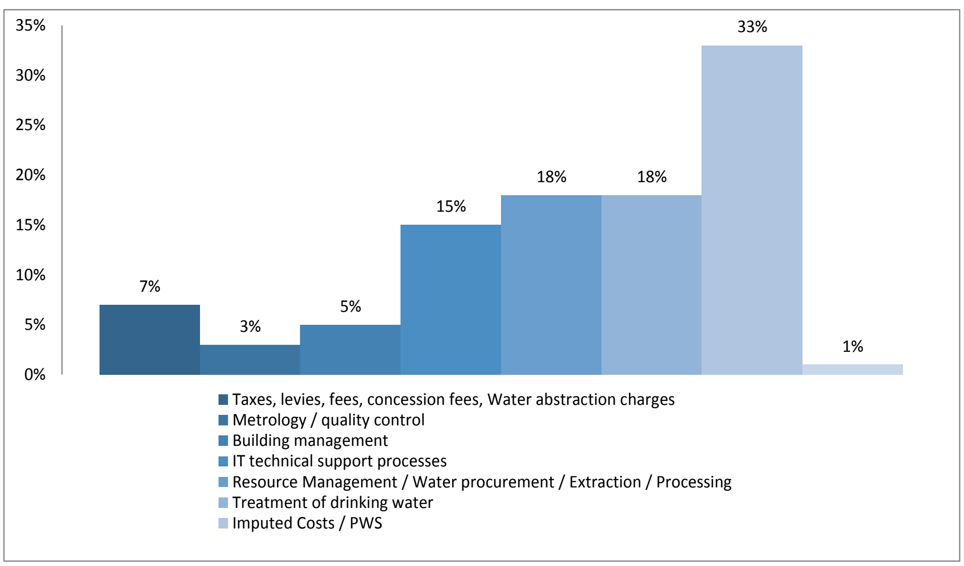
The key economic impacts from the suggested policy options that have been identified include: growth and investment; sectoral competitiveness; facilitating SMEs growth; achievement of the Single Market; increased innovation and research; technological development and digital economy

7.2.1 Economic baseline

The sections below discuss the baseline and the impacts following the implementation of the different policy options along the above mentioned main economic issues.

Drinking water provision to consumers costs roughly €46 billion in Europe on a yearly basis (evaluation of the EU DWD, 2016). Further, the water supply employed 387.000 persons and generated in 2010 a turnover of €128.000 per person or almost €60 billion in total.[116] The costs for supplying drinking water are spread over a number of macro-activities that are required to comply with strict quality and quantity regulations.

The graph below, that breaks the calculated total cost of drinking water provision down to the following cost-categories according to market findings for Germany (VEWA), should provide a clear view of the importance of each cost component in the baseline, in particular: Monitoring (metrology and quality control); Treatment effort (and accidental pollution); IT support; Taxes, levies, fees, concession fees and water abstraction charges; Resource management, water procurement, extraction and processing; Building management; and Imputed cost (as a measure of discounted PWS investments).



Source: Ecorys (2016), adapted from VEWA

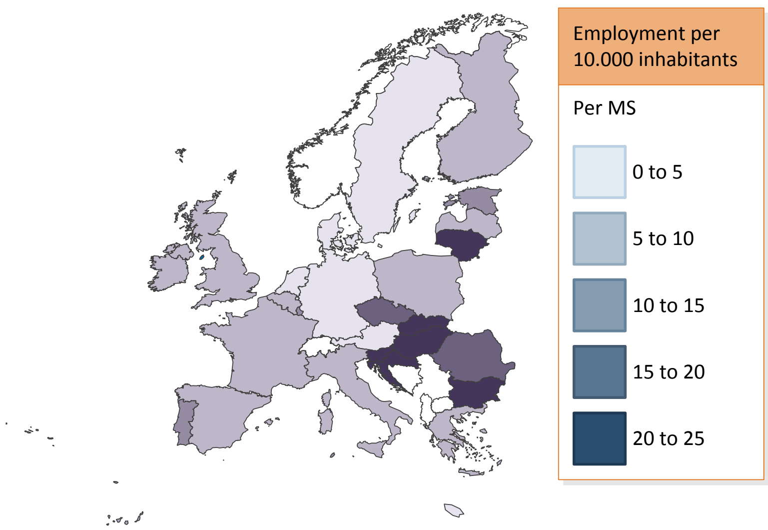
Figure 15. Distribution of costs across main cost components (2050 baseline)

116 Eurostat archive, Water collection, treatment and supply statistics - NACE Rev. 2, Table 2

The graph further shows that, for instance, an increase of 30% in monitoring cost is equal to an increase of 5% in treatment cost.

In the EU water supply sector[117], employment is relatively stable since 2005 with only a small decrease during the economic crisis (albeit overall employment in the sector was still larger than in 2005).[118] In 2010 the total employment for the sector was estimated at 387.000[119] people. According to the Eurostat data the average turnover per employee was €128.000 in this year.[120] Furthermore, the study on the potential on the EU water industry sector (2010), showed that there is a large difference between the numbers of FTE's per 10.000 inhabitants in each MS, as shown in Map 3.

Map 3. Map of direct employment in the drinking water sector in different MS per 10.000 inhabitants



For the DWD the annual costs per person have been estimated and from this afterwards the total value of the drinking water sector. As different approaches have been used the total market value for 2010 is not completely the same.[121] Estimations on total market value for 2010, 2015, 2030 and 2050 combine findings from the DWD, Eurostat and the PPDHW forecast. The estimated growth for these years has been used to provide a good approximation of the total employment in the water sector in both the baseline scenario and the impact that policy options have on the increase/ decrease in total market value.

In the 2015 baseline scenario it has been estimated that there are 413.000 people working in the water supply industry, which is an increase compared to 2010 and is most likely contributable to the end of the

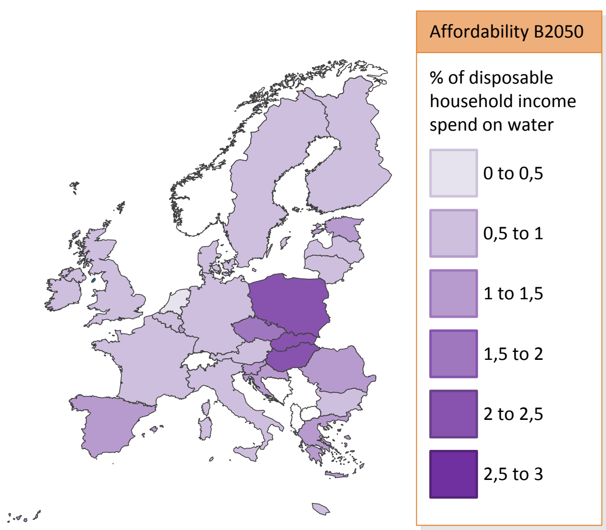
[117] The water supply sector entails, according to Eurostat, all activity directly related to water collection, treatment and supply.
[118] Study on the potential for stimulating sustainable growth in the water industry sector in the EU and the marine sector, 2010
[119] Eurostat (2010) figures and values for Malta and the UK are estimated to obtain the total for EU28 (as they are not available through Eurostat)
[120] Eurostat, 2010, corrected for Turkey, Switzerland, Hungary, Norway and the UK. Turnover per person for Ireland, Luxembourg and Sweden was over or near €1mln per employee and deemed incorrect. The number of employees has been increased based on expert opinion and turnover per fte is in line with similar countries.
[121] The DWD evaluation study developed the total using detailed information from 6 MS and estimated through disposable income differences the total value for the EU28 (assuming similarity in cost between MS).

economic crisis (which led to a reduction of the sector in 2008-2010). The number of people employed by the water supply sector is forecasted to slowly decrease to 409.000 in 2030 and 404.000 in 2050, in line with forecasted total market value. The main reason for this minor decrease is due to efficiency gains resulting from voluntary implementation of RBA, leading to less treatment required.

As can be seen from Map 3 the number of people employed in the water sector increases per MS from north-west to south-east (globally), with the highest employment per 10.000 inhabitants being found in Bulgaria, Hungary and Slovakia. Sweden, The Netherlands, Germany and Austria employ the lowest number of people per 10.000 inhabitants.

Next to total annual cost for the EU and the employment per MS, another important baseline indicator is the cost of drinking water per household and per MS. In 2015 the average cost per household is estimated at €229 per MS. This decreases slowly to €225 in 2050. The impact on the disposable income is in 2015 0,926% and in 2050 0,913%. Map 4 shows the cost as a percentage of disposable income for 2050 per MS. The map shows that water is compared to the disposable income expansive in Poland, Slovakia and Hungary. Countries that spend a small percentage of their income on water are the Netherlands, Sweden and Denmark.

Map 4. Map of the affordability in different MS, baseline 2050



7.2.2 Economic Impacts

Each policy option will have an economic impact on drinking water providers, other enterprises, consumers and/or public authorities. As the policy options have a direct effect on the (operations of) the drinking water providers, these effects will be assessed separately. The outcome of this assessment in terms of costs (of inputs, capital, labour, impact on the annual household bill and other), will be used to quantify the other (more indirect) effects.

Impact on drinking water sector

In this section we discuss the impact of policy options on two types of expenditures for water providers, namely the setting-up or investment cost and the annualized operating cost.[122] The setting-up costs are the sum of the 'initial' investments[123] that are expected to occur. The annualized operating cost cover the entire range of impacts due to a policy option and, among others, cover also the setting-up cost (the total setting-up cost have been divided by the average lifetime of a specific investment). Most of the policy options impact the cost, be it annually or through a direct investment, through an increase or decrease in monitoring, treatment, IT processes and connection rate in a MS. In the following sections we show the cost figures and the resulting direct economic impact compared to the baseline scenario for each option and sub-option. Additionally, we graphically show what the expected impacts are on annualized operation cost for each MS. Detailed figures per MS are included in Annex 8.

Including new, more or less parameters in Annex 1 (policy options 1) will require that new sampling systems for monitoring are set up and associated equipment is purchased. Since some of the new emerging substances are a health concern, operators will incur expenses in terms of equipment and the time involved in designing the new tests. This additional work will require that **additional treatment** takes place and this leads an increase in costs, especially where it concerns pharmaceutical or emerging substances, as there is of yet no understanding of which treatment techniques would produce the best results.[124, 125] To calculate the economic impacts of policy option 1.1 to 1.3 we used the information of cost of treatment as obtained from the DWD evaluation study (18% of total cost)[126]. In the baseline the yearly treatment cost of treatment for drinking water providers is €8.3 billion in 2014 and this decreases to €8.1 billion in 2030 (mainly caused by higher implementation of RBA) and increase slightly towards 2050.

In addition including new parameters in Annex 1 will require that **new sampling systems for monitoring** are set up and associated equipment is purchased. For the new substances operators also need to design tests and set-up procedures for collecting and analysing samples. Once these investments have been made, changes in operating costs will however be insignificant. However, the operating costs of monitoring are mostly independent of the number of parameters analysed. This was also concluded by COWI in the 2008 study on the "Impact Assessment of possible Revisions to the Drinking Water Directive" [127].

[122] Note: A third cost/ impact component, that is not taken up in the cost of water provision but included in the analysis as it impacts total cost for consumers, is the spending on bottled water.

[123] Note: Water providers spread on average high investments out over a 'longer' period of time, e.g. in the Netherlands large PWS investments are discounted over 30 years (economic discount rate, the technical lifespan of a PWS can be up to 100 years).

[124] Human pharmaceuticals in the water cycle (STOWA, 2013)

[125] Based on an article by Waterworld it costs (in the UK) 27 billion euro to add 15 substances to overall monitoring and treatment. In the analysis we assumed that two-third of these costs are related to treatment investments and one-third to additional monitoring. Source: http://www.waterworld.com/articles/wwi/print/volume-27/issue-4/editorial-focus/micropollutants/priority-substances-impact-on-water.html

[126] Ecorys (2016), Study supporting the revision of the EU Drinking Water Directive. Chapter 3.1.

[127] https://circabc.europa.eu/sd/a/0f6acdc1-54d4-4009-8bf7-c2ee5b92ed85/IA_DWD_Review_Report_Sept2008.pdf

The economic impacts of the number of parameters are furthermore expected to differ significantly on a regional level.[128, 129] In Table 8 below we have set-out the main assumptions and total economic impact of the three sub-options.

Table 8. Main assumptions and total economic impact of the policy option 1

Sub-option	Setting-up cost/ Other cost	Annualized cost change compared to 2050 baseline	Change in cost per household
1.1: Monitoring and treatment of new parameters in Annex 1	€2 bln setting-up cost for treatment	€535 mln	€2,30
1.2: Long-list of parameters and emerging substances	€6 bln setting-up cost for treatment.	€3.137 mln	€13,6

The overall increase for PO1.1 and PO 1.2 are expected to be somewhat higher by 2030 than by 2050 as both the number of emerging substances (only PO1.2) and voluntary implementation of RBA (see option 2) are lower as compared to the 2050 scenario. Furthermore, one should take into account when investigating the overall treatment cost in the future that other types of legislation can also impact the quality of drinking water (see box 5).

Box 5. Impact of 'other' water quality (related) legislation on treatment effort of water providers

What needs to be taken into account is that even if the cost to society of pharmaceuticals entering to our waters is high[130], there are other legislative instruments such as the UWWD and the WFD which are designed to reduce the presence of these substances.

Apart from relying on existing waste and water legislation, the EP study on "The Cost of Non-Europe in Water Legislation" (ibid) advises to investigate the costs and benefits of upstream measures such as adding environmental aspects to the EU pharmaceuticals authorisation system and EU-wide campaigns to encourage the replacement and safe disposal of unused drugs and measures to coordinate upstream action to reduce the level of pharmaceutical residues from urban waste water streams would lead to lower water wastewater treatment costs, which are estimated at an annual savings of 9 billion euro per year. This approach is in line with Article 191 of the Treaty on the Functioning of the European Union.[131]

According to the WHO (2012), for drinking-water sources that are contaminated with pharmaceuticals, advanced treatment may already be in place to meet regulations.[132] In such cases, removal of pharmaceuticals during treatment may already be optimized and the above calculated additional cost might be an overestimation.

[128] *Water quality monitoring in the French part of the Rhine district* (2006), argues that parameter is the main factor determining costs and new parameters may cost up to 30 times the cost for general physical-chemical parameters.

[129] Available data sources are either on EU or MS level (in most instances) and this assessment does therefore not provide regional results.

[130] The report on The Cost of Non-Europe in Water Legislation (EP, 2015), states that *water treatment costs of removing pharmaceutical residues from urban waste water streams are significant*

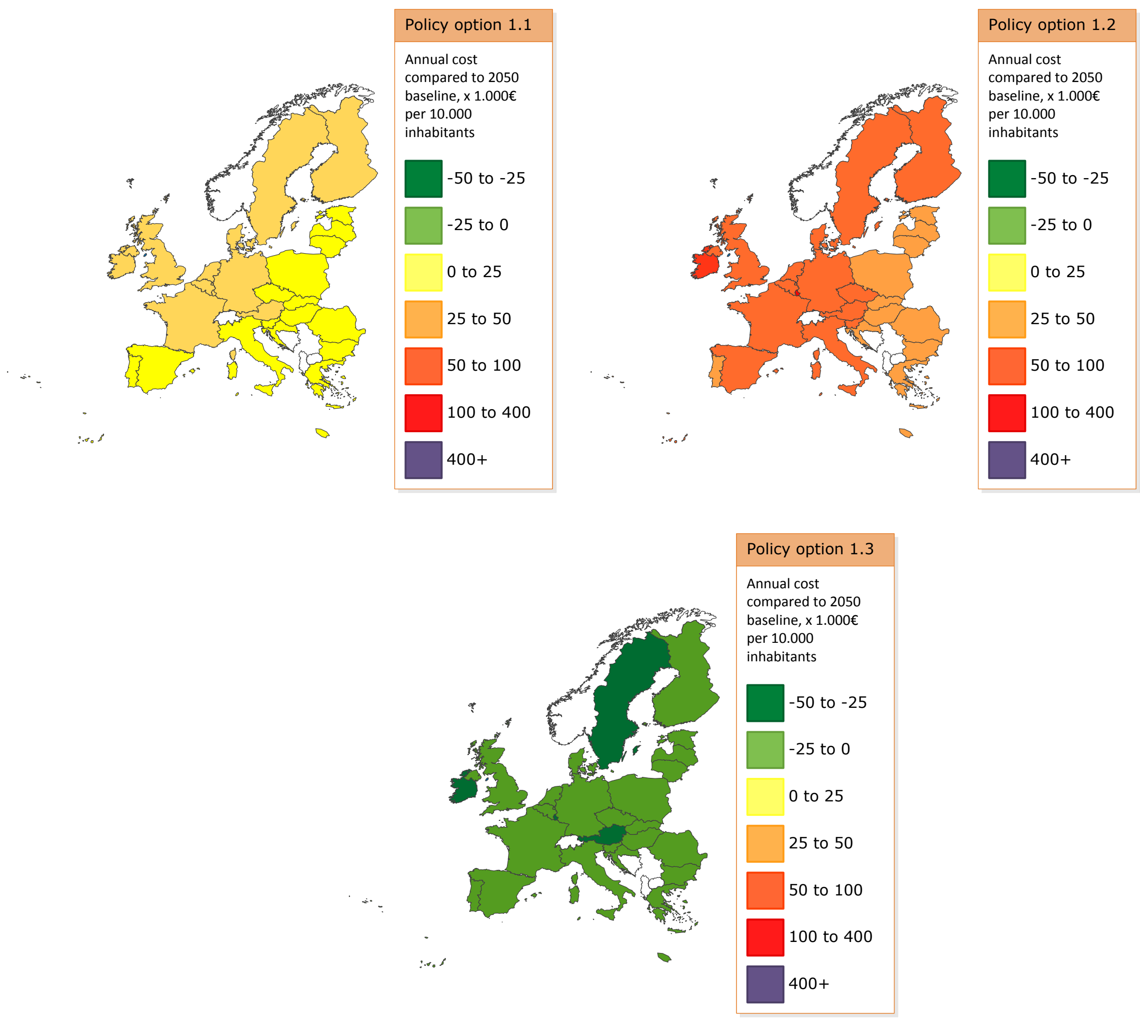
[131] Article 191: "'Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."

[132] WHO 2012, Pharmaceuticals in Drinking water

However, in spite of advanced and costly water treatment technologies available and applied, micro pollutants in concentrations below the detection limits of the most sensitive analytical procedures will continue to occur and the toxicological relevance of various compounds in the context of appreciable risks to human health should be taken into account (ibid).

Map 5 compares the impact each of the above sub-options would have on the annual cost (in total cost per MS) as compared to the 2050 baseline. The maps show how the sum of the impact is spread across MS.

Map 5. Annual costs distribution by MS in Policy options 1.1, 1.2 and 1.3



Overall the impact of any change to Annex 1, and associated impact on notably treatment, will be higher for northern and western European MS (both negative and positive impact). The higher impact is associated with the higher current cost in these MS.

The systematic implementation of RBA across all MS (option 2) is split between sub-option 2.1, in which we analysed the impact that all large water suppliers apply RBA, and sub-option 2.2, that also obliges small water suppliers to develop and implement a simplified WSP by 2030. The setting-up cost of the overall PO related to development and implementation of a WSP, 6-monthly audits and 3-yearly updates. For large water suppliers, the cost of implementation, auditing (every 6 months), updating (every 3 years)[133] is estimated at respectively €0,028, €0,001 and €0,003[134] per person served and savings on monitoring costs are expected to be 5%. For small water supply companies, the costs will be about half of this, and no saving in monitoring costs are expected (WHO, 2008). Table 9 below presents the total economic impacts of the sub-options by 2050 as compared to the baseline.

Table 9. Main assumptions and total economic impact of the policy option 2.

Sub-option	Setting-up cost/ Other	Annualized cost/(savings) change compared to 2050 baseline	Change in cost per household
2.1: Large WS implement RBA	€22 mln	-€73 mln	€-0,2
2.2: Large and small WS implement RBA	€25 mln	-€93 mln	€-0,4

For PO2.1, the total setting-up cost are €32m for 2030 and €22m for 2050, total setting up costs being respectively €38m and €25m for PO2.2. These setting-up costs, annually about a tenth of the total investment cost, are expected to result in significant (mainly treatment) savings. In the RBA option, it is assumed that more preventive actions would be implemented, leading to a reduced need of water treatment before distribution compared to no RBA. Savings through less treatment are estimated at €73m for PO2.1 and €95m for PO2.2 by 2030. In our analysis we assume that the investments for preventive actions account 10% of the total cost of treatment as preventive actions are more efficient, leading to an increase of €7m to €10m in the respective POs.

It is considered that reporting costs are unchanged as compared to the baseline scenario. In total the additional yearly cost of PO2.1 are - €134m by 2030 and - €169m for PO2.2. The yearly decrease in cost, when compared to the baseline, will decrease considerably (roughly by half) towards 2050 as by then nearly all WSZ have a WSP in place.

Costs linked to (accidental) pollution, i.e. costs of emergency intervention (treatment) and costs to distribute bottles of water to people facing outbreaks are in the baseline 0, as these costs are not a specific cost component of drinking water providers and we as such do not have insight into the share of these costs in the 2015 baseline. In general, accidental pollution and emergency treatment are not occurring to a large extent and cost, in case they occur, are spread through various cost components

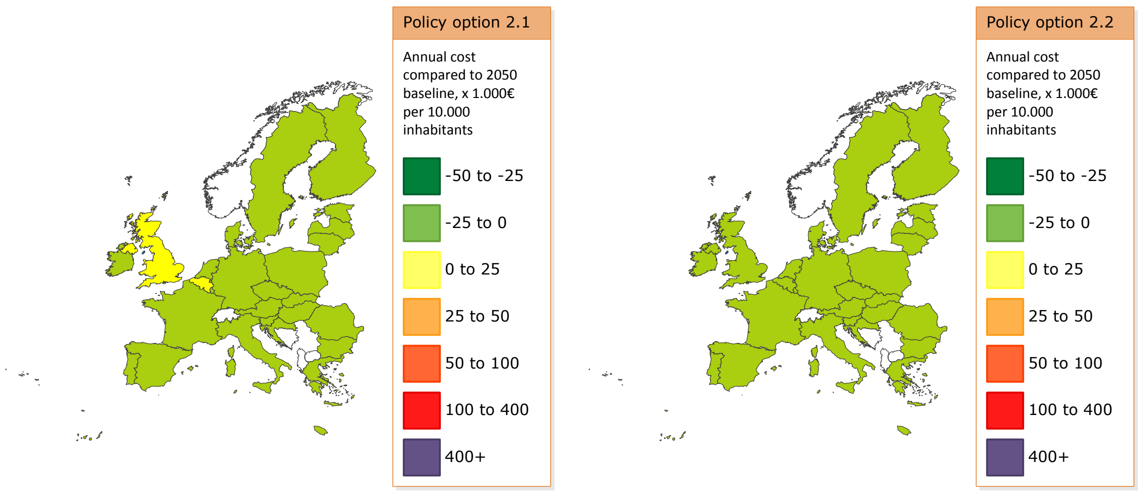
[133] These values are an average of various reported cases. The WHO reports in its 2008 Guidelines for Water Quality that Water Safety Plans need to be updated based on the treat level and as such a uniform time is not provided.

[134] Implementation cost of €0,03 euro/pp is based on the report by WHO on an Australian and European case. From this we have taken the mean (€0,17) and discounted it over 6 years. The €0,001 euro/pp is based on the WHO report (times 2 to have the yearly cost) and the €0,003 euro/pp for the 3-yearly update is based on the WHO Australian case (10% of implementation cost) and discounted over 6 years as it alternates with the set-up of a new Water Safety Plan.

over many years. We, however, expect that these (unknown) costs will be reduced as RBA should lead to a reduction of the occurrence of accidental pollution and emergency treatment.

Map 6 below compares the impact that each of the above sub-options would have on the annual cost (in total cost per MS) as compared to the 2050 baseline.

Map 6. Annual costs distribution by MS in Policy options 2.1 and 2.2



The map shows that overall the impact of policy option 2.1 and 2.2 is quite evenly spread across each MS (with an exception for option 2.2 in the UK and Belgium due to their already high implementation of the RBA).

For the economic impact of option 3 (harmonization of the system for materials in contact with drinking water), the implementation of a certification system for materials and chemicals in contact with drinking water will require investments to make existing materials compatible with those standards. Panteia (2016) estimated the current cost to approve/certify products and materials in contact with drinking water at €1.208 million per year (2.8% of turnover of Article 10 products). In addition, they estimated that the yearly cost savings through harmonisation are €664 million[135] (which is the reported cost made by producers to comply with foreign legislation).[136] The study did, however, not assess/ obtain findings on the expected costs related to implementation of harmonization of products (total benefits are thus slightly overestimated and setting-up costs are not included in the economic impact analysis). Regardless, it is widely expected that the future benefits of product harmonization will far outweigh the setting-up cost of product harmonization.

The impact of PO3 is calculated at the EU level (as certification in 1 MS will allow market access to all MS) and information is scarcely available on who will benefit from the reduction in certification cost (producers or consumers and MS X will benefit more/ less compared to MS Y). Therefore, it is not possible to present the benefit of this PO spread across the various MS.

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[135] The values reported are 2015 results. Now information on the increase/ decrease towards 2050 of product certification is available. The annual benefits for 2030 and 2050 are therefore assumed as constant compared to the baseline situation.

[136] Panteia, 2016. Economic Effects of article 10 of the Drinking Water Directive options

Policy option 4 is related to information and spread over three sub-options, namely: PO 4.1: Simplified automatic reporting to the EC; PO 4.2: Timely basic online information to consumers about quality of drinking water; and PO 4.3: Ensuring advanced SMART access to a wider range of information. Table 10 below provides an overview of the main differences and financial annual cost of each of the three sub-options[137]:

Table 10. Main assumptions and economic impact of the policy option 4.

Sub-option	Information provision	Annualized cost change compared to 2050 baseline	Change in cost per household
4.1: Simplified automatic reporting to the EC	€3.3 mln setting-up cost	€0.23 mln/yr increase	€0,0
4.2: Timely online information to consumers on water quality	€4.5 mln setting-up cost	€540 mln/yr increase	€2,3
4.3: Advanced SMART access to a wide range of water information	€5.9 mln setting-up cost	€325 mln/yr increase	€1,4

Option 4.1 (simplified automatic reporting to the EC) will ensure that information provided to the public will automatically be reported to the EC, reducing after a setting-up period the overall cost of reporting to the EC (DWD Regulation). The investment cost that are assumed for this policy option relate to employing additional expertise in each MS and at the EC. The setting-up cost amount to €3.2m by 2030 and relate mainly to developing the software and linking of systems. After these investments (with a renewal period of about 5 years) are made, there are yearly savings on information provision of €0.35m., to be compared to the current cost of reporting to the EC estimated at roughly €2.3m per year for the EU28 (COWI, 2008). As such, we expect that the investment is both leading to some (minor) savings and increases the information base of the EC, which should lead to more informed decision making. In the analysis we have not quantified the effect of more informed decision making by the EC. We do not expect any impact on other cost components or serious other economic impacts from PO4.1.

The costs of implementing option 4.2 are determined by the type and frequency of publications and the increased involvement of consumers that is expected to increase overall treatment efforts. Providing timely information about the quality of drinking water is not expected to place extensive additional administrative burden on water supply companies (this information is readily available, often in digital format). There may be small upfront costs to (re-)format the available information for consumer purposes. We expect a total of €4.5 million setting-up cost to develop the dissemination process and as such inform consumers timely about the quality of their drinking water.

The main annual costs related to this PO are concerned with the pressure from consumers to ensure that the quality of drinking water is upheld at every moment and as therefore additional treatment by water

[137] Without other economic costs and impact of savings from the bottled water

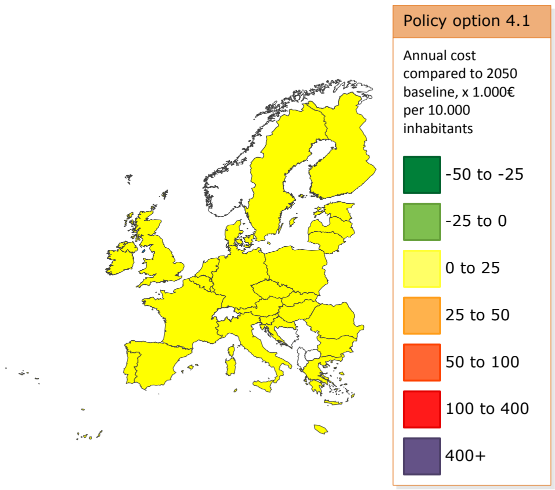
providers is expected. The impact of the more informed concerned citizen is difficult to determine, but assumed in the analysis to be 5% due to increased treatment effort, resulting in a cost increase of €540m per year. There will be some regional disparities, as MS in Western Europe may already have more advanced systems for e-communication than countries in Eastern Europe (with a notable exception of Estonia), that are not accounted for in the current analysis.

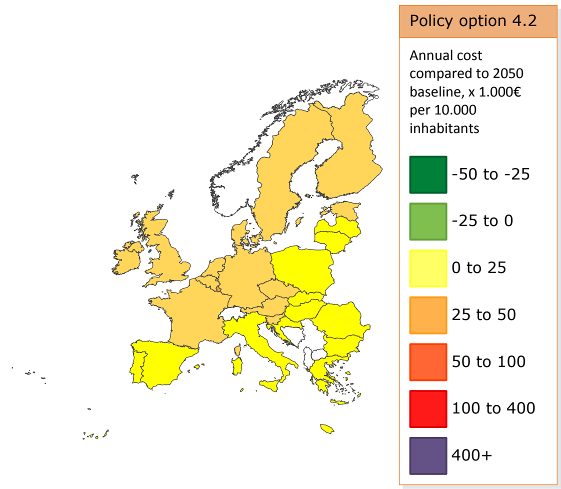
Option 4.2 might further create awareness on the quality of tap water and affect the level of bottled drinking water consumption. We assumed a reduction in bottled water consumption of 3% by 2030 and 10% by 2050, leading to savings of €336m. Overall we calculated that PO4.2 will lead to an increase in cost of €540m by 2050.

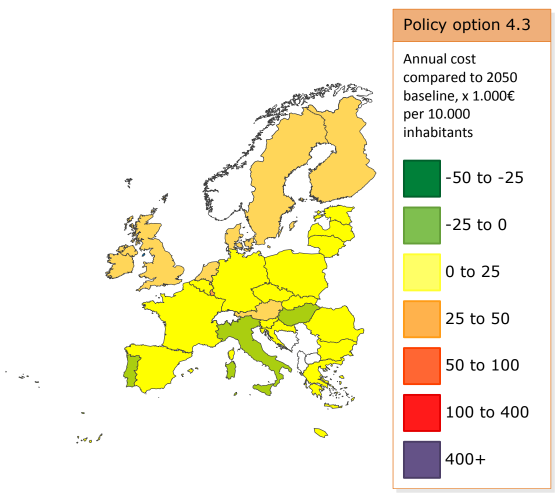
The economic impacts for sub-option 4.3 are similar to that of sub-option 4.2, but with a different level of consumer involvement. PO4.3 provides consumers with a much higher level of information on the performance of water suppliers (e.g. source, hardness, breakdown of water pricing, leakage rates, emergency response time, energy usage). Sharing this information is expected to lead to a more active involvement of consumers in the decisions made by water suppliers and. It is not possible to predict what this will mean for the water companies, but one possible outcome can be that citizens will be more willing to actively engage with the water companies in providing active and real-time feedback on the quality of water and the water supply system. This may in turn make the water companies more efficient. The access to information of option 4.3 will help consumers to influence water suppliers to become more efficient in terms of water and energy savings technologies, apply newer and better monitoring which can lead to better water quality (through adoption of more cost-effective measures to address pollution at source instead of treating polluted water) and increased trust. These measures are connected directly to the water pricing and linked to ensuring affordability of the drinking water for all (SDG 6 1). Increased information leads to a higher awareness of the quality of their drinking water, as such the number of people at risk is expected to decrease significantly and additionally we expect a switch from bottled water to tap water consumption (a significant share of economic gains stems from this switch).

The map(s) below compare the impact that policy options 4.1-4.3 have on the annual cost (in total cost per MS) as compared to the 2050 baseline:

Map 7. Annual costs distribution by MS in Policy options 4.1, 4.2 and 4.3



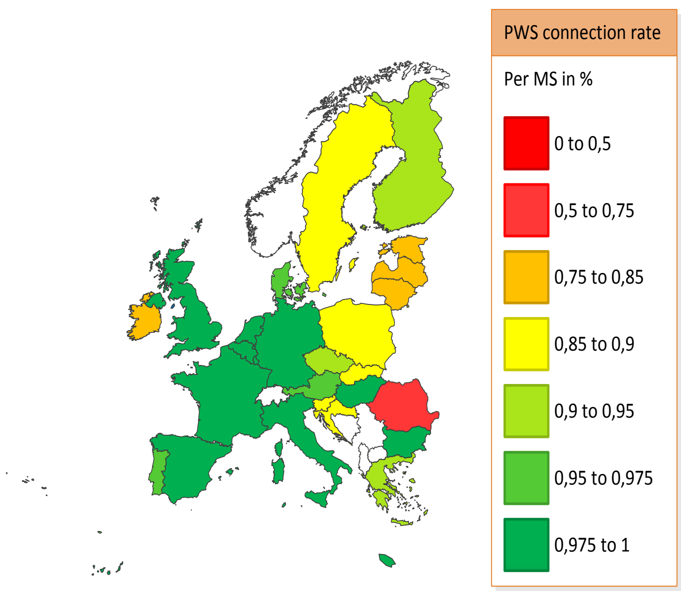




The impact per MS for Policy Option 4.1 is slightly positive (minor cost reduction in each MS) and as expected almost equal across Europe. PO 4.2 and 4.3 are leading to somewhat more diverse results. The annual cost per MS of PO 4.3 is mainly impacted by the percentage of population supplied by suppliers which implemented RBA among population connected to PWS (e.g. a very low percentage for Italy results in lower cost of additional information provision/consumer involvement, whereas a high percentage for Denmark results in a cost increase). The main annual costs related with this PO are assumed to increase treatment efforts by 10%, resulting in a cost increase of €873m per year. There will be some regional disparities, as MS in Western Europe may already have more advanced systems for community involvement than countries in Eastern Europe, that are not accounted for in the current analysis. PO 4.3 is expected to create awareness on the quality of tap water and affect the level of bottled drinking water consumption. We assumed a reduction in bottled water consumption of 5% by 2030 and 15% by 2050, leading to savings of €610m. Overall we calculated that PO4.3 will lead to an increase in cost of €325m by 2050.

Providing water to all EU citizens (option 5.1/5.2) Based on a literature review and previous interviews as part of the DWD evaluation showed that people who currently lack access to water services lack this not because they cannot afford it, but because they have no fixed dwelling to be connected to a PWS (such as homeless persons[138], Roma, and nomadic communities). The current refugee crisis has also added significant numbers to this group, especially in Southern European countries. The map below shows the percentage of a MS population that is currently (95.5% in 2015) connected to a PWS. In 2050 we expect an average connection rate of 95.9%, or an increase of 18.5 million people (increase is mainly due to increase in population size).

Map 8. Population connected to a PWS, 2015, % of MS population



Providing water to all of the above citizens (and others) is an aim that will require interventions at several levels and can be reached through various methods. In this assessment we analyse two of the possible approaches identified by the literature. Option 5.1 aims to connect all households in an Member State to a PWS, taking the following criteria to mind:

1. In many cities throughout the EU (especially in Eastern European countries), PWS can be expanded to include more households.
2. Second, in smaller towns and settlements, new PWS can be set up. These PWS should serve at least 500 people.[139]
3. Third, for small and remote settlements, houses which are presently supplied with water from local wells or cisterns, should be included in the monitoring schemes which guarantee that the water from these sources is safe and healthy.
4. The last 5% of households that will be connected will be three times as expensive to connect as they are located in remote areas or areas with 'difficult' geologic conditions.

[138] The number of homeless persons is not insignificant; it is estimated that in 2012 the number of people without a fixed abode was 878,000 (Estimate is based on data from European Federation of National Organisations working with the Homeless (FEANTSA)).
[139] Presently small water supply systems in the EU serve 760 people on average.

Option 5.2 aims to connect all citizens to at least a minimum level of water quality through obligating the purchase of a cistern/well. Table 11 provides an overview of the main differences and financial annual cost of both sub-options.

Table 11. Main assumptions and total economic impact of the policy option 5

Sub-option	Setting-up cost	Annualized cost change compared to 2050 baseline	Change in cost per household
5.1: Connecting 95% of population per MS to PWS	€82 billion, resulting in an annual increase of €2.8 billion	€4.639 million increase	€21,9
5.2: Providing citizens with a minimum water quality	€1.411 million, resulting in an annual increase of €472 million	€452 million increase	€2,2

For PO 5.1, the costs involved in the PWS investment varies widely and is depending on location, scale and type of system. To connect dwellings to an existing network, we have taken the current imputed cost (DWD evaluation, 2016) and divided this by the current connected population to obtain the annual cost of a 'normal' PWS, which is on average 31 euro per person. Afterwards we have calculated the number of people in Europe who still need to be connected to a PWS, which amounts to just over 21 million. The total, discounted, setting-up cost for option 5.1 amounts in this way to €2.8 billion per year.[140, 141] As more people will be connected the total cost for treatment, monitoring and information provision also increase slightly. For policy option 5.1 the total annual increase is calculated at €4.639 million in 2050. On average the cost will increase by €22 (ranging from €0 to €202) per household, making PO5.1 by far the most expensive policy option.

For PO 5.2, the costs involved with the investment in wells/cisterns to ensure a certain minimum quality of drinking water to all are based on the investment cost of a cistern times all the people who are currently not connected to PWS.[142] Based on the cost figures from various private providers of home water cleansing systems (they are cheaper, but also much more expensive systems available with varying water qualities) we estimated the cost at 130 euro per person, discounted over 3 years and including the cost for new fittings (operational cost). This policy option is expected to impact 10.9 million EU citizens.

[140] PWS systems are discounted according to the Dutch approach where PWS systems are written off in 30 years. PWS systems have however a technical lifetime of up to 100 year, as they require maintenance (repairing leakage) or have to be replaced (regional planning) we take the 30 year discounting value.

[141] A different method to estimate the per person cost of a PWS systems is the recent example for Hungary municipalities that received funding from the EU Cohesion Fund: *The project "Drinking Water Quality Improvement Programme of Békés County" in Hungary was worth €129.8 million (€98.2 million contribution from the Cohesion Fund). This investment was to connect 300,000 inhabitants in 66 municipalities to a PWS, putting the cost per person at €327*. The cost of installing a new connection has been estimated at €320, when correcting for 30 years of discounting and differences in dispensable income between MS (disposable income in Hungary is below the EU average) the annual cost of a 'normal' PWS is 33 euro showing the validity of the chosen approach.

[142] Half of all people not connected to PWS are assumed to already have a well/cistern.

The total, discounted, setting-up cost amounts in this way to €470 million per year. As all people will also be obliged to conduct more often tests of their water source the cost of monitoring are expected to increase by €51m. For policy option 5.2 the total annual increase is calculated at €452 million in 2050. On average the cost will increase by €2.2 (ranging from €0 to €25) per household.

Box 6. Providing water and sanitation services for travelling communities[143]

A: Flemish public water at trailer parks *In order to provide basic services to persons that are legal residents but that live in trailers or travel around on a regular basis, the Flemish Region of Belgium has established four transit areas. Each of these transit areas offer basic facilities for electricity, waste collection and water and sanitation, with a capacity to receive between 10 and 25 families for a short period of time (a few days or weeks). The minimum water facilities include one frost free water tap on the outside of the service building, and drinking water taps with an adequate flow and a drain for excess water at maximum of 100 metres from any emplacement. For larger travelling groups (at least 10 families) and in case all official emplacements are taken (often the demand exceeds the supply), a solution is offered through the use of temporary stopover areas. A stopover area is an area that is normally not meant for housing trailers (i.e. parking), and can only be used by traffic-worthy trailers in exceptional situations, under specific conditions and for an agreed and limited period. These stopover areas also have to offer basic facilities, but less than the transit areas. The Flemish Government assumes 90% of the investment costs (acquiring, establishing, renovating and/or extending the transit area), while the provincial or municipal government assumes the rest of the cost. Users contribute financially towards the maintenance of the infrastructure through daily fees (rental, stall or user fees). For example, in 2010, in the transit area of Ghent users had to deposit EUR 100 per trailer and pay a daily user fee of EUR 5 per family and a weekly fee of EUR 5 per trailer. Waste collection is included in the daily fee, electricity is not. Access to water and sanitation is particularly important for such people, since being able to keep themselves clean helps to improve self-confidence and the capacity to reintegrate society.*

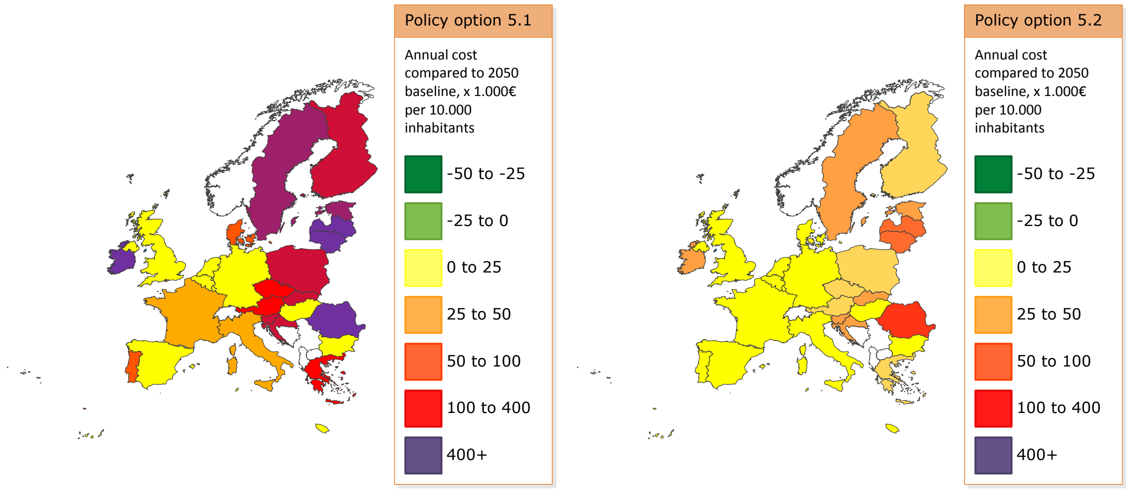
B: The plight of Roma people *Roma people can often be found living in unsanitary housing in many countries across the pan-European region. Out of the 12 to 15 million Roma living in Europe, most are sedentary. In Central and Eastern Europe Roma communities have suffered processes of segregation and exclusion. Roma communities living in small towns and villages face a double challenge in accessing water and sanitation services. First, they share the same problems as the other rural inhabitants, as small towns and villages struggle with technical and financial constraints. But in addition, they also face specific problems. In the village of Richnava (Slovakia), 700 people live in the centre of the village and 1,700 in the nearby Roma settlement. Richnava does not have a public drinking water system or wastewater collection and treatment services. In the village, household wastewater is stored in septic tanks, often with artificial leaks in order to reduce costs for regular emptying. The Roma settlement does not have water supply and has been set up illegally in forest lands, which means that Roma households do not have property titles. At the request of the mayor of Richnava, GWP-Slovakia carried out and discussed with citizens a study assessing alternatives for wastewater management. In addition to the problems of the village, the study paid attention to the specific needs of the Roma settlement, suggesting a combination of centralized and decentralized schemes with natural filters, root fields, composting toilettes, drainage fields with fast-growing willows and retention reservoirs.*

Map 9 below compares the impact that policy options 5.1 and 5.2 have on the annual cost (in total cost per MS) as compared to the 2050 baseline. The graph of annual cost for PO5.1 shows that mainly Romania, Poland, Sweden, Greece and Ireland will need to invest in their distribution system. However, the sometimes thin spread population and high share of the population that does not have a fixed housing location make it unlikely that a 100% coverage, currently assumed, can economically be met. The total cost and also the ambition of this PO are perhaps too optimistic.

[143] UNECE 2012: *No one left behind. Good practices to ensure equitable access to water and sanitation in the pan-European region*.

When comparing PO5.2 and PO 5.1 at the MS level, we find that some MS (e.g. Germany, France and Denmark) already have a connection rate between 95 and 100 percent. This difference explains why these MS are expected to be impacted less by PO5.2. Countries that currently have a lower PWS rate are expected to have high costs if policy option 5.1 (also 5.2) will be implemented. Countries with a high PWS rate (and who have reached the economic feasible connection rate) will have nearly no.[144]

Map 9. Annual costs distribution by MS in Policy options 5.1 and 5.2 in comparison to baseline



Comparing the annual cost of each policy option (including annualized setting-up cost) compared to 2050 baseline

The focus of the direct economic impact assessment of each of the policy options was to calculate the setting-up cost and the increase in annual cost at MS and EU28 level. In the figure below the impact of each policy option is compared from a financial economic point of view. The figure shows, amongst others, that PO5.1 and PO1.2 will lead to the largest increase in annual cost. Further it shows that the cost of PO4.1 and PO2 are very low.

[144] Note that to the maps produced for this chapter have more colours than shown in the legend. This is done to ensure that differences between MS are better visible – the colours that do not show on the legenda are intermediate values between two colours that are taken up in the legend. Annex 8 provides input for the value per MS.

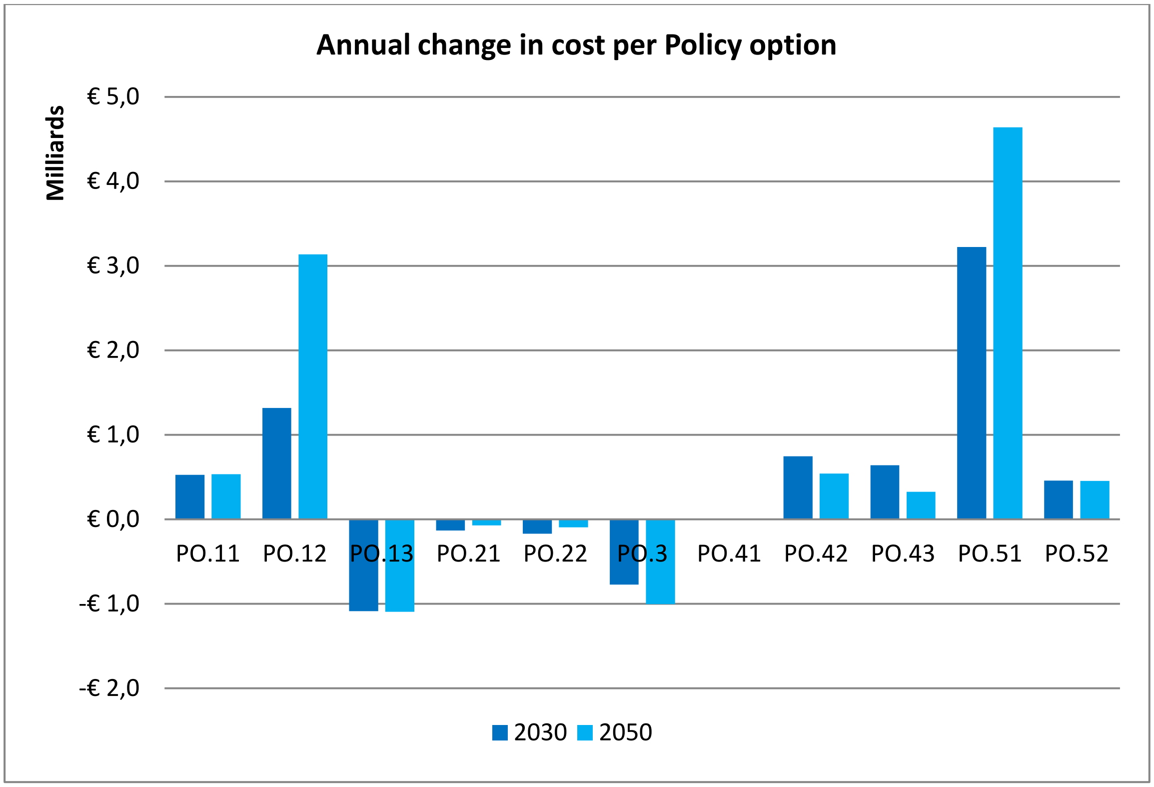


Figure 16. Annual change in total cost per Policy Option

7.2.3 Other economic impacts

While the previous sections focussed on the consequences of the proposed policy options for the water supply sector, the sections below discuss the effects of the policy options on those companies for whom clean and healthy drinking water is an important input into their production process. ,, on private citizens, and to a limited degree, on third countries.

As mentioned before, these impacts involve issues such as growth and investment, sectoral competitiveness and SMEs growth, the internal market, innovation and research and the digital economy. As the economic effects of the policy options will have a minor effect on large enterprises, the analysis below is limited to the potential impact on small and medium sized companies.[145]. The main questions to be answered are: i) which sectors are affected; what is the effect on competitiveness; iii) what is the effect on the enterprises' capacity to innovate; and iv) what might be the effect on the sector's international competitiveness? In this analysis, the effects on SMEs are taken on board.

[145] The analyses is based on the issues raised in Tool #17, #19 and #23 of the BR Toolbox (http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf)

Impacts on SMEs, R&D facilities and employment

Water from public supply systems is used as an input by various economic sectors, notably the food industry and the tourist sector. Enterprises in these sectors can be either SMEs or large firms and it is assumed that the effects of the options will be similar for all sizes of enterprises, except for option 5, for those enterprises currently not connected to a PWS.[146] In these cases, there will be some additional costs for connecting to the new systems of the installation of treatment facilities on site. In this case, the effect will also differ between SMEs and large enterprises, with the latter more easily absorbing the additional investment costs. Looking at Table 11 below we need to consider two aspects: i) the share of public versus self or other supply is often low (e.g. 2% in Poland, 8% in Belgium, and 12% in Bulgaria), and ii) the share of water from public systems supplied to manufacturing varies considerably between EU countries (56% in Belgium, 46% in the Netherlands, but only 4% in Poland and 6% in Hungary). Although no statistics are available to assess how these shares play out for SMEs in the various EU MS, it can be assumed that SMEs have a greater reliance on public water systems than larger companies. This means that the quality of water supplied by public systems can be an important feature for these companies and where the quality of drinking water would reduce, the need for additional investments in filters and other treatment equipment would become more urgent. This could be the result of PO 1.3 where the quality standards for drinking water would be reduced. However, no information on the possible (financial) consequences of this option is available and calculations based on the widely varying numbers (both between countries and between sectors) would result in unreliable information. Where water quality from public systems is to improve (as in all other options except PO 1.3), the reverse will be true, but the benefits to SMEs would be negligible as existing treatment equipment will have been written off already and the costs of treatment are relatively low.

[146] See Tool #19 (The “SME Test” of the BR Toolbox

Table 11. Public water use in EU MS by economic sector — 2013 (million m³)

	All NACE activities	of which:					Households
		Agriculture, forestry and fishing	Industry and construction	of which:		Services	
				Manufacturing	Production and distribution of electricity		
Belgium (¹)	185.0	9.0	103.0	103.0	2.0	73.0	107.0
Bulgaria	127.1	3.1	81.0	*24.7*	*1.7*	43.0	260.7
Czech Republic	160.7	7.6	42.9	:	:	110.1	317.6
Denmark	:	:	:	:	:	:	:
Germany	:	:	:	:	:	:	:
Estonia	:	0.3	:	7.9	0.1	:	:
Ireland	:	:	:	:	:	:	:
Greece (¹)	125.4	21.5	72.1	:	:	31.8	884.5
Spain (²)	932.8	47.8	361.9	351.2	0.0	*523.1*	2 688.0
France (¹)	366.0	:	:	:	:	:	3 506.0
Croatia	*84.5*	0.0	*84.5*	:	:	0.0	*194.1*
Italy	:	:	:	:	:	:	:
Cyprus	2.4	:	2.4	2.3	0.1	:	76.5
Latvia	:	:	:	:	:	:	:
Lithuania	40.2	0.1	13.4	7.8	0.4	26.7	58.0
Luxembourg	:	:	:	:	:	:	:
Hungary	105.8	1.3	58.2	6.4	0.1	46.3	331.3
Malta	*7.9*	*0.2*	*2.1*	*1.8*	*0.1*	*5.7*	*18.6*
Netherlands (²)	287.4	39.3	146.0	132.0	3.3	102.1	783.0
Austria (³)	206.0	:	:	:	:	:	381.0
Poland	330.7	145.2	27.0	12.5	8.7	158.5	1 191.1
Portugal (⁴)	98.9	0.7	:	17.1	:	10.8	619.3
Romania	388.0	1.4	272.3	:	5.6	114.3	587.5
Slovenia	29.7	1.8	9.3	10.7	0.2	18.5	78.6
Slovakia	:	:	:	:	:	:	:
Finland	:	:	:	:	:	:	:
Sweden	:	:	:	:	:	:	:
United Kingdom (¹)	1 066.0	120.0	345.0	263.0	26.0	601.0	2 902.0
Norway (⁴)	:	:	:	*165.1*	:	*118.6*	*372.4*
Switzerland (²)	264.0	*41.2*	*80.0*	*76.5*	0.0	141.8	544.0
FYR of Macedonia	:	:	354.6	352.9	0.4	:	84.4
Serbia	127.0	4.3	21.3	15.6	0.4	101.0	323.7
Turkey (³)	635.8	6.0	115.0	74.5	2.9	515.0	2 377.5
Bosnia and Herzegovina	30.8	1.5	12.6	:	:	14.3	109.3
Kosovo	63.0	52.0	7.0	5.0	:	4.0	43.0

(¹) 2011.
(²) 2012.
(³) 2010.
(⁴) 2009.
Source: Eurostat (online data code: env_wat_cat)

It is expected that the adoption of option 1.1 or 1.2 will increase R&D expenditures on (new) water treatment technologies of both government sponsored R&D facilities and small private R&D firms (SMEs) specialised in developing new treatment technologies. This type of research is carried out at an EU or even global level and increases in employment will be small, typically not more than a few hundred jobs, but for those technologies which can be successfully applied the potential for exports to other countries will be important and thus secondary employment effects can rise to 500 to 1,000 jobs. In terms of possible impact on trade, there will be small increases of imported testing equipment, appliances for treatment (reverse osmosis or nano-filtration membranes) or services.[147] On the other hand there will be export opportunities for EU firms which successfully developed new (treatment) technologies.

As the RBA approach of Option 2 relies on measures at source, this option is unlikely to have an effect on SMEs except if they will be affected by new measures taken to reduce water pollution at source or contracted to provide consulting services.[148]

[147] The actual trade flow is difficult to determine as the HS codes (international trade codes) are encompassing more materials than just pumps for water providers (ie. HS84219900 - Pumps for liquids; liquid elevators). Both the EU MS and US/China are some of the main producers of end material used for treatment. These sellers however also buy parts from other locations.

[148] Heberling M. et. al., 2015. Comparing drinking water treatment costs to source water protection costs using time series analysis. Water Resources Research, Volume 51 Issue 11.

It is expected that imports of materials used by the water industry will become cheaper once a common (EU) approach to approval and certification of material in contact with drinking water (Option 3) is in place. It is assumed that the cost for certifications and approvals will be 1% to 2% of turnover for companies that conduct certification for materials that are used by the wider water industry, although SMEs are expected to have somewhat higher benefits (Aqua Europa, 2015).

Those SMEs involved in supplying materials and products in contact with drinking water will be affected by option 3 and this option will give SMEs in some MS a comparative advantage as their industry already complies to the rules of the system, while industries in other MS will have to update their processes.

Although most certification institutes do not fall in the category of SME, it is important to note that with the adoption of option 3, these institutes can be expected to lose business as new materials would only have to be tested once to be accepted throughout the EU.

For those SMEs involved in setting-up new IT systems needed for option 4.2 and 4.3 (service companies involved in communication, web design, and the development of smart apps), a small positive economic impact can be expected. In general, better information will lead to better functioning of the markets as consumers will make better informed decisions.

For SMEs involved in installing new connections there will be important opportunities as a result of option 5.1 (and less so as a result of option 5.2). Although the major share of the work can be expected to be absorbed by large construction companies, SMEs will be engaged as either sub-contractors or – in smaller communities – as the main contractors (mostly in smaller communities). In addition, there will be an indirect effect on the supply chain. Given the scale of operations for some countries (notably those countries which presently have low connection rates), the competitiveness of companies in the supply chain may somewhat increase (i.e. Romanian contractors/workers and/or international consortia of experienced engineers). As these tend to operating mostly in domestic markets, no overflow on the internal market is expected and the effect on external trade and investment will be minimal (final or intermediate products, such as pipes, may however be purchased from third countries). Companies selling cisterns or refitting materials for these products will also see an increase in their operations if option 5.2 is adopted.

Impacts on the internal market, imports and exports and macro-economic impacts[149]

At macro-economic level option 1.1 is expected to have a low impact. The maximum increase in total cost in 2050 is calculated to be €535m and additional work is expected for monitoring, lab testing and to some extend manufacturing of new treatment methodologies in case current methods are not sufficient. The overall effect on turnover and employment of the operational cost increase is small as the increase in yearly expenditures is about 5%, of which a part will be used to cover a higher energy bill. This increase is not expected to have a significant economic impacts as the value added of the whole water supply sector is only 0.7% of the EU28- Economy (EUROSTAT, 2012), and the treatment cost are about 18% of the operating costs.

[149] See Tool #21, #22 of the BR Toolbox

The macro-economic impacts of option 1.2 are more important compared to option 1.1 and 1.3, as the setting-up cost and additional treatment and monitoring effort sum in 2050 up to an additional €3.5b or on average €6 per person. Percentage-wise option 1.2 will increase in 2050 the total cost of drinking water provision with just under 6% and when combined with the above Eurostat data the policy option would make up about 0,04% of the EU economy.[150] Policy option 1.3 is expected to have a negative impact on overall productivity, which is related directly to the increase in the number of people at risk.[151] However, we note that in the current analysis additional efforts by MS, such as mitigation of PO1.3 through implementation of national more stringent parametric values, are not taken into account and that they would mitigate at least some of the negative health impacts (but also reduce cost savings) locally.

According to the 2008 COWI report, the drinking Water Safety Plan (WSP) scenario was considered likely to affect public authorities, for example in regards to: communication (e.g. developing new guidance material, campaigns); skills (e.g. training/ providing information to inspectorate staff); and, inspection visits (for surveillance and to ensure implementations).

One aspect which is easily overlooked is that option 2 would affect regulatory convergence with third countries as RBA or WSP follows the guidelines of WHO and convergence is therefore likely to take place and the learning platform will be expanded. The knowledge on WSP can as such be exported to third countries, this will mainly be beneficial for companies active in advisory/implementation work and directed to more developed countries that also already have a high level of drinking water quality.

The macro-economic consequences of the option for economic growth and employment are positive but insignificant. The RBA will first lead to an incremental increase in monitoring and treatment cost for large and small water suppliers due to set-up costs. At a later stage the RBA will result in benefits as a shift occurs from treatment to the less expensive approach of addressing pollution at source. As the contribution of the total water supply sector and its water monitoring and treatment costs are of an insignificant size with respect to the overall EU28 economy, no major impact on the economy or employment can be expected due to these changes. The small change is, however, expected to be positive and is related to higher efficiency.

Further, we foresee efficiency gains of RBA, because more comprehensive information will become available across the value chain of drinking water. As a result investors will be better seated to make cost effective investments in the treatment of polluted water and thereby improving the conditions for investments in the market.

The largest impact will be on the industry supplying materials and products in contact with drinking water (PO 3). We expect that some MS will gain a comparative advantage as their industry complies to

[150] Note that we (wrongly) combined the impact in 2050 here with the share of the water sector in the EU28 economy in 2012 and as such the value provided is a rough calculation.

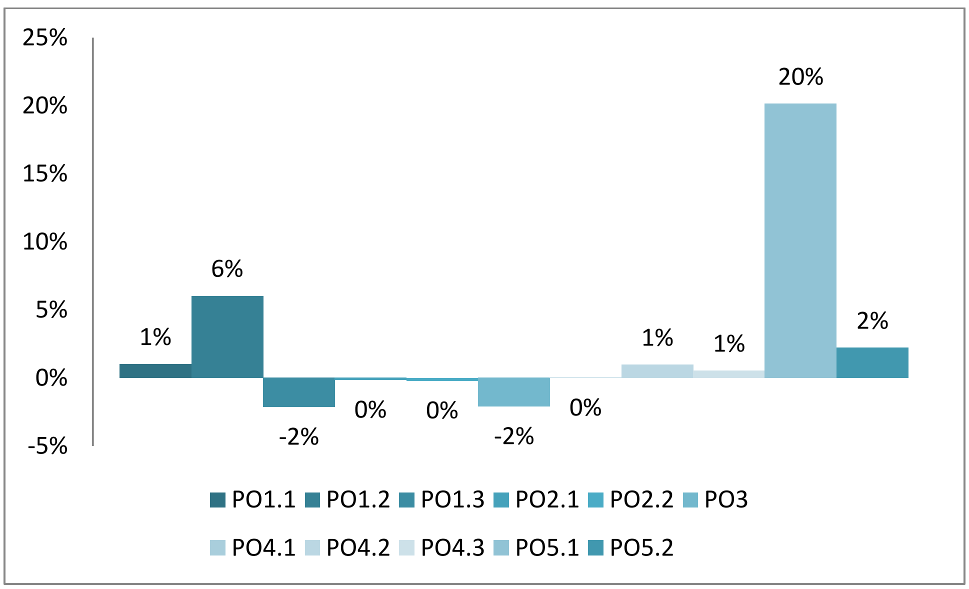
[151] Note that a part of the negative productivity impact stems from long-term negative effects that are not quantified sufficiently in the current analysis due to insufficient data on this specific issue..

the rules of the system, while industries in other MS will have to update their processes. Overall, employment will decrease somewhat due to a decrease in the number of approvals needed.

Moreover, import of materials from third countries is expected to decrease as they do not/do not yet comply with the set product requirements thus favouring the internal market. In the water supply value chain pollution can be prevented. There might be a backlash for third countries that export materials for water distribution systems (especially for China), but this impact is estimated to be rather small and these countries should be able to adjust to the new requirements within a short period.

Impact on employment and consumers[152]

Each policy option will impact employment to a different extent. The figure below shows the effects of the policy options on employment, compared to the 2050 baseline (see also baseline employment method for calculating impact on employment).



Source: Ecorys (2016), Eurostat (2010). Note that the employment impact has been calculated as impact on water providers, although they should be seen as employment effects in the sum of all sectors as an increase in total cost for water will increase the employment for all sectors active in the water supply industry.

Figure 17. Employment change due to policy option in 2050 compared to 2050 baseline

When looking at the above employment impacts, it is apparent that most options have a positive impact on employment (as expected) and that mainly options 1.2 and 5.1 will boost employment. The large increase in employment that is expected to occur when option 5.1 is implemented, differs strongly per MS. For instance MS such as the Netherlands and Germany will see almost no increase in employment, whereas Romania and Slovenia are expected to more than double the number of people that work in or for the water industry (mainly constructing pipes).

[152] See Tool #25 and #28 of the BR Toolbox

As mentioned earlier, better information (options 4 and 2) can empower citizens by allowing them to follow and participate more actively in water management decisions that are - for the most part - taken at national, regional or local level and influence water suppliers to become more efficient in terms of water and energy savings technologies, apply newer and better monitoring. Also, more and more consumers want to stay tuned and informed about the water they drink, and be actively involved in the decisions made which would concern the water quality, management and pricing resulting in a minor increase in employment (see Public Consultation Report).

The indirect implications of policy option 5.2 on EU citizens will be an increased spending on the drinking water they consume, but on the other hand they are better protected and the chance of falling ill is most likely decreased in the short and long-term. In particular option 5.2 would have a positive effect for vulnerable groups such as in populations in rural, peri-urban areas or temporary settlement which currently have intermittent drinking water provisions and quality as well as that they are often supplied by small water suppliers with unknown quality. It would have a positive impact on social inclusion on population living in these areas.

7.3 SOCIAL IMPACTS

The main social impacts of the suggested policy options that have been identified include: information to consumers – consumers' trust in drinking water quality; social impacts from shifting bottled water consumption to drinking water consumption; behavioural changes: as the possibility to influence consumers and water suppliers behaviour to improve water quality; cost and affordability of drinking water; and, social inclusion. The sections below discuss the above mentioned impacts and the impacts following implementation of the different policy options.

7.3.1 Information to consumers – Consumer's trust in drinking water quality

Information and transparency play a key role in improving citizens' access to water and sanitation, impacting on its three main dimensions (i.e. accessibility, affordability and quality). Information is therefore contributing to the creation of awareness of the importance of high quality drinking water at the level of stakeholders involved, both at the level of national legislators and regulators, suppliers and among consumers. Table 12 presents the situation in a number of MS, in terms of information provided to consumers.

Table 12. Access to information and public participation in selected Member States

Member Sate	Access to information	Public participation
UK	England and Scotland provide more comprehensive information to consumers, thanks to the regular reports published by the Scottish Office of Water Services (OFWAT) and the Scottish water regulator (the Water Industry Commission for Scotland (WICS). The Information Commissioners are responsible for dealing with consumers' requests for information on tariff and service standard setting.	The involvement of consumers in tariff and service standard setting is encouraged. Participation is guaranteed by law: consumers can provide their opinion in consultation processes initiated by OFWAT and WICS and the government. The input of consumers in the decision-making process, however, seems to be limited.
France	National legislation exists to ensure information is provided to customers. Moreover, local authorities are required to inform the local council every year of changes in tariffs and service standards. The Commission d'Accès aux Documents Administratifs is responsible for dealing with citizens' requests for information on tariff and service standard setting. See box 6 for additional information.	Participation is guaranteed by law. In medium and large towns, local consultative commissions ensure citizens' participation. Consumers have an advisory role in local consultative committees. However, their contribution is limited to informing about their preferences of service quality standards.
Italy	Participation is guaranteed by law, to some extent. According to the national legislation, the ATOs are responsible for collecting and disseminating information to consumers, although there are no specific requirements on the type and degree of information which must be provided. In general, the published information covers water consumption and tariffs, while little is said about investment plans, past activities, etc. The *Commissione per l'accesso ai documenti amministrativi* is responsible for dealing with citizens' requests for information on tariff and service standard setting.	The regulatory framework ensures that consumers are consulted when deciding on quality service standards, but the same does not apply with respect to tariff setting. Consumers have an advisory role in local consultative committees, although their contribution is limited to providing information about their preferences on service quality standards.
The Netherlands	The Netherlands has a long tradition of information provision to consumers, resulting from the Freedom of Information Act. A large amount of information is provided to consumers. For example, regular information on activities and performances is provided by *Vereniging van waterbedriven in Nederland* (VEWIN), the association of drinking water companies. In addition, local and regional authorities, which are legally responsible for providing water services, are required to provide information on policies and plans. No commission exists for dealing with citizens' requests for information: past disputes in this context were solved, in the past, through arbitration and ordinary judicial courts.	Public participation in tariff and service standard setting is not the object of specific legal provision. Public participation is developed on a voluntary basis by water companies who may consult consumers in the process of tariff and service standard setting.
Spain	As is the case in France (see above) water services are provided at the local level. Thus, the type of information available to consumers largely depends on local approaches to water services. In the case of delegated management (both public and private), most of the relevant information on water services is contained in the service contract, which is a public document. The degree and type of information varies across the country. Moreover, local authorities are required to inform the local council every year of changes in tariffs and service standards. In contrast, no entity is responsible for processing citizens' informational demands, nor has specific legal provision been made for facilitating consumers' access to information.	Citizens have the right to participate in the meetings of the Regional Price Commission, which ratifies water tariffs where they have member status. These meetings play a decisive role in the decision-making process. In contrast, when it comes to quality standard setting, no legal provision exists to ensure consumers' participation in the decision-making process.

Source: EEA, 2013, Assessment of cost recovery through water pricing, EEA Technical report No 16/2013

Option 4.2 and 4.3 are the options which are providing the most significant improvements in terms of information provided to consumers. The access to clear and smart information for all consumers connected to PWS will be compulsory in sub-options 4.2 and 4.3. Thus, the percentage of population with such an access is assumed to be equal to 95% of drinking water consumers connected to PWS by 2020, with the most detailed information being provided in 4.3. This will bring a significant increase of the share of population with access to "live" information on water quality across EU-28 as compared to the baseline.

Automatic reporting to the EC, building on information made accessible via water suppliers, will be implemented under the three sub-options (4.1, 4.2 and 4.3). For example, according to Portuguese law, every drinking water supplier has 24 hours to communicate any non-compliance. The warning is sent through the ERSAR Portal tool, which enables immediate evaluation by ERSAR and health authorities. Additionally, the drinking water supplier must report causes, remedial actions and their results (to evaluate their efficacy).

Geographical distribution and population groups most affected

The social impact of the option will vary among MS. All MS currently provide some information to consumers on drinking water quality and it is more developed in large supply zones and in areas which have RBA. A few MS already have in place online systems and smart phone applications to provide “live” information to their citizens about the water quality. France, Portugal and UK have advanced information systems in place and the whole population is considered to have access to live information, as presented in Box 7.

Box 7. Examples of SMART information systems applied in MS

France online information

National legislation exists to ensure information is provided to customers. In France, for example, tariffs have to be published by the city hall, and local public authorities have the obligation to publish an annual water service report that includes elements on water tariffs and on the quality of water services. Because water services are provided at the local level, the mechanisms chosen for communicating this information to consumers and the type and level of detail provided can vary across the country. In the case of delegated management (both public and private), most of the relevant information on water services is contained in a service contract, which is a public document. Moreover, local authorities are required to inform the local council every year of changes in tariffs and service standards. The Commission d'Accès aux Documents Administratifs is responsible for dealing with citizens' requests for information on tariff and service standard setting. The main entry point is the website of the Ministry of Social Affairs and Health. Control in France is carried out by the Regional Health Agencies. (http://social-sante.gouv.fr/sante-et-environnement/eaux/)

On the home website of the ministry there is a map of France region by region. After clicking on a given region the user can choose a commune within this region where information about the last time of control, information on distribution service and the company in charge of distribution, information on conformity of parameters with the norm and the bacteriological and physico-chemical conformity. There is public awareness information available on microbiological qualities of tap water, nitrates in tap water, pesticides in tap water, radiological qualities of tap water, lead in tap water and emerging substances in tap water. For all of these substances there are available reports from previous years. The reports are 1-3 years old. There are five major water suppliers in France sharing the market Veolia being the biggest one with 39% of the market. On the website of the Ministry of Environment, Energy and Sea there are dozens of article on the quality of drinking water.

ERSAR Mobile App, Portugal

An example of smart technologies of communicating relevant information to users is the mobile application launched in 2014 by the Portuguese Water and Waste Services Regulation Authority (ERSAR). The app contains information about the quality of service provided by each provider in the 278 municipalities in mainland Portugal, so that any user living in that area have access to all the information and is able to compare his/her service to the service provided in other geographical areas. It includes data and indicators for the quality of service, drinking water quality, tariffs, as well as some practical information about water and waste services, such as news of the sector, tips and advice on how to reduce water consumption or waste production, among other information.

Despite that a lot of data and information are made public there is still a lack of knowledge between users regarding this information. The major idea underlying the development of the "ERSAR" mobile app was the intention of reaching a wider audience, in particular, end-users and citizens anywhere and at any time. The application makes this information more accessible and easily understandable by citizens, compared to the available online information.

A widespread publication of this tool is yet to be done. Early lessons learned from this project are that operators are reactive to more information published and to more transparency and that they will make efforts to correct any inefficiency that is publicly shown to the general public. Moreover, it is important to reach consumers with user friendly tools and to address them providing the proper amount and detail of information.[153]

In other MSs, the culture of e-communication is less developed and there is a significant margin for improvement in these areas. Consequently, the impact will be more significant in SWZ, MS and areas without RBA as well areas which are assumed to have less developed e-information systems in place.

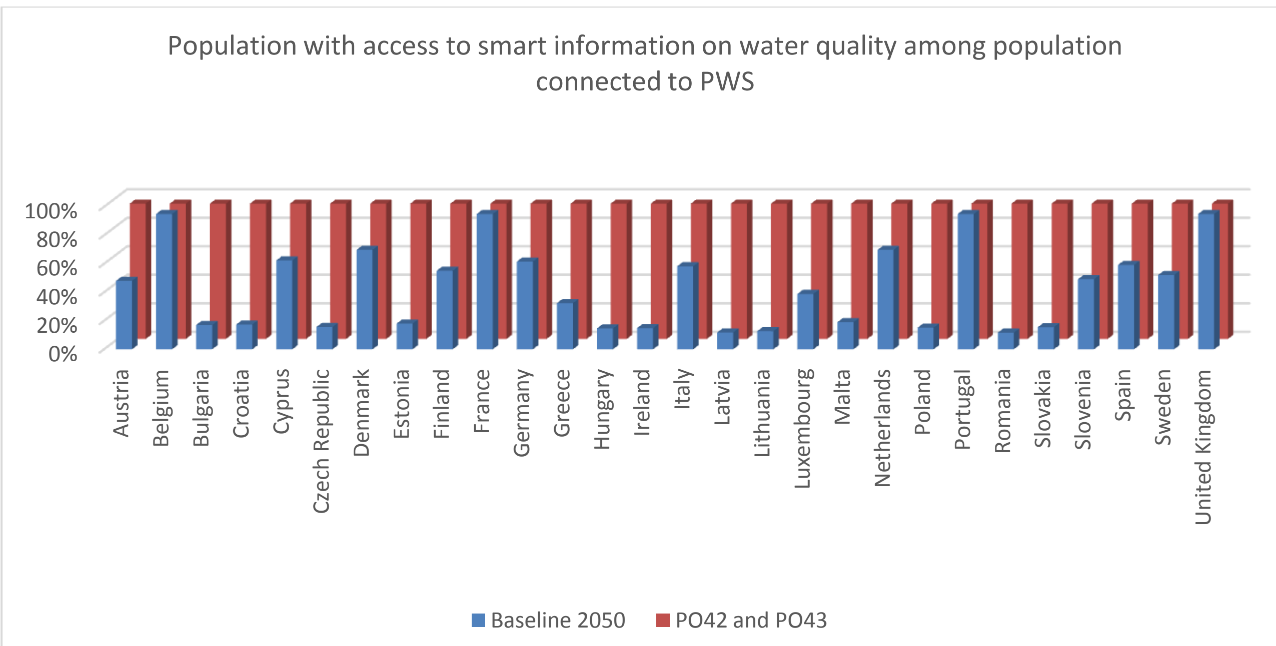


Figure 18. Share of population with access to smart information on water quality among population connected to PWS

The most significant increase will be in countries with the lowest level of information in the baseline scenario, such as Latvia, Lithuania, Ireland, Hungary Poland and Romania which has a current level of information in the range of 12-15 %. The positive impact of the option in terms of consumers' confidence might be weaker in those MS and in certain areas where citizens have a more limited access to the internet (e.g. in rural areas) as well as among certain population groups (such as elderly people, and travelling populations etc.)

[153] https://www.oecd.org/governance/observatory-public-sector-innovation/innovations/page/ersarmobileapp.htm#tab_implementation

7.3.2 Impact on consumption of bottled water

It is considered that the level of confidence people have in tap water quality is one main driver of tap water consumption compared to bottled water consumption. Studies have shown that consumer decisions to purchase bottled water are predominantly driven by; (1) sensorial information about taste, odour and sight and (2) quality and health risk concerns.[154] According to a US study[155], the perception of risk is thought to be closely related to the subjective assessment of drinking water quality. This suggests that perceptions of drinking water safety and beliefs about the ground and surface water quality in a local area might be explanatory factors for a decision to select bottled water over tap water.[156] Thus, the level of confidence among consumers is directly linked to the effective water quality but also to the access to information on water quality. Increased awareness and enhanced transparency is expected to bring about higher trust in the overall quality of the drinking water and of drinking water services. The decrease of bottled water is expected to be proportional to the level of information provided.

For policy option 3 we assumed that there will be a decrease of bottled water 10% in percentage of total drinking water from 2015 to 2050 as compared to baseline. The EU28 average would be decreased from 2.7% in the baseline to 2.4% in 2050. The consumption per capita would decrease from 100 litres in the 2050 baseline scenario, to 94 liter/capita and year on EU28 average, saving on average 0.6 EUR/capita[157].

Improved information systems is relevant for policy options 4.1, 4.2 and 4.3, and the assumption is made that bottled water consumption will be reduced proportionately to the level of information provided.

For policy option 4.2, the decrease will be 10%, same as in option 3.

In option 4.3, more information is made available than in 4.2 and in addition, the transparency of information of water service providers' operations will be enhanced. This in expected to result in an even bigger reduction of the share of bottled water consumption of 20% in 2050 as compared to baseline. This would result in a decrease to 2.2% for EU 28 in the 2050 scenario. The consumption per capita would decrease from 100 litres in the baseline scenario, to 88 litre/capita and year on EU28 average, saving on average 1.7 EUR/capita.

Policy options 5.1. and 5.2 both show a very marginal decrease of bottled water consumption, to 99 and 98 litre/capita annually, as compares to the 2050 baseline of 100 litre/capita annually.

Geographical distribution and population groups most affected

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[154] Helle Marcussen, Peter E. Holm, and Hans Chr.B. Hansen, Composition, Flavor, Chemical Foodsafety, and Consumer Preferences of Bottled Water, 2013 Institute of Food Technologists http://onlinelibrary.wiley.com/doi/10.1111/1541-4337.12015/epdf and Miguel F. Doria, Bottled water versus tap water: understanding consumers' preferences, WA Publishing 2006 Journal of Water and Health 04.2,2006

[155] Zhihua Hu, Lois Wright Morton, Robert L. Mahler, Bottled Water: United States Consumers and Their Perceptions of Water Quality
Int J Environ Res Public Health. 2011 February; 8(2): 565–578. Published online 2011 February 21. doi: 10.3390/ijerph8020565, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3084479/

[156] According to the study, perception of drinking water safety is found to be highly associated with bottled water use. A person who feels their home water is safe to drink was more than 4.8 times more likely to use bottled water as their primary source of drinking water compared to a person who does not trust their home drinking water safety. The findings about water quality perceptions generally confirmed that when public doubts about the safety of their tap water, they look for alternatives like bottled water.

[157] Unitary cost of bottled-water is estimated equal to 0.1 €/litre.

As mentioned under environmental impacts, the biggest relative decrease in bottled water consumption will be recorded in Malta which has the highest bottled water consumption in the EU with 11% in the baseline scenario. Germany and Hungary which also record high bottled water consumption will both reduce their share of bottled water in total drinking water consumption along the reduction levels expected following option 4.2 and 4.3.

Unitary cost of bottled-water is estimated equal to 0.1 €/liter and the price of tap water is on average, 400 times lower than that of bottled water.[158] Tap water consumption for drinking and cooking represents in average 7.5% of total tap water consumption by households and services in Europe. It can be concluded that reducing the consumption of bottled water would ultimately lead to marginal cost savings for households as it would allow this savings on bottled water to be allocated to priority expenditures for the household. Reducing the cost for bottled water would have an especially positive impact on households with low income.

Taking Hungary as an example, the consumption of bottled water per capita would decrease from 120 liters in the baseline scenario to 98 liters in option 4.3, a saving of 22 liters. As the unitary cost of bottled-water is estimated equal to 0.1 €/liter implementing option 4.3 would mean a saving of 2.2 EUR/capita. This would have a marginal positive effect on the economy of households in the example of Hungary.

See section on environmental impacts of bottled water for figures on detailed data for MS. For further analysis of the household expenditures on drinking water, please refer to the section on affordability below.

Behavioural changes: Possibility to influence consumers and water suppliers' behaviour to improve water quality

Better information can empower citizens, by allowing them to follow and participate more actively in the water management decisions that are − for the most part − taken at national, regional or local level.

In option 2.1 and 2.2, the expected increased availability of drinking water quality information for the public and stakeholders, accompanying the RBA and WSP, is leading to an enhanced awareness of the local drinking water process and in building trust in the drinking water quality among the public. This is creating a sense of ownership among the local community and provides incentives for protecting and improving their water supply. The local community can then facilitate to identify, access and manage the risks and hazards of the area, and to balance the importance of safe water supply against other competing needs, such as housing and education. The impact would be bigger in 2.2. as it would include all water suppliers, not only the large ones as is the case in 2.1.

E.g. in South Africa and Bangladesh, due to increased understanding of all parts of the water supply system after WSP implementation, operators were observed to have an improved ability to prevent and resolve water quality issues on their own. These examples show that the use of WSPs led to direct action by caretakers that improved the safety of the drinking water, including making repairs to damaged water

[158158] EEA, Tap water, one of our most valuable resources, http://www.eea.europa.eu/media/audiovisuals/tap-water-one-of-our/video_popup_view

infrastructure, moving of sources of contaminants such as latrines and animal pens, and cleaning of the surroundings of the water supplies.[159] In addition, implementing RBA and WSPs can lead to increased communication and collaboration among stakeholders as public participation and consumer involvement becomes an essential part of the process. Improved communication and collaboration may lead to better social cohesion and improve the process of decision making on a community level. This is exemplified through examples in Box 8.

Box 8. Examples of Portugal, Scotland and Guyana

Portugal: Portugal has ten pilot projects on risk assessment for water supplies and is considering a legal obligation for small water supply zones. Experiences from the pilots has shown that a key benefit of implementing a holistic RBA is that is creates a platform for communication with stakeholders concerning water quality issues and helps the organization to focus on critical issues that become well known to the parties involved. At the moment Portugal organizes training sessions for the owners/operators of small and very small water supplies.

Scotland: Scotland has over 19,000 private water supplies, and legislation requires local authorities to complete risk assessments for all supplies which provide >10m3 per day (or serve 50 or more persons), or are supplied or used for a commercial or public activity. Local authorities are also required to assist in completing risk assessments for any other private water supply on request. The local authority completes the source to tap risk assessment and any sampling and analysis that is required by legislation, but the control of hazards, operational monitoring and corrective actions are the responsibility of the supply owners and users. Experiences from Scotland show that "[w]hile health benefits are still difficult to assess, it has been reported by the interviewed local authority that the raising of awareness of risk to owners and users of private water supplies that is generated through the risk assessment process is an important benefit in ensuring real and lasting water quality improvements."[160]

Guyana: In Linden, Guyana, the WSP process brought together various stakeholders, including the water supplier and the Ministry of Health, which is the drinking water regulator. A representative of the water utility stated that the WSP process had greatly improved relations and communications with the regulator, leading to better coordination of efforts to improve drinking water safety, such as monitoring of water quality in the distribution network. This water service provider served a population of roughly 40,000 people in Linden, Guyana. The Linden water service provider operated five water treatment plants and provided household connections for approximately 70% of its residents, roughly 40,000 people. The WSP intended to incorporate good watershed management practices aimed at ensuring the integrity of source waters, while optimizing drinking water supply systems. [161]

Moreover, option 2 would also bring wider social benefits as information and communication related to RBA can address other related topics such as agriculture and latrines and hence have an even stronger social impact through education and behavioural changes. This could in particular have targeted social and health benefits and improve social cohesion in remote areas in impoverished communities such as Roma community in countries in Eastern Europe such as Bulgaria, Romania, Hungary, Slovakia and Czech Republic. An initiative to develop Water Management Plans has been taken up in Australia in the Australian Aboriginal settlements. These examples can be classified under the heading of community involvement through transporting and storing the water for example or through using alternative sources such as rainwater or a local spring. The issue of water supply could be used to provide additional

[159] http://www.cdc.gov/nceh/ehs/gwash/Publications/WSP_Evaluation_Framework.pdf and http://www.sswm.info/sites/default/files/reference_attachments/APSU%202006%20WSP%20in%20Bangladesh.pdf

[160] KWR 2011, Towards a Guidance Document for the implementation of a Risk Assessment for small water supplies in the European Union, Overview of best practices

[161] http://www.cdc.gov/nceh/ehs/gwash/Publications/WSP_Evaluation_Framework.pdf

education to these communities which impact the water issue but go beyond such as inadequate sanitation, stock herding and all forms of small- and big-scale agriculture. Schools are one of the target groups of the Australian Water handbook.[162]

Option 4.3 will establish a SMART information systems where water service operators are required to include information about pricing, performance, efficiency, which can result in the more active participation of citizens in the decision-making process, e.g. through reporting risks and by identification of the need for improvements which can ensure that management decisions are addressing the most pressing needs of the local population. Moreover, information is one of the most important mechanisms for the regulator to empower the end-users of a service, because it allows them to demand better services by comparing their service to other services. In option 4.3, it is therefore assumed that as consumers are better informed on water quality they have the power to put pressure on water suppliers and local authorities in order to get a water quality improved. Consumers are often unaware of the real price that they pay for water, a SMART information system providing information on price can raise awareness on the actual price paid for drinking water and consumers might thus be prompted to decrease consumption. Consumers will have stronger incentives to reduce water consumption as they can see the direct link between the water they consume and their water bills (in addition environmental improvements will be made). Ultimately, reducing the water expenditures would allow for allocating previous expenditures in other household priorities.

Geographical distribution and population groups most affected

With regards to **option 2.1 and 2.2**, the social impact of the aforementioned issues would be more significant in countries that do not have RBA in place. As the implementation of RBA and the creation of a WSP is a long and costly process, it is considered that it is easier for a large water supplier to enrol in this way than for a small water supplier. Nevertheless, small water suppliers[163] would in particular benefit from RBA introduction as personal behaviour and activities of community members such as their sanitation and agricultural practices affect their own water quality more directly than in a large water supply. For small supplies, a relatively large proportion of the population can be regarded as additional stakeholders having a strong impact on water quality.[164] According to the WHO small community water supplies are more at risk of breakdown and contamination, leading to outbreaks of waterborne disease and gradual decline in their functionality and service. Operators of small supplies may nevertheless require external advice, support and training from WSP facilitators (e.g. from local health or water offices) to learn about the WSP approach and implement a WSP for their systems.

With regards to **option 4.3**, the largest social impact will be larger in those MS with the lowest level of information in the baseline scenario, such as Latvia, Lithuania, Ireland, Hungary Poland and Romania.

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[162] Desert Knowledge CRC 2008, Alice Springs Australia

[163] Only few MS apply RA and risk management in their national legislation that also applies to small water suppliers (UK, Switzerland, Norway and Slovenia). Special attention to small water suppliers are made in Ireland, Portugal, Finland, Germany and the Czech Republic.

[164] KWR 2011, Towards a Guidance Document for the implementation of a Risk Assessment for small water supplies in the European Union, Overview of best practices

7.3.3 Cost and affordability of water for consumers

The price of water and sanitation has risen over the last 40 years by a factor of 5 in terms of percentage of household expenses. The affordability of water charges has been measured by the national average household water bills as a share of the average net disposable household income. In terms of affordability of drinking water supply for households, a study of selected countries from 2013 show that drinking water tariffs range between 0.5 - 1% of disposable income.[165] The percentage of income spent on paying water charges depends on the household income level and the lower it is, the higher is the probability of finding the price of water expensive and even for being water poor. In a public opinion survey from 2011, nearly 90 % of low paid people stated that water was expensive, which was 50 % more than when people with average income were asked the same question. It can be concluded that price accept ability is income dependent even if water expenditures are relatively small.[166] The UK has established a poverty line for water which has been found at a threshold of 3% which means that the lowest three income deciles spent 3% of their net income on water.[167] According to the OECD, national or international affordability criteria are usually put at 3%-5% of household income. Moreover, it is also stated that the price elasticity of drinking water demand by urban households is typically low. In European countries it ranges between -0.1 and -0.25, i.e. the demand for water decreases by 0.1% to 0.25% for every 1% increase in tariffs. [168]

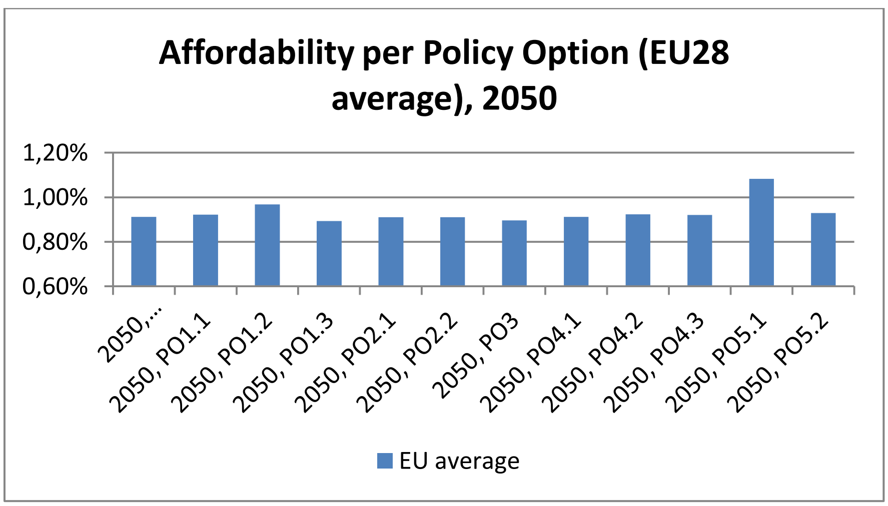


Figure 19. Affordability per policy option (EU28 Average) 2050 scenario

In the baseline 2050 scenario, the average affordability among EU28 is 0.91% of disposable household income. As can be seen in the graph above, the impact on the affordability of water cost for the households of the policy options are marginal, and ranges between 0.89%-1.08%.

[165] EEA, 2013, Assessment of cost recovery through water pricing, EEA Technical report No 16/2013

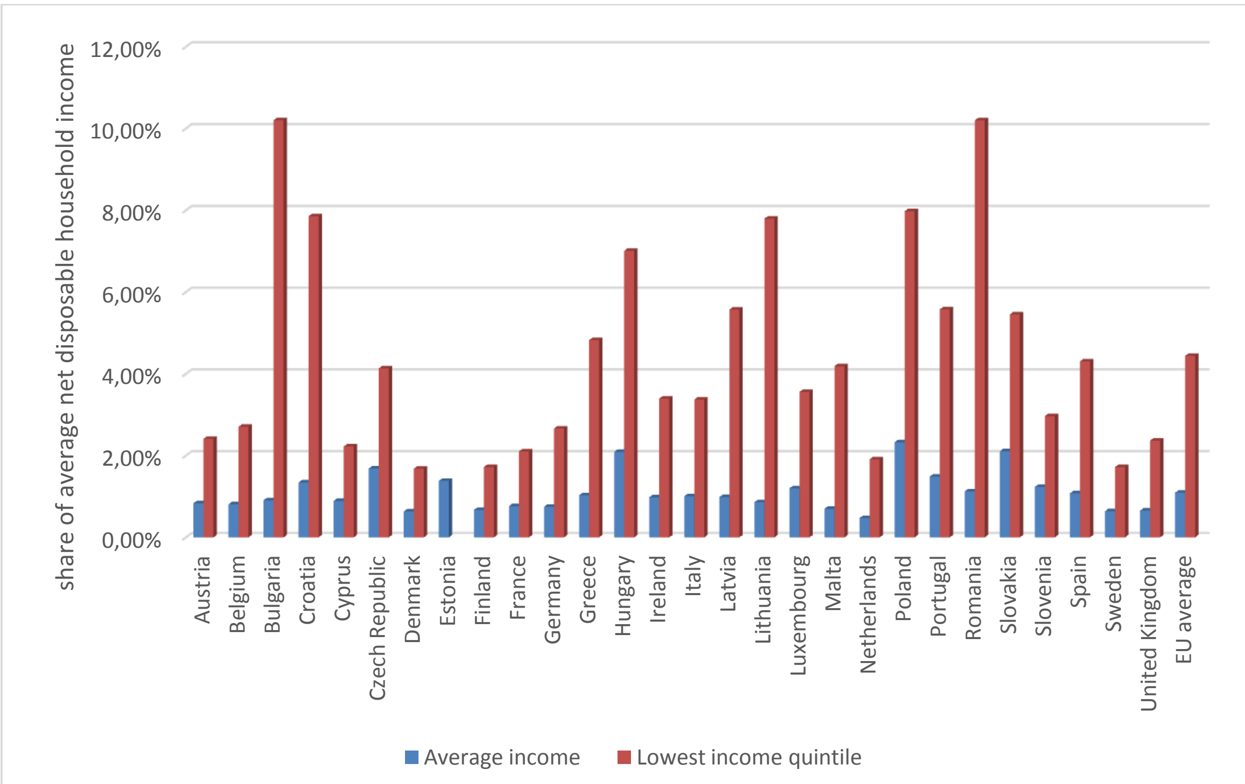
[166] Smets, Henri, Charging the poor for drinking water, Water Academy, France, http://www.publicpolicy.ie/wp-content/uploads/Water-for-Poor-People-Lessons-from-France-Belgium.pdf

[167] https://eau3e.hypotheses.org/files/2009/11/Water_Affordability_in_Europe.pdf

[168] OECD, 2090, Managing Water for All, An OECD perspective on pricing and financing, http://www.oecd.org/tad/sustainable-agriculture/44476961.pdf

The most notable changes, although small, is for **Policy Option 1.2 and 5.1**, where cost of water as a share of disposable income would increase with 0.06 and 0.19 percent points respectively from the baseline in 2050 scenario. For option 5.1 the connection to PWS or equipment with individual systems for all citizens increased up to 100% would bring associated cost that would have an impact on the tariffs for consumers. The average increase in cost of water would for option 5.1 be 22 EUR/year per household. This can be compared to the EU28 average for the baseline 2050 scenario would be 225 EUR. The only policy option that sees a minor reduction of cost is 1.3, due to the reduced levels of treatment.

Geographical distribution and population groups most affected



Source: Calculation based on Disposable income of private households by NUTS 2 regions (net income)[169], Eurostat (nama_10r_2hhinc) and Distribution of income by quantiles (source: SILC) [ilc_di01] and estimations of cost for households**.**

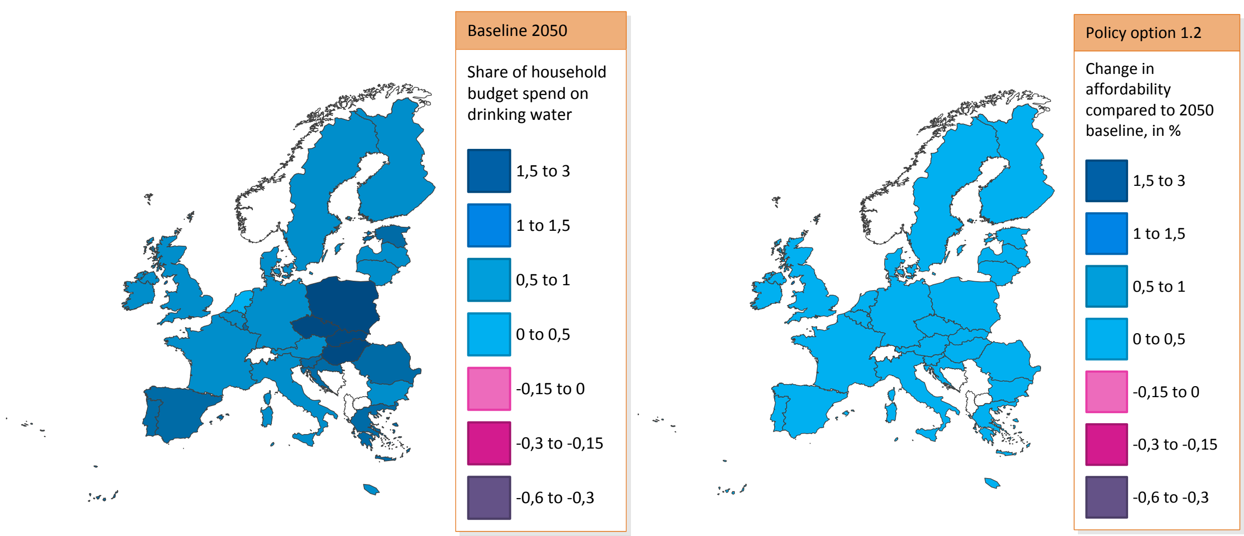
Figure 20. Affordability of drinking water per MS in the Baseline scenario

[169] The disposable income of private households is the balance of primary income (operating surplus/mixed income plus compensation of employees plus property income received minus property income paid) and the redistribution of income in cash. These transactions comprise social contributions paid, social benefits in cash received, current taxes on income and wealth paid, as well as other current transfers. Disposable income does not include social transfers in kind coming from public administrations or non-profit institutions serving households.

The affordability in EU28 varies across the MS as can be seen in the figure above. According to our data, the lowest ratio in the baseline scenario current prices is found in Sweden, Denmark, Malta and the UK which all spend 0.6% of disposable income on water. The highest ratio is seen the poorer countries of Poland, Slovakia and Hungary which spend above 2% of disposable income on water and where costs of water is a significant expenditure for households. Low-income countries are the most vulnerable to costs increase of drinking water. Due to the small percentage represented by price variation, we have included the possible impact on the lowest quintile of the population, where the changes in affordability are more critical. The graph above shows that for the lowest income quintiles of the population the affordability of water costs are very low in many countries, in particular among the new member states. For instance in Bulgaria it is as high as 10% of the disposable income and even higher in Romania[170], [171]. These countries are also the MS with the largest share of population at risk of poverty, 40% of the population in Bulgaria and Romania.[172] In Croatia, Lithuania and Poland, the level is around 8%.

The maps below show the % of change of disposable income that is spent in 2050 on drinking water as compared to the baseline for the policy options that represent the biggest change.

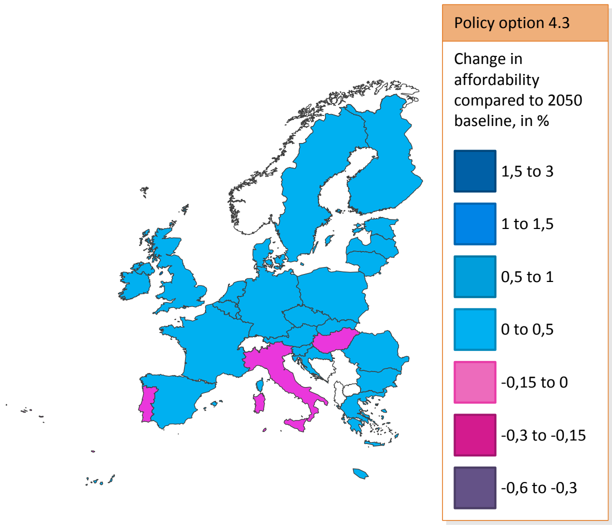
Map 10. Change in affordability between 2015 and 2050 scenarios

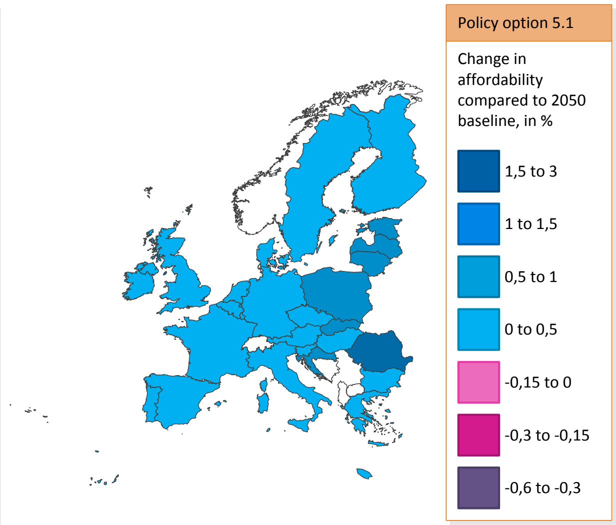


170 The data for Romania has been corrected and aligned with the data for Bulgaria due to inconsistencies in the income data.

171 Based on comparison with current prices and disposable medium income for lowest quintile 2012 http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Change_in_equivalised_disposable_income_for_first_and_fifth_quintiles,_2011%E2%80%9312.png

172 According to OECD report "In EU countries it varies from 0.2% (Italy), 0.7% in France and 0.9% in Germany to 1.4% (Slovak Republic, Poland and Hungary). This can however represent a considerable share of disposable income for poorer families in many MS (micro-affordability). Looking at the affordability of the lowest decile of the population, the share varies between 1.1% (Sweden, Netherlands, Italy) and 5.3% in the Slovak Republic, 9.0% in Poland and 10.3% in Turkey.





For Poland, which on average has the highest share of disposable income spent on water (2.28%) the affordability is lowered for policy options 1.2 and 5.1, where respectively 2.42% and 3.09% of income is be spent on water. The social impact of cost reductions will be higher in MS which do not have in place social mechanisms to ensure water supply for all social groups.

The EEA study shows that among the reviewed EU MS, four of seven countries have mechanisms in place to ensure access to water services to all income groups. In other countries such as e.g. England and Wales, affordability of water services is ensured to low-income metered customers with a high essential use of water by the Government's national WaterSure tariff. This mechanism caps the bills of these customers in receipt of a qualifying means-tested benefit for the average bill for their company. In Flanders, Belgium, legislation introduced in 1998 gave all citizens the right to a minimal supply of 15 m^3 of water per person per year, as a means to guarantee equal access to drinking water and sanitation for everyone. There is a similar system in South Africa, where each household receives 72 m3 per year of free water. This system is completed by a social tariff to take account of special needs of the poorest segment of the population. In France, there is a law on water and the aquatic environment whose first article stipulates that each individual has the right to reach drinking water under conditions economically acceptable by all. Water cannot be provided free of charge but it is possible to provide a block of water at a subsidized price provided that overall the users pay for water.[173] Thus there are no social tariffs in place and the affordability of water services is dealt with through separate social policy.[174]

[173] Smets, Henri, Charging the poor for drinking water, Water Academy, France, http://www.publicpolicy.ie/wp-content/uploads/Water-for-Poor-People-Lessons-from-France-Belgium.pdf

[174] EEA, 2013, Assessment of cost recovery through water pricing, EEA Technical report No 16/2013 and

It is interesting to add the cost of bottled water to the discussion on affordability. As mentioned above, the average EU citizen consumes 104 litres of bottled water every year, which equals 10.4 EUR/capita. This is can be put in the context of the average water tariffs which are 225 EUR per household. To illustrate, we can compare with the expected increases in the water cost per households are ranging up to 22 EUR at the most, as in the case of option 5.1 or with 14 EUR in option 1.2. Cutting down on expenses on bottled water therefore holds a significant potential for cost-savings for households.

7.3.4 Social inclusion from better access to safe drinking water

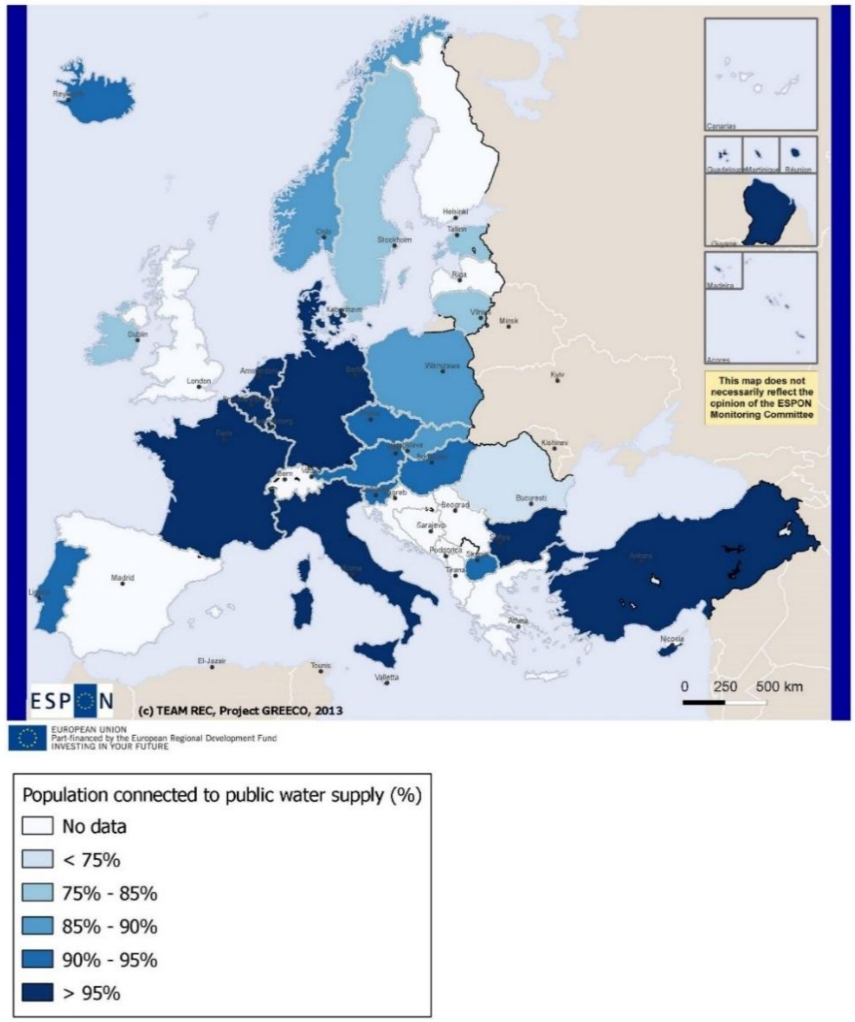
This impact is mainly related to **Policy Option 5.1 and 5.2 - Access to safe drinking water for all.** Water is a public good fundamental for public health and quality of life. Expanding the current obligation of the DWD to include a human right to safe drinking water and sanitation to all citizens as well as increasing the drinking water quality standards to cover all small communities and any person living in Europe would have significant social impacts as a larger number of people would get access to safe drinking water. This option would thus support the human right to water and sanitation as it was recognized by the UN Resolution 64/292, which acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights. Also, the UN Sustainable Development Goals includes the goal to 'Ensure availability and sustainable management of water and sanitation for all' in which by 2030, universal and equitable access to safe and affordable drinking water for all should be achieved. In addition to immediate benefits in terms of better health of the population, benefits include productive days gained per year for the working population and time-savings (working days gained) resulting from more convenient access to services.

Adding specific provisions for very small supplies (serving less than 50 persons and which can be exempted from the provisions of the DWD), would help to ensure efficient, risk-based management of small supplies and allow better mapping of drinking water quality in small supply zones. Such monitoring would allegedly increase the availability of drinking water quality information for the public and stakeholders in those areas, currently supplying drinking water up to 11 % of the European population.

Geographical distribution and population groups affected

According to Eurostat data, in many MS, the share of total population connected to public water supply (or covered by specific regulation) is above 90%. In some MS these rates are however significantly lower, and the biggest impact of the option as compared to the baseline scenario would be seen there; e.g. in Romania where only 57 % of population is connected to PWS (or covered by specific regulation) as well as for Lithuania and Latvia (76% respectively). There might be big gaps between regions within a MS which are not shown in the national data.

Map 11. Population connected to public water supply, Nuts 0 level



Source: GREECO, ESPON programme, 2014

In particular, the option would have a positive effect for vulnerable groups such as in populations in rural, peri-urban areas or temporary settlement which currently have intermittent drinking water provision and quality as well as they are often supplied by small water suppliers with unknown quality. It would have a positive impact on social inclusion on population living in these areas.

What is the level of uncertainty – how do we deal with it?

In terms of the robustness of the social impacts, it needs to be stressed that many of the observations made in this chapter are based on a qualitative and subjective basis as in most cases, accurate data has not been available to support assumptions and conclusions. In general, the social impact discussed in this section are of “softer” character and therefore in many cases challenging to quantify. This is valid primarily with regards to the discussion on access to information – consumers’ trust, behavioural change and social inclusion where it has not been possible to establish precise correlations with the quality of drinking water supply and provision. To support the conclusions drawn in this study, the authors have therefore undertaken a literature review and studied relevant case studies in order to identify trends and possible outcomes of the policy options to support the assumptions that are the basis for the conclusions presented.

For instance, to reiterate the discussion conducted in the environmental impacts section, the link between the policy options and the level of consumption of bottled water is difficult to predict accurately. However, based on comparative studies, it is possible to draw the conclusion that a reduction in bottled water consumption will lead to cost savings for consumers, and therefore the uncertainty lies in to what extent. By assuming a weaker correlation between information provided and reduction of bottled water consumption (e.g. of 5% instead of 20%) we can reduce the possible margin of error but we would see that we still can expect certain cost savings for the households, although less significant.

Discussing uncertainties, it is important to highlight reservations on the accuracy of the discussion on affordability of drinking water services among MS. Firstly, it should be noted that the price estimations presented are calculated based on the assumption that the income levels and the relative cost of water remains at the current level, as any predictions on future income levels is associated with great uncertainties - as they are dependent on inflation, politics and many other external factors. The analysis providing the basis for the affordability discussion is therefore calculated based on the current income levels. In addition, the price changes of the different policy options in the DWD considered in this assessment are therefore solemnly related to the DWD, not taking into account other possible variables.

The graph below shows the difference of the baseline in 2050 calculated with two different levels of income. The first column shows the baseline as calculated with 2015 income levels (which was used in the analysis) and the second column shows the baseline based on predicted future income levels in 2050[175]. It can be seen that in the baseline the cost of water in a household spending decreases from 0,9% based on 2015 wages to 0,7% for 2050 forecast. This is a result of the reduction of costs that are expected in the baseline and that the disposable income estimation is increasing faster than the estimated increase in cost of water from drinking water providers. Due to the large uncertainties in these predictions for 2050 it is not likely that drinking water will become more affordable towards 2050 in the baseline. Therefore the analysis is rather on affordability than focusing on the relative changes among the policy options.

[175] 2050 predictions are based on 2010 to 2014 Vewin (Dutch umbrella water organization) water price development (excluding taxes) in estimated the increase towards 2030 and 2050.

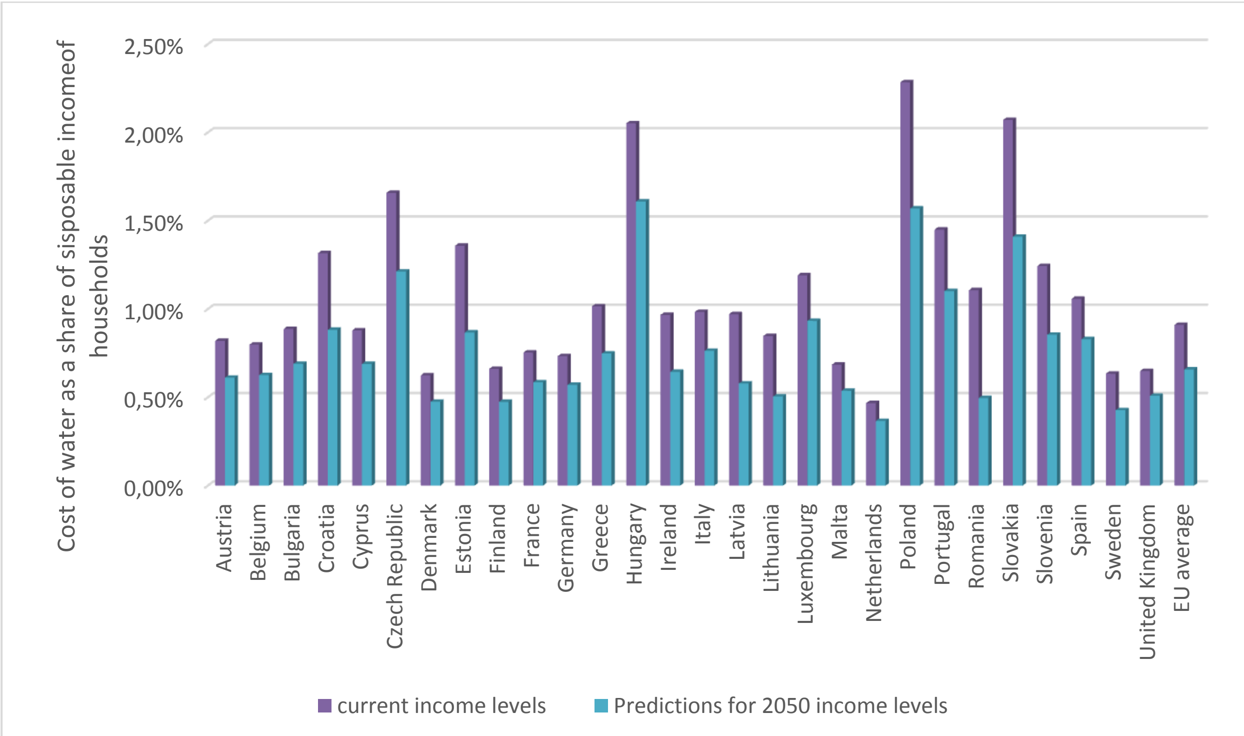


Figure21. Comparison of affordability of water costs based on two different income bases (2050 baseline)

Calculations show that the price of water is changing very marginally although the cost of implementing the various policy options varies to a large extent, as seen in the table below. The level of affordability will remain close to constant at the EU28 level, but also when looking at the individual member states.

To better reflect the impact on affordability, we have added a comparison with the lowest income quintile to illustrate what effect the policy options could have on the affordability of the most vulnerable population groups. Due to a lack of consistent data, the income levels for the lowest quintile are from 2012 while the income for the average population is 2014, and should therefore be treated with caution and merely function as an illustrative example.

7.4 ENVIRONMENTAL IMPACTS

The main environmental impacts from the suggested policy options that have been identified include: the quality of water resources; reduction of pollution at source for water resources abstracted; improvement of water resources where waste water is discharged (following lower levels of pollutants in drinking water); energy consumption; environmental externalities of consumption of bottled water; resource efficiency; and biodiversity. The sections below discuss the above mentioned impacts and the impacts following implementation of the different policy options.

7.4.1 Impact on water quality

It is assumed that in the baseline 2050 scenario, fresh water bodies' quality will globally keep on improving, however not specifically due to DWD actions. The achievement of good water status improved from 43% to 53% between 2009 and 2015. Following this trend, it has been assumed that chemical status of surface and ground water bodies will keep on improving: by 10 points by 2050 for all water bodies, and by 20 points for water bodies used as a drinking water source by water suppliers which implemented RBA (as it would mean that more measures at source are implemented).

The implementation of the DWD has led to an increase in overall water quality over the past 20 years as derived from an increase in compliance, as stated in the Evaluation report.[176] Reducing the amounts of pollutants in drinking water by unlisted and emerging substances would have a positive environmental impact on water bodies such as less potentially harmful substances would enter the drinking water cycle and consequently also be discharged as waste water. Small amounts of hazardous chemicals, such as e.g. medications and oil, in the drinking water can have serious impacts on status of water bodies.

The relevant policy options and their expected impacts on water quality:

The expected outcomes of policy option 1.1 would lead to reductions of pollutants in drinking water as a result of the update of the list of parameters in Annex I and consequently more pollutants are monitored. The revised directive would include “new” substances in the list of parameters to monitor with set limit values for drinking water which all MS would have to comply. The monitoring would provide timely information on the increased set of parameters which would allow suitable interventions and thus removing potential risks for the environment. **In option 1.2**, the revised directive would in addition to updating the list of parameters in Annex I (as for option 1.0), include emerging substances in the list of parameters to monitor. Fix limit values would be set for those parameters. The environmental impact would therefore be more significant than for option 1.0, as the pollutant loads released in water bodies would decrease both in terms of unlisted and emerging substances.

With regards to sub-option 1.3, no environmental gains can be identified**.** On the contrary, by reducing the number of parameters in Annex I to a minimum there is a probability that water quality will decline as any increase of substances falling outside of the monitored parameters would go undetected and

[176] Evaluation report of this project

could lead to an increased risk for the environment. It is assumed that the population supplied with drinking water compliant with current thresholds would be reduced. Pollution of water resources - and thus of water distributed - by unlisted and emerging substances would remain unchanged from the baseline scenario following option 1.3. The negative environmental impact will be more significant in areas that are already under pressures from point sources and in MS and areas which do not implement RBA.

Following implementation of Policy Option 2.1 and 2.2, RBA, the compliance of drinking water with current parameters and current thresholds will be similar as compared to baseline. The compliance of drinking water with currently-listed substances, current parameters, strict thresholds and other substances of emerging concern will stay unchanged as compared to baseline. It is assumed that the level of contamination by high priority substances of emerging concern will be reduced by half. In sub-option 2.1, these considerations are valid only for large water suppliers. For small water suppliers, assumptions are similar as in the baseline scenario. In sub-option 2.2, these considerations are valid for all large water suppliers and for 90% of small water suppliers. For the other 10% of small water suppliers that will not apply RBA by 2050 (most probably the very small ones), assumptions are similar as in the baseline scenario.

With regards to policy option 3, products in drinking water systems can affect the quality of drinking water by release of undesirable substances potentially harmful for the environment. These materials may cause undesirable changes in the taste and odour of drinking water and may even affect the aquatic environment if their residues are not removed in wastewater treatment. Metals leaching from metallic materials include lead, nickel, chromium, copper, and zinc, but it is possible for metals to leach from many other types of material. Examples of non-metallic substances leaching from materials, identified in the study, include PAHs from bitumen and coal tar, solvents from paints, asbestos fibers from asbestos cement, organic compounds from plastic pipe and fittings, styrene and benzothiazole from sealing rings, vinyl chloride and Bisphenol A, some of which are historic issues.[177] The evaluation report concludes that the DWD, and in particular Article 10, has been a main factor explaining the trends in improved water quality and decreases in non-compliances for distribution network related sources such as for lead and copper. Current problems with pipes include: coal tar linings; lead and lead solder; Plastics stabilizers and unreacted monomers and antioxidants; solvent cements; epoxy rasin lining; Ion exchange rasins. Solving these issues by harmonizing systems for materials in contact with water would lead to a reduced risk for pollution and a reduced risk for environmental impacts stemming from these substances. It is assumed that the contamination from materials and products in contact with drinking water concerned by the new standards will be reduced and thus the drinking water quality will be improved, both in terms of currently-listed substances, high priority substances of emerging concern and by substances of emerging concern. The contamination of drinking water by new List B substances will decrease with -5 percentage units for MS with RBA and -3 units for areas with RBA. For contamination by List C substances, the reduction will be -6 percentage units for all areas.

[177] Specific contract No. 07.0201/2015/716466/SFRA/ENV.C.2, Support to the implementation and further development of the Drinking Water Directive (98/83/EC): Study on materials in contact with drinking water.

Option 4.2 and 4.3 which both applies SMART information systems, including components of SMART monitoring systems, would allow for timely information on exceeding parameters or identifying outbreaks which would permit suitable interventions and therefore removing potential risks for the environment. An example of how this could be applied is the Portuguese Drinking Water Quality Control Regulatory Cycle which is a web based communication system to record non-compliance.

For sub-options 4.2 and 4.3, no change as compared to the baseline scenario is expected in the compliance rate with current annex I. But as consumers will have better information on water quality and WHO guidelines, they might also require a stricter application of the precautionary principle to limit risk to a minimum (within reasonable cost implications). As a result, we assume that the contamination by currently-listed below current limit values and above precautionary parametric values substances will be reduced by 10% (i.e. that an additional 10% of the drinking water compliant with current parametric values will respect stricter thresholds values). For sub-option 4.3, it is assumed that contamination by high priority substances will be reduced by 2% compared to baseline. Because consumers will ask for a better drinking water quality than the required one.

In terms of sub-option 5.2, quality of self-supplied water will have to comply with current standards - so contamination of self-supply drinking water will be reduced until reaching the same level of contamination than PWS-drinking water.

Geographical distribution and population groups most affected

The compliance with current DWD (current substances and current thresholds) currently ranges from 95% to 100% among MS. During the last years, non-compliance by substances currently listed in annex I kept on decreasing regarding current thresholds - with a reduction of approximately 0.07% per year, primarily a result from improvements of drinking water quality supplied by small suppliers. Some limit values defined in the current DWD are considered by some experts as above what would be coherent with precautionary principle (strict limit values).

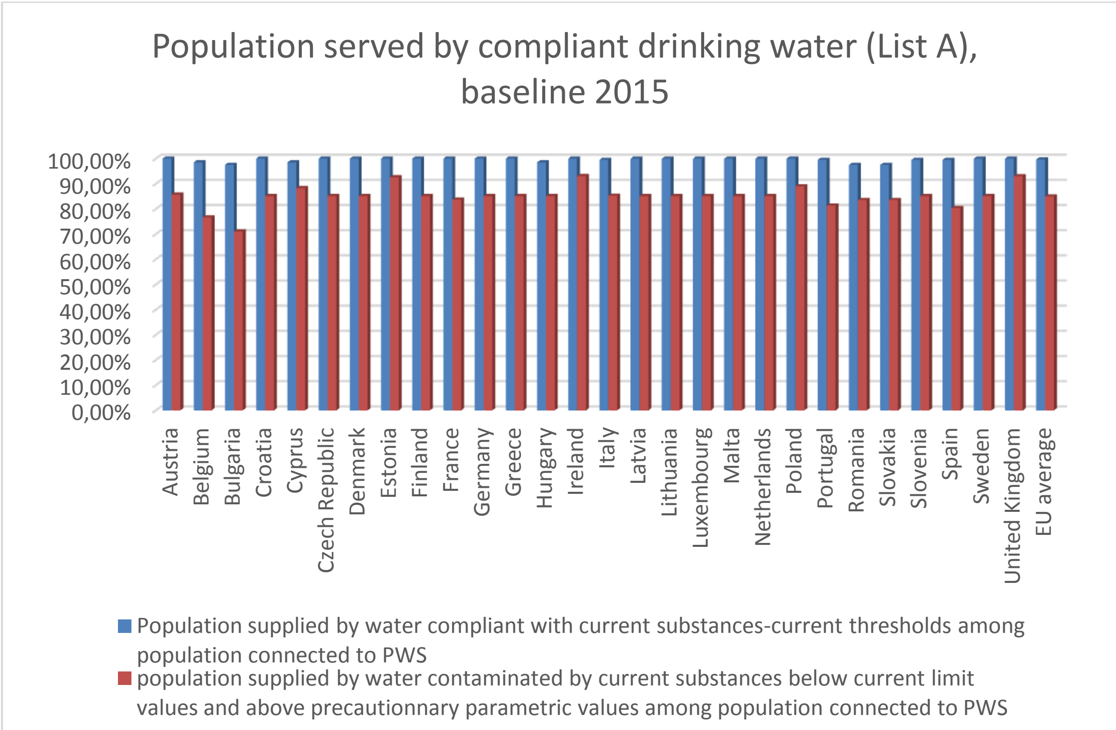


Figure 22. Comparison between population served by drinking water compliant with current substances current thresholds and stricter thresholds (List A and B).

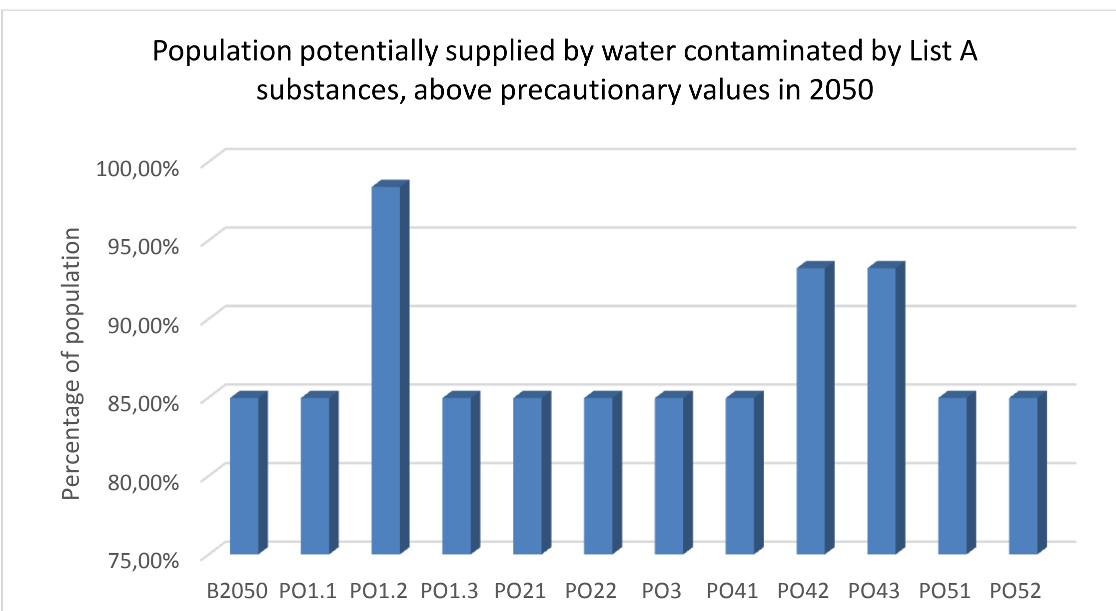


Figure 23. Population supplied by DW compliant with List A above precautionary parametric values among population connected to PWS (no separation into RBA/no RBA).

According to data from the Waterbase database (EEA, 2014), it has been assumed that between 74% and 94% of the drinking water were contaminated by currently-listed substances at a concentration below precautionary thresholds for the main parameters considered (nitrate, ammonium and other hazardous substances). This will stay stable by 2030 and 2050 if nothing changes. Please see the figures below for an overview of the current population served by compliant drinking water.

The figure above shows how the policy options will impact on the population supplied by water contaminated by List A among population connected to PWS in the 2050 scenario. As can be seen, option 1.2 would lead to the lowest risk for contamination by List A substances, an increase of compliance of 13 percent units to 98% in 2050 as compared to the baseline. The risk would this decrease from 14% in the baseline to only 2% in 2050. Option 4.2 and 4.3 will reduce the risk for contamination by List A substances to 7%. The options will lead to increase of compliance with currently listed substances with 6 percentage units on EU28 average, from 85% in the baseline scenario to 93% in 2050, as consumers will have better information on water quality and WHO guidelines and might require a stricter application of the precautionary principle to limit risk to a minimum, reducing contamination by currently-listed substances by 10%. All other policy options remain on the baseline level.

Population supplied with DW potentially at risk of contamination with List B substances (high priority substances of emerging concern)

In all sectors (domestic, industry, agriculture), increasing number of compounds will be created and used, which will lead to increasing number of pollutants – even with small concentrations – in water resources. Those pollutants are not all present in fresh and drinking water at the same concentration, and their noxiousness is not the same for all of them. The ones already known as harmful for human health and for which technologies already exist to monitor and treat are called high priority substances of emerging concern. It has been assumed that with no revision of the DWD, no update of the list of pollutants to monitor and to comply with will be done. As a consequence, the contamination of fresh and drinking water quality by List B substances will continue to exist and will increase in the future. At the exception of water suppliers which implemented RBA, which may add some of those pollutants of emerging concern to the list of monitored parameters. Thus, List B contamination would be partially treated and reduced by half - both measures at source and treatments could be used as for currently-listed substances. For water suppliers whom did not adopt RBA, the contamination will be the same in drinking water.

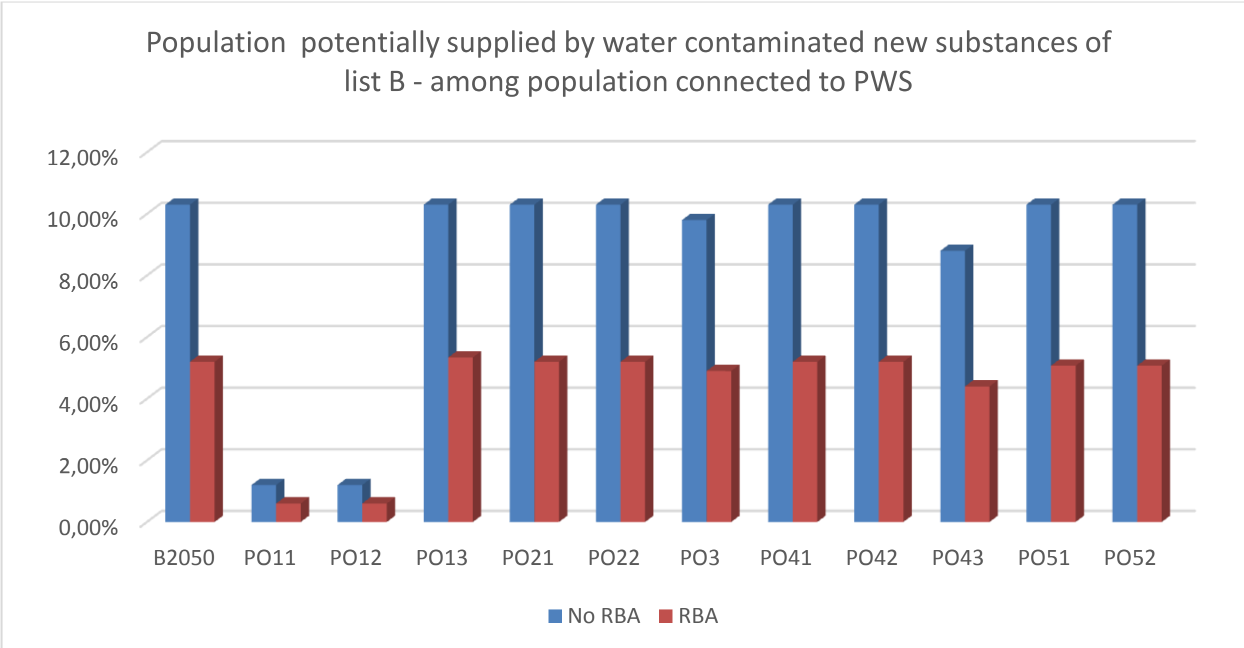


Figure 24. Population supplied by water contaminated by List B *substances (*high priority substances of emerging concern at adverse concentration) - among population connected to PWS

Policy option 1.1 and 1.2 will have the biggest positive impact in terms of compliance rate of the new standards regarding List B substances. The reduction of population supplied by water contaminated by List B substances will be from 10% to 2% in 2050 as compared to the baseline scenario for EU28 in areas with no RBA. In areas with RBA the reduction will be from 5% to 1%. The biggest impact on MS will be recorded in Bulgaria (-32 percent units), Spain (-26) and Slovak Republic (-22) for the 2050 scenario. Option 4.2 will reduce the concentration by approximately 2 percent point in areas with no RBA as compared to baseline.

Population supplied with DW potentially at risk of contamination with supplementary substances from List C (other substances of emerging concern)

It is considered that a reason for the contamination of fresh and drinking water by List C substances could be the consumption of pharmaceuticals. So it has been assumed that contamination of freshwater by List C substances will increase by the same proportion as pharmaceutical consumption increase. Water suppliers which implemented RBA will not treat the water for those substances, which is visible in the graph below.

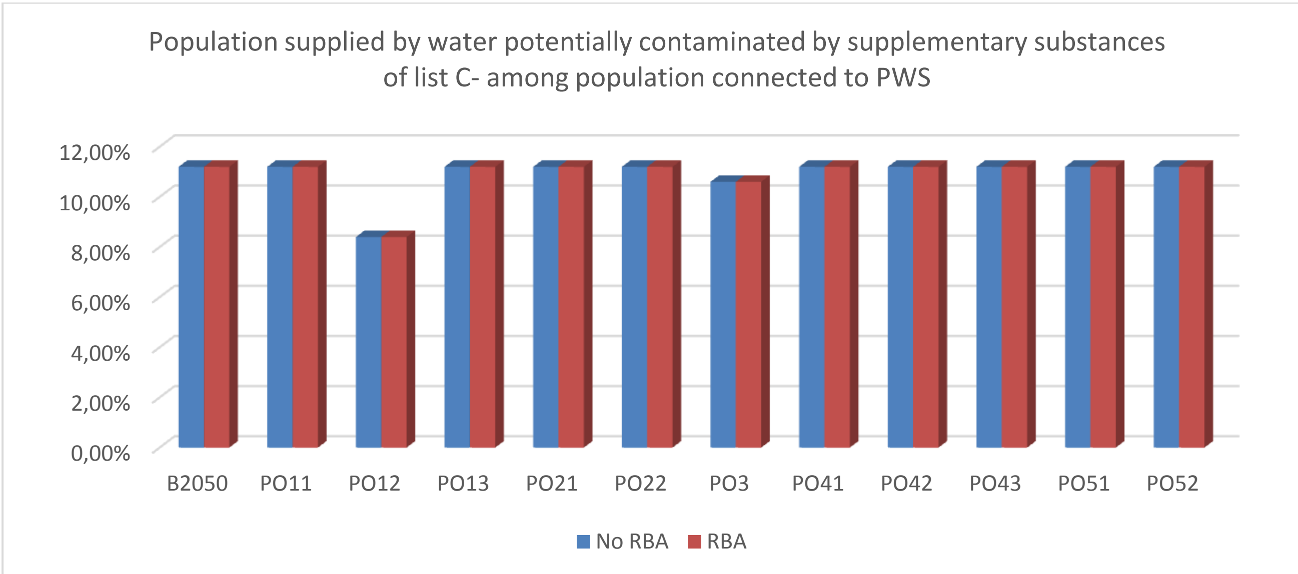


Figure 25. Population supplied by water contaminated by supplementary substances of list C (other substances of emerging concern at adverse concentration) - among population connected to PWS

Also in terms of population supplied by water contaminated by List C substances of emerging concern at adverse concentration among population connected to PWS, policy option 1.2 will have the biggest impact. It would result in that the population supplied by water polluted by List C substances would be reduced by 3 percent point from 13% to 10% in 2050, as compared to the baseline scenario on EU average. The MS which will experience the biggest impact in terms of reducing by other substances of emerging concern in 2050 as a result of the option is Cyprus and Malta that will both see an 8 percent unit decrease from the baseline scenario, in Luxembourg and Portugal the population exposed will be reduced by 7 percent units respectively. In option 3, the population supplied by water contaminated by List C substances - among population connected to PWS, the reduction will be around 2 percentage points.

To conclude:

- **Option 1.2 is having the biggest impact on water quality across all categories and the potential for the largest reductions in pollution loads** as a result of the updated list of parameters and extended monitoring of pollutants.

- it is visible **that RBA is having a big influence and a possibility to improve water quality across all policy options for List B substances, high priority substances with emerging concern.** On a general level, the areas with RBA have in general lower levels of pollutions than areas without. The reason for the reduced pollution in water following RBA implementation is twofold. Firstly, the RBA process can help to identify some potential pollutants that are not in the annex I but which represent a risk for drinking water quality if not treated - thus those pollutants will be added to the list of parameters monitored.

Secondly, the water suppliers that will implement RBA will increase their efforts for addressing pollution at source which have a positive impact on raw water quality.

7.4.2 Impact of measures at source

Increasing implementation of measures that aim at reducing or suppressing pollution at source (i.e. measures that target specific sectors or stakeholders among farmers and industry) is expected to have positive environmental benefits as it will contribute to the improvement of status of water bodies and to achieving the objectives of the WFD in the areas concerned.

Increased measures at source include changing agricultural practices that have a significant environmental impact, not only on water bodies but also on soil quality as well as biodiversity. The level of contribution depends on different characteristics of the farming such as the crop rotations, intensity of cultivation, integration or not of livestock production and type of livestock production. Addressing issues such as the level of fertilizers, tillage, irrigation, green manuring and liming, reducing monoculture, which all have a bearing on the quality of water bodies in the area, might therefore significantly reduce the level of harmful environmental impact. The positive effect of implementing measures addressing pollution at source on raw water quality (especially for groundwater) is delayed in time after the adoption of these measures. However, it is considered that if measures addressing pollution at source are adopted from 2020, effects would be effective in 2030.

The impact on biodiversity is further described in the last section of this chapter.

Following the implementation of policy option 2.1 and 2.2, a wider application of RBA, and in some cases a stricter application of cost-effectiveness analysis in the context of the WFD implementation, water service providers are expected to progressively put their efforts on timely and effectively controlling water pollution at source (by pollutants listed in the current DWD, additional new pollutants and emerging polluting substances which is identified sufficiently in time for taking preventive action). As more water suppliers implement RBA than in baseline, and as indicated above, the wider implementation of measures for addressing pollution at source will help reducing the reliance on water treatment and thus water treatment costs (-10%). It would in addition strengthen the implementation of the precautionary principle, through a multidisciplinary approach based on cooperation and dialogue with industry and other actors such as farmers, retailers and consumers.[178] This can be done through methods such as catchment inspection, source water monitoring, plant maintenance programme and plant treatment process monitoring and distribution system maintenance and monitoring at tap. As a result, RBA would lead to a decrease of certain substances in water which, in addition to representing health risk, pollute the environment, increasing the compliance with water legislation for the water suppliers.

[178] EurEau presentation 21/01/2016, Brussels

With regards to option 4.3, as a result of organized pressures from better informed drinking water consumers, it is expected that more water suppliers implement measures for addressing water pollution at source than in the baseline scenario and as indicated above, this will result in improved water quality.

As a result of the increase of persons connected to PWS in **sub-option 5.1** there will be a global increase of measures at source implemented. **In option 5.2,** to ensure safe drinking water to all Europeans and to quality guarantee all water supplies and private wells would mean that additional measures at source (50%) will have to be implemented on water bodies used to supply non-connected people. Such measures might have positive local impacts on fresh water quality through reduced pollution loads following monitoring in areas previously not covered by regulation.

The impact would be biggest in those MS and areas with a low share of population covered by PWS or regulations as well as for small water suppliers previously not covered by regulation. The most affected countries are Romania, Lithuania and Latvia.

Geographical distribution and population groups most affected

The marginal effect of implementing **policy option 2** would be more significant in countries and areas that do not have RBA in place, for small water suppliers as well as in MS and regions with lowest compliance with the WDF as well as rural and agricultural areas. Increased application of measures at source and the efforts to improve fresh and drinking water quality will in addition to DWD implementation, also result from WFD enforcement. The relative influence of measures at source can be linked to the current status of water bodies in the MS. MS with a higher share of water bodies not living up to the WFD objective of good environmental status in surface and ground water bodies, and with a low coverage of RBA in the baseline scenario are likely to experience a larger influence of measures at source given the full implementation of RBA which is expected by 2050 in policy option 2. Please see the map 12.

Box 9.
Poland has only 10% of its surface water bodies living up to a good status which is supplying some 31% of the PWS. 43% of the drinking water in Poland is supplied by suppliers which implemented RBA and accordingly the expected improvements in terms of water quality will mainly be seen in the remaining 57% of the water bodies

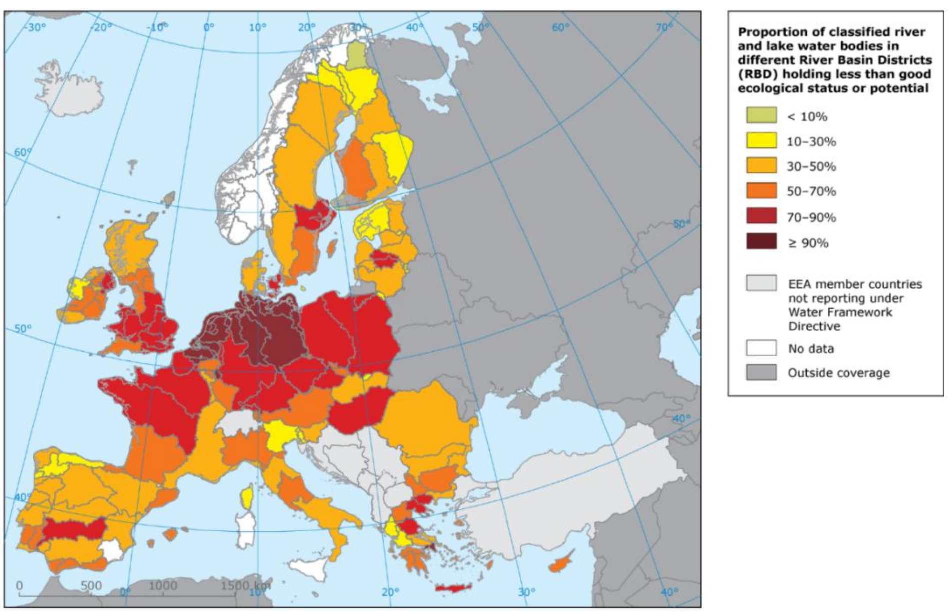
Measures at source following RBA is therefore likely to have the largest influence in these MS where the biggest improvement will be seen, e.g. by reducing point source pollution, and thus increasing the compliance with the WFD. In the MS which already have high implementation of RBA in, such as Belgium, the Netherlands and the UK, all with 95%, the environmental impact of measures at source will be less significant. See table 13 below for a few selected countries.

Table 13. Drinking water bodies and WFD performance in selected MS, baseline 2015

MS	% of population supplied by suppliers which implemented RBA among population connected to PWS	% water bodies in good quality status (WFD) - volume	Environmental objectives achievements (WFD) = chemical good status in area of groundwater bodies	Environmental objectives achievements (WFD) = chemical good status in area of surface water bodies	% of water bodies subject to point source pollution (waterbodies with known ecological status)	percentage of water (PWS) coming from groundwater sources
Bulgaria	48%	46%	65%	29%	35%	47%
Germany	47%	78%	69%	100%	28%	70%
Greece	37%	38%	93%	9%	35%	35%
Luxembourg	49%	51%	43%	59%	0%	51%
Malta	49%	7%	7%	5%	23%	100%
Poland	43%	72%	100%	10%	66%	69%
Romania	39%	40%	91%	14%	8%	34%
Slovakia	18%	63%	65%	55%	0%	84%
Spain	46%	63%	100%	48%	41%	28%

Source: Consultants' calculations in the Excel Database

Map 12. Proportion of classified river and lake water bodies in different River Basin Districts (RBD) holding less than good ecological status or potential



Source: EEA, SOER 2015, http://www.eea.europa.eu/soer-2015/europe/freshwater

7.4.3 Energy consumption

Energy consumption in this context relates to the energy consumed in the process for producing drinking water, which varies greatly due to differences in the size of the water systems, pumping requirements between geographic locations, and raw water characteristics and quality. Desalination of brackish groundwater or seawater requires much more treatment, so the energy intensity is significantly higher. Also the size of the water utility matters and the intensity of water production and mean water production cost from energy both show that smaller utilities use more electricity per unit of water.[179] The unitary consumption of energy to produce drinking water in kWh per cubic meter with a mean/min/max consumption is presented in the below table. As can be seen, the energy consumption for treatment represents 50% of total energy consumptions throughout the drinking water production (see Table 14).

Table 14. Energy consumption by activity (kWh/m^3)

Action	Energy consumption (kWh/m^3)	Min Energy Consumption (KWh/m^3)	Max Energy Consumption (KWh/m^3)
abstraction-treatment-distribution	0.46	0.08	0.72
Abstraction	0.207	0.036	0.324
Treatment	0.23	0.04	0.36
Distribution	0.023	0.004	0.036

Source: Rachel Young (2014) Watts in a Drop of Water: Savings at the Water-Energy Nexus, An ACEEE White Paper and European Benchmarking Cooperation (2013) Public report of the International water benchmark: Learning from International Best Practices.

Box 10. Example from Member States:
In Germany, drinking water supply and wastewater disposal accounts for merely half a percent of the entire primary energy consumption (Source: German Federal Statistical Office 2011). This takes account of the energy required for the abstraction, treatment and distribution of drinking water and the collection, discharge and purification of wastewater. In terms of drinking water, it takes on average 0.51 kWh to provide 1,000 litres of drinking water. There is a large fluctuation range. The amount of energy required depends, for instance, on whether spring water is available or deep-seated groundwater needs to be abstracted, and on the differences in altitude to be overcome for water transport and distribution. Taking the average per capita water consumption as a basis, the water sector uses 29 kWh per year for the drinking water supply of one person. Source: dvgw Wirtschafts- und Verlagsgesellschaft Gas und Wasser mbH, Profile of the German Water Sector 2015, http://www.dvgw.de/fileadmin/dvgw/wasser/organisation/branchenbild_engl_2015_langfassung.pdf

In Denmark, the energy intensity is lower and the weighted average electricity use for drinking water production is 0.44kWh/1000 liters of drinking water sold. (DANVA, 2015)

[179] : Rachel Young (2014) Watts in a Drop of Water: Savings at the Water-Energy Nexus, An ACEEE White Paper

Malta is heavily dependent on the desalination of water for its national potable water supply and it accounts for over 50% of Malta's potable water. Historically Malta has always lacked natural freshwater resources. As the level of exploitation is high and natural freshwater is not enough to supply demand, four reverse osmosis plants have been put in place. This is an energy intensive process which is consuming 3% of Malta's total electricity generated. Other countries which have turned to desalination technologies to meet water stress are Cyprus and Spain.[180]

The policy options will have different impacts on the need for treatment for drinking water. Reducing the need for treatment, by for instance applying measures at source, would result in energy savings. It is assumed that the energy consumption will change accordingly to the variations in levels of treatment. Reduced energy consumption will also bring associated reductions in GHG emissions.

The policy options that would require increased levels of treatment are primarily, **Option 1.1 and 1.2** that will require a wider range of treatment to ensure that drinking water quality complies with the extended list of parameters and with the new limit values. The additional water treatment required to achieve compliance with the updated Annex 1 will lead to increased energy consumption of the water treatment plants. In option 1.1, treatment will be increased by +5% and in option 1.2, the increase will be more significant with +30%. In option 1.3, it is assumed that water suppliers will lower their treatment efforts as the number of parameters to legally comply with will be shorter and treatment costs are expected to be reduced by -10%.

Introducing RBA, following policy option 2, it is assumed that the need for treatment of the drinking water is reduced by 10%, as measures at source will be improved. The energy consumed in the treatment process is therefore expected to be reduced to the same range. It is also assumed that energy efficiency will be additionally increased as a result of changes in the application of new and modern treatment technologies. Water treatment technologies are becoming increasingly energy efficient and any replacement or new installation of treatment technologies are expected to lead to energy savings with the accompanying reductions in GHG emissions.

For sub-option 4.2 and sub-option 4.3: treatment will increase by 10% because consumers demand a drinking water of better quality than what is required in DWD.

In sub-option 5.2, additional measures for addressing pollution at source (50%) or for treating water (50%) - e.g. with UV treatment devices for cisterns will have to be implemented.

[180] http://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-malta.pdf and IEEP, Ecologic and Acteon (2008), Potential impacts of desalination development on energy consumption, DG Environment Study Contract #07037/2007/486641/EUT/D2, 2008

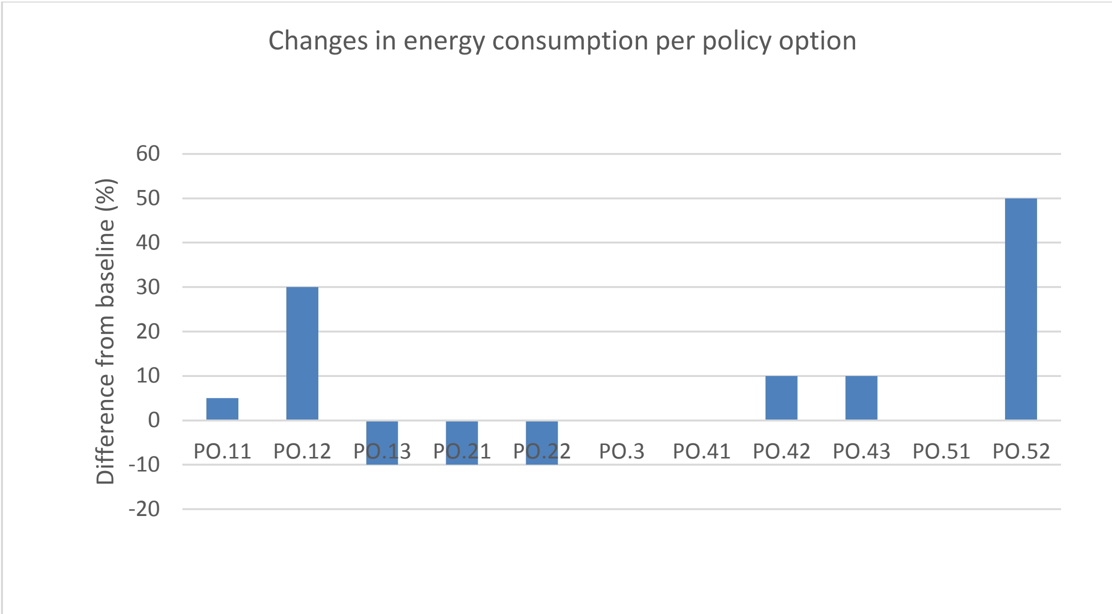


Figure 26. Changes in energy consumptions per policy option, % from baseline

Geographical distribution

To illustrate how the energy consumption might be affected across MS from potential savings during the processes of treatment we have compared the above data with the cumulative energy demand (CED) (or primary energy consumption)[181] of the utilization of 1 GWh in MJ in the MS. Depending on the share of the different energy sources in the countries we can expect different environmental impacts among MS as the CED differs across the MS.

The average for EU27[182] is 2.7 $MJ_{primary\ energy}$ per 1 $MJ_{electricity}$ or 9,720,000 MJ/GWh. Among the MS, France has the highest CED (3.6 MJ/MJ or 12,924,000 MJ/GWh), Hungary (3.5 MJ/MJ or 12,492,000 MJ/GWh) and Cyprus (3.3 MJ/MJ or 12,024,000 MJ/GWh). The most significant unitary energy savings can therefore be expected in these countries.[183]

7.4.4 Environmental effects of bottled water consumption

The expected reduction of bottled water consumption in EU28, further described under social impacts above, will have a positive environmental effect. Reduced consumption of bottled water would result in a reduction of the associated use of resources, energy consumption, emissions and waste generation from the production and transport of plastic and glass bottles.

[181] The Cumulative Energy Demand (CED) is an approach that quantifies the energy content of all different (renewable and non-renewable) energy resources.

[182] No data is available for Croatia.

[183] GEMIS 4.9, ca. 2010, next update envisaged for 2020

Life-cycle assessments (LCA), where the environmental impact of a product is assessed in stages from cradle to grave, have shown that the environmental impact of bottled water is 90 to more than 1000 times higher than that of tap water, depending mainly on how far the water is transported.[184] An average EU citizen currently consumes 106 litres of bottled water per year.

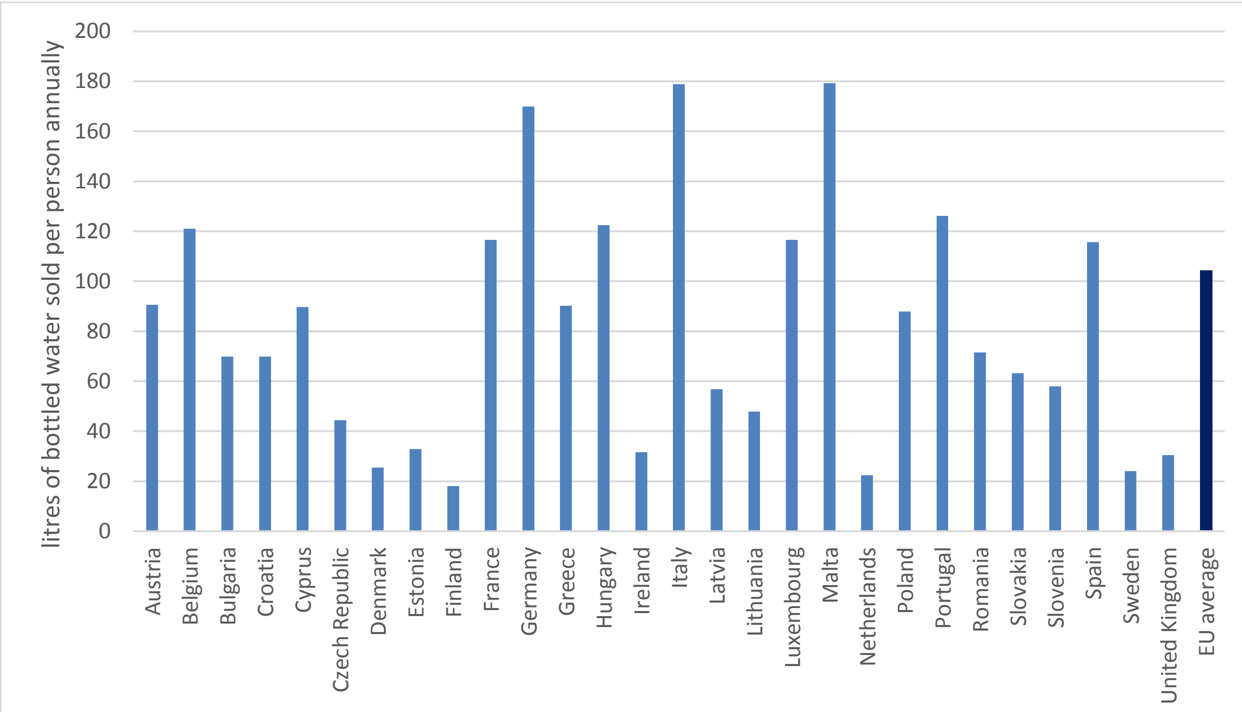


Figure 27. Annual consumption of bottled water in the EU, litres per person

In terms of water efficiency, studies based on the US market show that on average it takes 3 litres of regular water to produce 1 litre of bottled water, which can be illustrated through 100 billion litres of wasted water annually (2011 data). Bottled water production, including packaging, transportation, and refrigeration, also generates CO_2, contributing to climate change.[185] The EU total bottled water sales in 2009 where 51.6 billion (excluding Malta, Luxembourg and Cyprus, according to the European Federation for Bottled water.

[184] Helle Marcussen, Peter E. Holm, and Hans Chr.B. Hansen, Composition, Flavor, Chemical Foodsafety, and Consumer Preferences of Bottled Water, 2013 Institute of Food Technologists http://onlinelibrary.wiley.com/doi/10.1111/1541-4337.12015/epdf http://onlinelibrary.wiley.com/doi/10.1111/1541-4337.12015/epdf Accessed on 5 May 2016

[185] Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol http://ec.europa.eu/environment/integration/research/newsalert/pdf/persuading_the_public_to_reduce_bottled_water_consumption_425na7_en.pdf

Most of the bottles are made of plastic which theoretically means that more than 50 billion 1 litre plastic bottles get sold Europe wide per year.[186] In 2011, it took more than 2.5 million tons of CO_2 to produce the amount of bottled water required for US consumption. On average, it takes 7 litres of water and 162g of oil to make the plastic for each one litre plastic bottle, generating 100g of CO_2[187]. The results from different analyses vary from 173 to 250g of CO_2 eq per litre of water bottled in a plastic bottle, which is up to 6,000 times more than the ecological footprint of a litre of tap water. Moreover, harmful toxic chemicals such as antimony can leach from PET bottles.[188] In terms of waste generation, approximately 40% of plastic bottles[189] are being recycled, and a large share is instead ending up in landfill or littering the natural environment with plastic waste. It is therefore appropriate to assume that it would be beneficial for the environment if consumption of bottled water was reduced.

The policy options that will have an impact on bottled water consumption is 4.2 and 4.3 as these two options will have an impact on the level of information provided to consumers which is assumed to influence the consumption of bottled water. For all other policy options the situation remains unchanged.

For sub-option 4.2 a 10% reduction by 2050 is expected as compared to baseline. **In sub-option 4.3,** even more information is made available than in 4.2 and in addition, the transparency of information of water service providers' operations will be enhanced. This is expected to result in a bigger reduction of the share of bottled water consumption in total drinking water, resulting in the decrease in bottled water consumption of 20% in 2050. It is expected that corresponding reductions of the use of resources will follow. The positive environmental impact following the reduced consumption of bottled water will therefore be more significant for option 4.3 than for 4.2.

Geographical distribution and population groups most affected

In terms of the share of bottled water in water consumption, Malta has the significantly highest consumption of bottled water per capita of total consumption of water for drinking and cooking, 11%. Hungary and Germany are following behind with app. 5%. In option 4.2 the decrease in Malta would be from 11% to 10% in 2050 as compared to the 2050 baseline. In option 4.3 the percentage would be from reduced to 9% in the same scenario. For Germany and Hungary the share of bottled water in total drinking water consumption would be 4% in option 4.3.

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[186] http://www.efbw.eu/index.php?id=90 Accessed on 5 May 2016

[187] University of Nottingham, Environmental Technology Center, http://www.nottingham.ac.uk/etc/news-water.php

[188] "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol http://ec.europa.eu/environment/integration/research/newsalert/pdf/persuading_the_public_to_reduce_bottled_water_consumption_425na7_en.pdf

[189] http://ec.europa.eu/environment/waste/studies/pdf/plastics.pdf Accessed on 5 May 2016

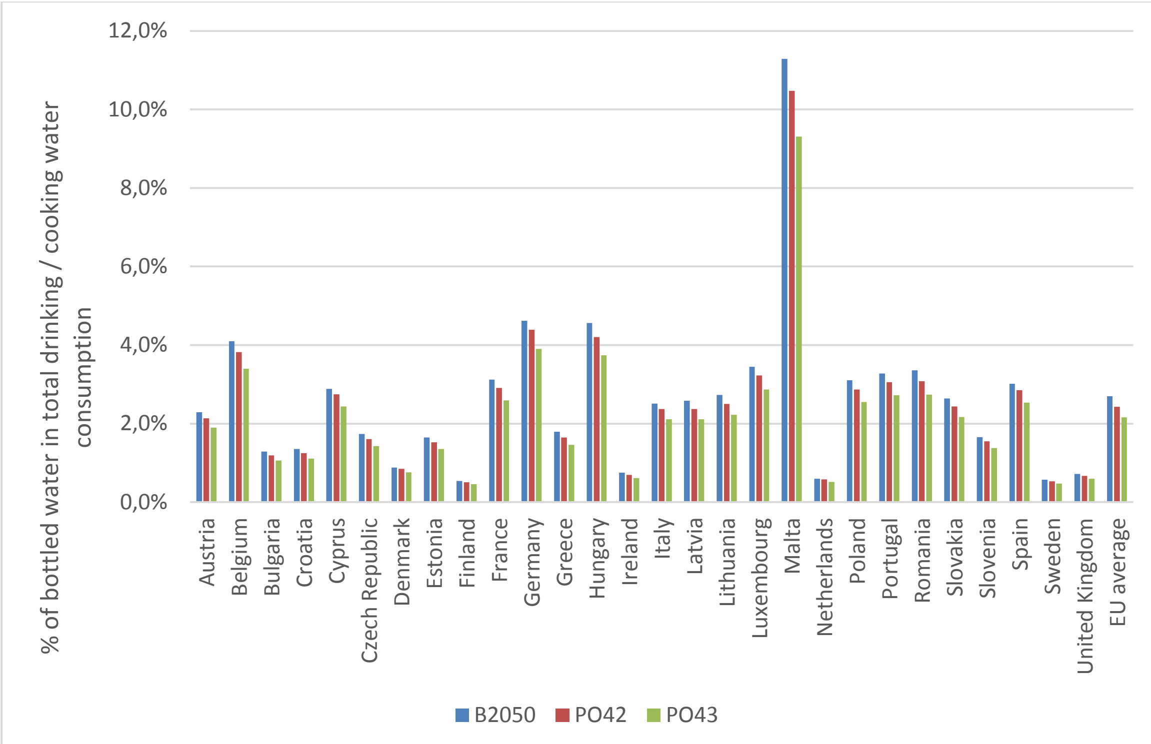


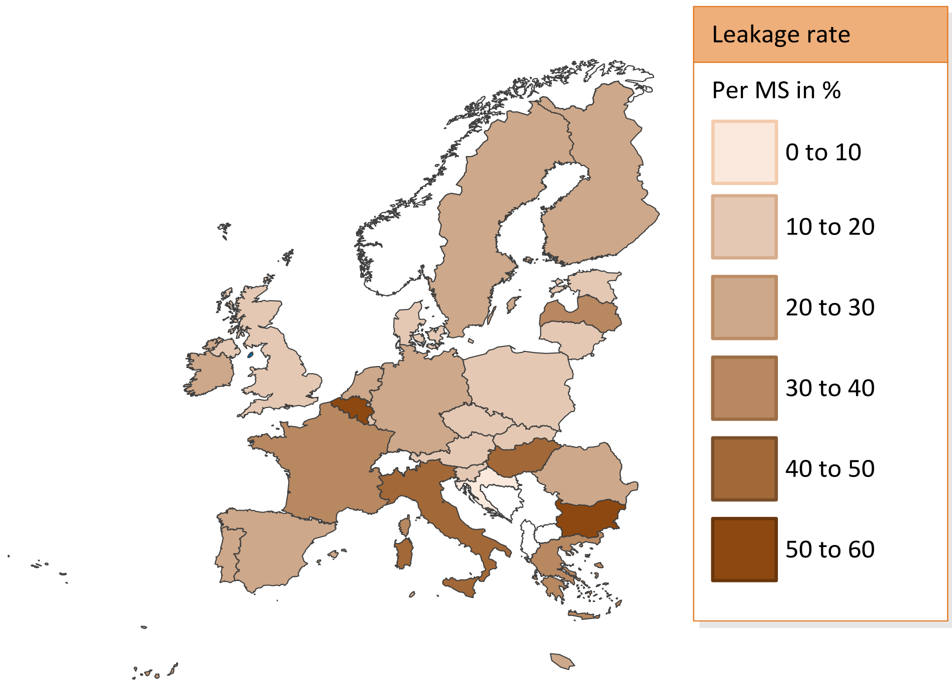
Figure 28. Changes in bottle water consumption per policy option, %

7.4.5 Resource efficiency

Along with improved access to information, consumers may have the possibility and the power to influence water suppliers' decisions that determine drinking water management (for instance by increasing treatments or measures at source). In a number of the suggested policy options, consumers and suppliers will be provided with incentives for implementing voluntarily for water and resource efficiency. This is assumed to have an influence on resource efficiency. Resource efficiency is a wide concept and is in this context related to (1) water efficiency and (2) related energy savings as a result of more water efficient management. The policy options that are expected to have an impact on resource efficiency are primarily 4.2 and 4.3.

Option 4.2 suggests that the SMART information system should include information of water leakage rates and leakage reduction measures. This can potentially lead to water savings as consumers would be prompted to take voluntary measures in addressing leakage problems in households which would reduce water consumption as well as lead to energy savings. SMART information on ways to detect leakages will lead to early leakage detection and fixing and decreased water use (for example, such information is available in Flanders). Leakages from water supply networks remain well over 30% in many member states. Denmark, the Netherlands and Austria are example of how optimization of the distribution network through network registration and leakage searching may reduce water loss to as low as 6%[190] (see Map 13).

Map 13. Water leakage in PWS in EU28



Source: Eurostat

Leakage reduction, especially in water stressed areas, has direct benefits for the environmental and chemical objectives under the WFD art. 4. In addition, leakage reduction can address significant pressure, as unnecessary abstraction may have negative hydromorphological consequences and may cause higher concentrations of pollution in the originating water body where the water is abstracted from. Experiences in France, England and Wales suggest that these systems are not costly but, on the contrary, they oblige for an efficient use of public expenditure. Further investigation e.g. on the systems developed in Portugal, France, England and Wales would be needed. However, implementation of this option is not expected to be lengthy or time-consuming. This option would mainly affect water suppliers, regulation/RBD authorities, citizens and industry (in case domestic water suppliers are also supplying industries). The marginal effect of the option would be larger in countries that do not have RBA in place and small water suppliers. In addition, the impact would be larger in MS and regions with lower compliance with the DWD as well as in water stressed areas.

Option 4.3 is giving citizens access to comparable data on the key economic, environmental, technical and quality performance indicators of water operators which will create a higher awareness and can lead to the voluntary reduction of water consumption by consumers which would have numerous

[190] Danva.dk

environmental benefits. Voluntary actions by consumers would be further enhanced if the smart information systems also included tips and recommendations on how consumers can improve their water consumption.

Improving energy efficiency of drinking water operations (e.g. through more energy efficient water abstraction pumping systems and improved water efficiency) will have a positive impact on CO_2 emissions related to drinking water production. Water savings can be achieved through application of water saving technologies, leakage reductions and the exploration of alternative water resources such as rainwater in addition to finding optimal ways of using low-quality local water sources such as grey-water or water contained in Sustainable Urban Drainage Systems (SUDS) in households, municipal use, fire-fighting etc. According to estimates in Germany, Austria and Switzerland, potential energy savings for drinking water and wastewater utilities are in the region of 10–30% per year.[191] Rachel Young's report based on the US is assessing that 30% energy savings could be achieved from improving water efficiency.[192] Water saving measures will have a significant environmental impact on the water ecosystem and related ecosystem services, especially in already water stressed areas.

SMART information systems, where efficiency, performance, approval rates etc. for the service suppliers are communicated, will create incentives for performance enhancement among the suppliers. This will e.g. be the case when companies, previously not surveying these aspects, become aware of inefficiencies and flaws of the system and are prompted to intervene. Moreover, improved transparency and communication of suppliers' efficiency might encourage voluntary measures of the companies (especially among the lowest performing operators), in order to improve approval rates among consumers. Increased application and communication of benchmarking systems through SMART information systems can improve the performance and efficiency for water service providers, improving energy and resource (including water) efficiency performance and consequently reduce the environmental footprint. Benchmarking can induce competition among operators, in a sector where competition is limited due to the fact that the users often do not have the possibility of changing their service provider. In the Netherlands, introducing voluntary benchmarking, which is made publicly available to consumers and stakeholders, has raised efficiency by 35% and brought high customer satisfaction at 7.7/10. Benchmarking of drinking water providers is currently done in several MS, such as Denmark, the Netherlands, Spain, Finland, Sweden, UK and Germany.[193]

7.4.6 Impacts on biodiversity

Reducing polluting substances in drinking water

Reducing the amounts of pollutants in drinking water by unlisted and emerging substances would have a positive environmental impact on water bodies as less potentially harmful substances would enter the drinking water cycle and consequently also be discharged as waste water. Small amounts of hazardous chemicals, such as medications, oil, in the drinking water can have serious impacts on the status of water

[191] Municipal Infrastructure Conference: "Efficient Use of Energy in Water Supply and Wastewater Disposal – Southeast Europe and Turkey" 26 & 27 November 2013, KfW, Frankfurt am Main, Germany, https://www.kfw-entwicklungsbank.de/PDF/Entwicklungsfinanzierung/Sektoren/Wasser/Veranstaltungen/Conference_Documentation_online.pdf

[192] Young, 2014

[193] EurEau, 2015, How benchmarking is used in the Water Sector

bodies, water ecosystems and organisms. The benefits would have an impact on the status of aquatic ecosystems and for related ecosystem service, a positive impact on soil quality which would have a positive effect on biodiversity, and it would enhanced the non-use and recreational value of ecosystems. The policy options with impact on levels of water pollution are mainly option 1.1 and 1.2 in terms of limiting the content of pollutants in drinking water.

Measures at source and agricultural practices
The increased measures at source following option 2 will to a large extent include changing agricultural practices that have a significant impact on water bodies, soil quality as well as biodiversity. When farmers are adapting their practices for reducing pollution at source, this can have positive impacts on biodiversity/landscape in the areas where changes in farm practices take place.

The level of contribution depends on different characteristics of the farming such as the crop rotations, intensity of cultivation, integration or not of livestock production and type of livestock production. Addressing issues such as the level of fertilizers, tillage, irrigation, green manuring and liming, reducing monoculture, which all have a bearing on the quality of water bodies in the area, might therefore significantly reduce the level of environmental impact. The negative impact from agricultural practices are seen in many ways including decreased soil organic matter content, the composition and functioning of soil organisms, loss of soil structure, loss of soil through wind and water erosion, development of acidic, saline and sodic soils, and soil contamination with pesticide residues and heavy metals (Doran and Parking, 1994) as well as fragmentation of habitats and loss of biodiversity. Agriculture with external inputs for crop production can have far reaching effects in soil, water and other ecosystems, including:

- Deterioration of soil quality and reduction in agricultural productivity due to nutrient depletion, organic matter losses, erosion and compaction
- Pollution of soil and water through the overuse of fertilizers and the improper use and disposal of animal wastes
- Increased incidence of human and ecosystem health problems due to the indiscriminate use of pesticides and chemical fertilizers
- Loss of biodiversity due to the use of reduced numbers of species being cultivated for commercial purposes
- Loss of adaptability traits when species that grow under specific local environmental conditions become extinct
- Loss of beneficial crop-associated biodiversity that provides ecosystem services such as pollination, nutrient cycling and regulation of pest and disease outbreaks
- Soil salinisation, depletion of freshwater resources and reduction of water quality due to unsustainable irrigation practices throughout the world
- Disturbance of soil physicochemical and biological processes as a result of intensive tillage and slash and burning.

Clean unpolluted water is essential for ecosystems. Changing into more sustainable farming practices as a result of RBA, such as through the application of organic wastes, moderate use of mineral fertilisers, crop rotations, irrigation in dry and drainage in wet areas generally have positive impacts on soil organism densities, diversity and activity. Agricultural practices continue to play a crucial role both in the maintenance and the loss of biodiversity in rural areas.[194] Studies clearly show a strong relationship between a number of key water quality parameters and biodiversity measures in both invertebrate and vertebrate species and a degradation of water quality can be expected to result in a loss of biodiversity. The predominant parameters showing strong consistent correlations were nutrients (nitrogen and phosphorus), alongside pH, temperature, dissolved oxygen, and conductivity. The interdependency between water and biodiversity also means that disrupting the biodiversity will have a negative influence on the water quality as it would mean disturbances in the hydrological cycle. Biodiversity maintains ecosystem functions and services that we need to sustain drinking water supplies. The need for comprehensive biological monitoring of aquatic ecosystems has been recognized at national and international levels.[195]

High fertilization doses, short crop rotations or monoculture combined with chemical plant protection measures cause depletion of species richness and species diversity (McLaughlin and Mineau, 1995), and thus are likely to make farmland lose the high nature value status. Paracchini and Britz (2010) have developed an indicator to assess the likelihood for farming systems at an EU-wide scale to support biodiversity which gives an indicator of the influencing factors. The indicator is a so called "aggregated indicator of biodiversity friendly practices", which delivers crop shares, stocking densities, yields and fertilizer application rates for the EU (based on the CAPRI index). The final aggregated indicator is obtained by adding components corresponding to arable crops, grasslands and permanent crops and the rest of the Utilised Agricultural Area (UAA). The index also takes into account the combination of a rich crop composition and very extensive management and/or extensively managed grasslands. With regards to nutrients load the literature gives different estimates of the steepness of the relation between increased N doses and biodiversity loss (Billeter et al. 2008; Batary et al., 2008, Clough et al., 2007; Kleijn et al., 2009). The proposed indicator builds its index on the past studies and developed a linear function describing an average overall estimate of species loss, dropping from a value of 10 to a value of 8 in the range of 0-30 kg per ha, then from 8 to 1 on the range of 30-200 kg N per ha, and then to zero at 800 kg per ha.[196]

7.5 ADMINISTRATIVE BURDEN REDUCTION IMPACTS

In this section we analyse several impacts that relate to the following: administrative burden reduction potential; and implementation time.

Overall, as the different policy options directly build on the current structure, logics and content of the DWD and of its annexes, no significant constraint is expected in terms of implementability for any of the proposed policy option.

[194] FAO, http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/soil-biodiversity/agriculture-and-soil-biodiversity/en/ accessed on June 3 2016.
[195] https://www.cbd.int/development/doc/cbd-good-practice-guide-water-booklet-web-en.pdf, accessed on June 3 2016.
[196] Paracchini M.K. and Britz W.: *Quantifying effects of changed farm practise on Biodiversity in policy impact asessment - an application of CAPRI-Spat* Paper presented at the OECD Workshop: Agri-environmental Indicators: Lessons Learned and Future Directions, Tuesday 23 March - Friday 26 March, 2010, Leysin, Switzerlandhttp://www.unep.org/gemswater/Portals/24154/pdfs/new/2008%20Water%20Quality%20Index%20for%20Biodiversity%20TechDoc%20July%2028%202008.pdf)

- The challenges faced for different policy options will be more significant for MS *where <u>small water suppliers are important</u>* (in number and in population connected), as these will be more limited by human and financial resources available for implementing the proposed changes.

- *<u>Positive economic and social aspects</u>* related to administrative burden-reduction will mostly concern option 4.1 (as it is a simplification and automation of the reporting).

- For Policy option 2.1 and 2.2 the main challenge will be the assessment of robustness and *assessment of compliance*, which implies significantly more resources required to monitor implementation and assess compliance and in particular in 2.2 where these will be significant for the countries with a significant share of SMEs.

- Policy Option 4.2 that will expand the scope of the EU drinking water initiative to a wider management focus (accounting for resource efficiency issues, cost-effective solutions, etc.). This will require the establishment, management and use of new (more comprehensive) information systems. It might face some *<u>"opposition" from some water supply companies that do not see resource efficiency and cost-effectiveness</u>* as driver to their own business;

- Policy Options 5.1 and 5.2, as these will require the establishment of an information knowledge system that can *<u>monitor the population</u>* (number of people, period of the year, location…) targeted by the measures in each individual MS, and *<u>the implementation of measures</u>* that can ensure safe drinking water supply to these populations. It is expected that Policy Option 5.1 in particular will face *<u>additional constraints</u>* linked to the current capacity of (private building) companies to develop new drinking PWS networks that will be required for achieving the objectives of this PO.

In terms of the **reduction of the administrative burden,** the development and endorsement of the future electronic reporting tool under WISE, joint activities between Commission, Member States and European Environment Agency are currently under way on the basis of a Guidance Document and Decision 95/337/EEC. The electronic reporting tool is available for the drinking water data for the period 2005–2007. It will make optimal use of WISE (Water Information System for Europe) to improve management and availability of data. It will also reduce the administrative burden, based not least on experience already gained with integrating other water-related Directives into WISE.

The time frame for implementation of the Policy Option is another criterion that might be considered when assessing the comparative advantage of individual Policy Options. It is expected that time required for putting the proposed Policy Options into practice will be more important for Policy Option 2.2 (as this requires small water suppliers to adapt their current practice), Policy Option 4.3 (requiring a widening of the drinking water quality issues in EU-wide water management discussions) and Policy Options 5 (be it 5.1 or 5.2).

The challenges faced by Policy Option 3 are more of a regulatory nature. There is an ongoing study which focuses on Article 10 of the current DWD, which will provide additional details on the main challenges faced with the implementation of a revision of Article 10 of the DWD. It is interesting to note that most of the administrative costs are spent on conformity assessment procedures and testing (75%). Smaller cost components include the design of products, their production processes (15%) and the awareness raising effort for companies (15%). Enterprises do have approximately 50 certificates or approvals for products linked to Article 10 of the DWD, with an average compliance costs of about € 6,000 per certificate or approval - leading to an overall cost of 300 000 € for certificates/approval on average.

Both sub-options of Policy Option 4 will face limited implementability challenges. Policy Option 4.1 is easier to implement as it builds on the traditional drinking water quality information system (and related services of water supply companies). Policy Option 4.2 will require the establishment of new working relationships between parts of drinking water companies that are less accustomed to work together (including the finance and administration unit). Overall, both options are expected to contribute to the reduction of the costs of regulation as much information will already be collected and structured.

Implementing option 5.1 is likely to be challenging, as connecting **all** population to PWS is likely to be literally impossible. Even though there is public demand (Right 4 Water) it is still remains very costly and in some cases impossible to deliver Policy Option 5.1. While option 5.2 provides better cost effective solution to the issue of “access to all to safe water, the implementability of this Policy Option will need further investigation.

Depending on the Policy Options considered, the level of effort for implementing these options is expected to be different between the drinking water operator, EU MS and EC level. Table 15 summarises the expected challenges that each level might find with the implementation of the proposed policy options.

Table 15. Expected implementation efforts required for implementing Policy Options

Policy Option	Policy sub-option	Water suppliers	MS	EC
List and limit values of parameters	PO 1.1	Same as today	Same as today	Following well-established WHO framework
	PO 1.2	Same as today	Same as today	Challenge with definition of emerging substances that need to be integrated into the obligations
Promoting RBA and WSP	PO 2.1	Need to speed up uptake of RBA as compared to baseline => challenges of capacity and training,	Challenges to assess robustness of RBA	Compliance more difficult to assess => more resources required to monitor implementation and assess compliance
	PO 2.2	Significant challenge for small water suppliers – issue of capacity, resources	Challenges to assess robustness of RBA for smaller water suppliers with simplified method	Compliance more difficult to assess => significantly more resources required to monitor implementation and assess compliance
Harmonising standards for materials in contact with drinking water	PO 3	Common standards applied to all materials and products developed in the EU => easier tendering	Easier implementation as today, as no need for separate standardization procedure to be established at the scale of each MS	More resources required (working groups, desk officer time and resources) for establishing commonly agreed standards
Ensuring SMART information to drinking water consumers	PO 4.2	More efforts required for small water suppliers. No additional effort required for large water suppliers (as compare to baseline)	Facilitation of reporting to the EU with up-to-date and targeted information Specific challenge with support to small water suppliers	Facilitated MS reporting to the EC Higher number of compliance checking cases brought by drinking water consumers that will need to be taken care of
	PO 4.3	More efforts required for all water suppliers for establishing information base and the right IT tools/applications to ensure timely access to up-to-date information. Need also for a cultural change for small water suppliers (make them more consumer focused)	Facilitation of reporting to the EU (see above) Need to mobilize expertise wider than the traditional "water & health" expertise for supporting implementation Specific challenge with support to small water suppliers	Facilitated MS reporting to the EC Higher number of compliance checking cases brought by drinking water consumers that will need to be taken care of
Providing the right to safe drinking water to all	PO 5.1	Significant challenges to identify who to supply and the best technical (cost-effective) alternative	Enforcement likely to be challenging	Checking compliance is expected to require additional financial & human resources
	PO 5.2	No additional burden	Enforcement likely to be challenging	Checking compliance is expected to require additional financial & human resources

7.6 Addressing uncertainty in the assessments

Many assumptions have been made for performing the ex-ante assessment of the main impacts expected from the implementation of the different Policy Options investigated. To address the main sources of uncertainty, a sensitivity analysis was performed on key parameters using the Excel model developed for the PPHR indicator and for costs – assessing in particular if the ranking of Policy Options would change (or not) with different assumptions on key parameters. The main results of the sensitivity analysis are presented below.

Sensitivity analysis for PPHR and direct Costs

In order to test the robustness of the results on PPHR and on direct costs, a sensitivity analysis was conducted for the 5 most uncertain parameters: information diffusion for consumers and related consumption of bottled water, implementation of measures at source, reduction of contamination associated with RBA adoption, connection rate to PWS in policy option 5.1, and voluntary RBA application (or under national legislation). Methodology, variations considered for each parameter as a low hypothesis and as a high hypothesis and detailed results are given in Annex 5. The following can be concluded about the robustness of the results:

- Concerning the reduction in PPHR, the same policy options always stay the most efficient as compared to the baseline, whatever the assumptions made (1.2, 4.3, 4.2, 1.1). The sensitivity analysis stressed, however, the sensitiveness of Policy Options 2.1 and 2.2 to assumptions made on RBA and on related impacts – even if their ranking is not modified.

- Concerning direct costs, the same policy option (2.1, 2.2) also always stay the “cheapest” as compared to baseline whatever assumptions made. The sensitivity analysis, however, stressed that Policy Options 1.1 and 1.2 are sensitive to assumptions made on the adoption of preventive measures adoption: PO 1.1 in particular is not always the third “cheapest” depending on the importance of preventive measures adopted in this Policy Option as compared to the a reference (baseline) by 2050.

Robustness of social impacts

In terms of the robustness of the social impacts, it needs to be stressed that many of the observations made in this chapter are based on a qualitative and subjective basis as in most cases, accurate data has not been available to support assumptions and conclusions. In general, the social impact discussed in this section are of “softer” character and therefore in many cases challenging to quantify. This is valid primarily with regards to the discussion on access to information – consumers’ trust, behavioural change and social inclusion where it has not been possible to establish precise correlations with the quality of drinking water supply and provision. To support the conclusions drawn in this study, the authors have therefore undertaken a literature review and studied relevant case studies in order to identify trends and possible outcomes of the policy options to support the assumptions that are the basis for the conclusions presented.

For instance, to reiterate the discussion conducted in the environmental impacts section, the link between the policy options and the level of consumption of bottled water is difficult to predict accurately, however, based on comparative studies it is possible to draw the conclusion that a reduction in bottled water consumption will lead to cost savings for consumers, the uncertainty lies in to what extent. By assuming a weaker correlation between information provided and reduction of bottled water consumption (e.g. of 5% instead of 20%) we can reduce the possible margin of error but we would see that we still can expect certain cost savings for the households, although less significant.

Discussing uncertainties, it is important to highlight reservations on the accuracy of the discussion on affordability of drinking water services among MS. Firstly, it should be noted that the price estimations presented are calculated based on the assumption that the income levels and the relative cost of water remain at the current level, as in any predictions on future income levels it is associated with big uncertainties being dependent on inflation, politics and many other external factors. The analysis providing the basis for the affordability discussion is therefore calculated based on the current income levels. In addition, the price changes of the different policy options in the DWD considered in this assessment are therefore solemnly related to the DWD, not taking into account other possible variables.

The graph below shows the difference of the baseline in 2050 calculated with two different levels of income. The first column show the baseline as calculated with 2015 income levels (what was used in the analysis) and the second column show the baseline based on predicted future income levels in 2050[197]. It can be seen that in the baseline the cost of water in a household spending decreases from 0,9% based on 2015 wages to 0,7% for the 2050 forecast. This is a result of that a reduction of costs are expected in the baseline and that the disposable income estimation is increasing faster than the estimated increase in cost of water from drinking water providers. Due to the large uncertainties in these predictions for 2050 it is not likely that drinking water will become more affordable towards 2050 in the baseline. Therefore the analysis on affordability rather focuses on the relative changes among the policy options.

[197] 2050 predictions are based on 2010 to 2014 Vewin (Dutch umbrella water organization) water price development (excluding taxes) in estimated the increase towards 2030 and 2050.

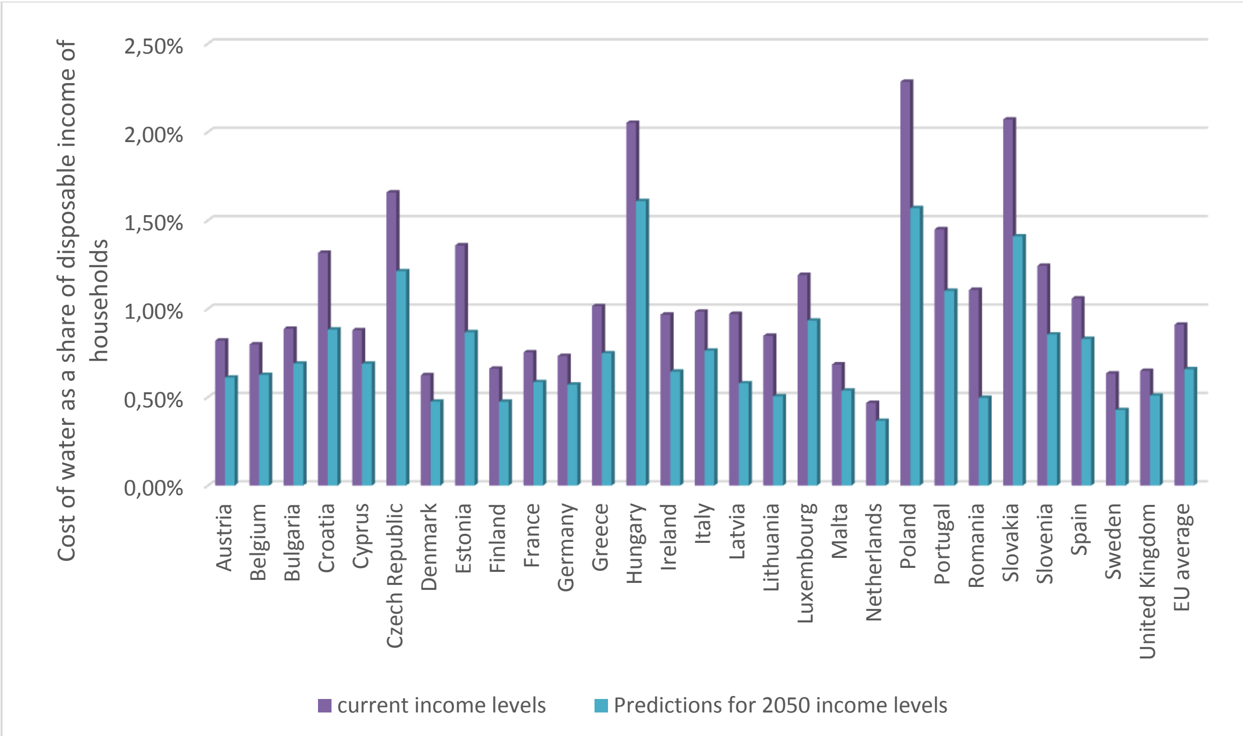


Figure 29. Comparison of affordability of water costs based on two different income bases (2050 baseline)

Calculations show that the price of water is changing very marginally although the cost of implementing the various policy options varies to a large extent, as seen in the table below. The level of affordability will remain close to constant at the EU28 level, but also when looking at the individual member states.

To better reflect the impact on affordability, we have added a comparison with the lowest income quintile to illustrate what effect the policy options could have on the affordability of the most vulnerable population groups. Due to lack of consistent data, the income level for the lowest quintile is from 2012 while the income for the average population is 2014, and should therefore be treated with caution and merely function as an illustrative example.

Robustness of environmental impacts

In the context of the environmental impacts the DWD directive, there are a number of uncertainties to consider as there are very few studies on the direct links between environment and ecosystems and the quality of drinking water. The level of evidence to support the above statements on environmental impacts of the policy options therefore varies among the different impacts identified. As comparable data or indicators on biodiversity, resource efficiency and the effect of implementing measures at source and the relation to drinking water are not available, the authors have instead relied on general knowledge and expertise as well as relevant studies when it comes to support statements within these areas. Through the literature review conducted it has been possible to indicating trends and tendencies of environmental impacts following implementation of the policy options which gives plausible statements on the likely impact of the policy options.

Likewise, referring to the environmental impact on bottled water, the assumed correlation between the policy options (i.e. the level of information available to consumers) and consumption of bottled water is based on expert judgements and on existing examples. Although it is therefore not possible to precisely quantify the predicted impacts, a number of studies have been reviewed, e.g. on the US market, and together with the data on consumption on bottled water in EU28, the expected environmental impacts from bottled water consumption can be considered to be accurate.

In terms of energy impacts, the estimations on energy consumption stemming from the variation of the levels of water treatment are based on rough calculations. To refine the analysis and to provide more accurate data on energy consumption, the volume of treated drinking water would be necessary which has not been accessible to date. Provided this data would be available, it would be possible to add more correct data on energy consumption from drinking water treatment on MS level and how it would be affected by changing the level of treatment. The discussion on energy consumption is in this context built on the assumption that measures at source can “replace” a certain amount (10%) of water treatment. It is however important to note that the possible replacement of the need for water treatment from implementing measures at source will naturally be depending on the specific measures implemented and that it is not possible to set a unanimous correlation to drinking water treatment. To further elaborate the discussion of the results on the energy impact analysis, it is possible to varying the assumption with 1) assuming a stronger correlation between measures at source and levels of water treatment and that implementing RBA would replace 20% of necessary treatment (instead of 10%); or 2) assuming a weaker correlation (5%) where for instance increased water treatment might be balanced by more energy efficient technologies and therefore not lead to any significant increase in the long-term perspective. From this discussion it is clear that further analysis is needed to assess the energy-impacts of the policy options but that we can state that there is a plausible link between the level of treatment and energy consumption (following e.g. a larger number of substances to treat or stricter parameter levels) while the correlation with the mitigation of pollution at source vs. water treatment, and in turn the energy consumed is more tentative.

With regards to measures at source, the positive impact on water quality, water bodies, ecosystems and biodiversity are more direct as it is valid to assume a positive environmental impact as implementing measures of source for mitigating pollution is anticipated to reduce pollution levels and risk of incidents as well as lead to lower probability of accidental pollution occurrence. Nevertheless, the exact impact will not be possible to assess and it is important to note that the areas impacted are in general smaller than water bodies and the level of improvements in water bodies as such is uncertain.

Finally, in terms of water quality, it is important to note that the absolute magnitude of the contribution of the DWD to reducing pollutants in water, relative to that of other environmental directives and the application of better practices, is impossible to quantify, as concluded in the evaluation report. Although it has not been possible to establish the exact contribution to water quality objectives, the assumptions providing the basis for this it has been possible to establish a link between improving drinking water quality, and the related waste water discharges, and an overall improvement of water status, soil quality and biodiversity. To improving the compliance with the directive and further strengthening it by monitoring additional substances, or introducing stricter parameter values would enhance these benefits.

8 CONCLUSIONS: how do the policy options proposed for addressing the challenges of the DWD compare?

8.1 Which Policy Option(s) is the most cost-effective in reducing health risk?

As illustrated in the previous chapters, the proposed Policy Options have significantly different health, economic, environmental and social impacts. In terms of potential health impacts, the **largest reduction in PPHR** (not considering the population at marginal risk) by 2050 is obtained for **Policy Option 1.2** (full list of parameters) followed by **Policy Option 4.3** (smart-information on water quality and water services performances) as illustrated in the figure below.

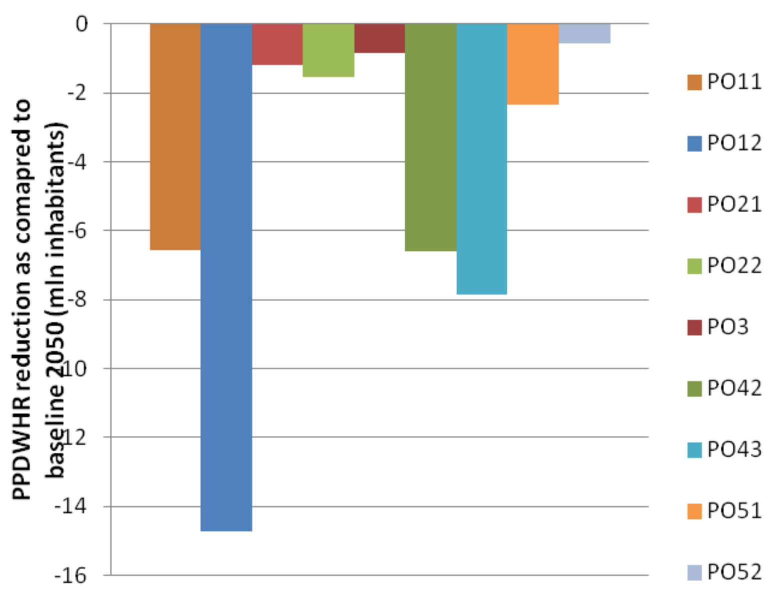


Figure 30. Difference in PPHR with baseline in 2050 (millions of inhabitants) for the proposed Policy Options by 2030 and 2050

In terms of costs, **Policy Option 5.1 and Policy Option 1.2 are by far the most expensive**, as illustrated in the diagram below. At the opposite, **Policy Option 3, Policy Option 2.1 and Policy Option 2.2 lead to some (although limited for these two last) benefits** (cost savings) as compared to the baseline scenario.

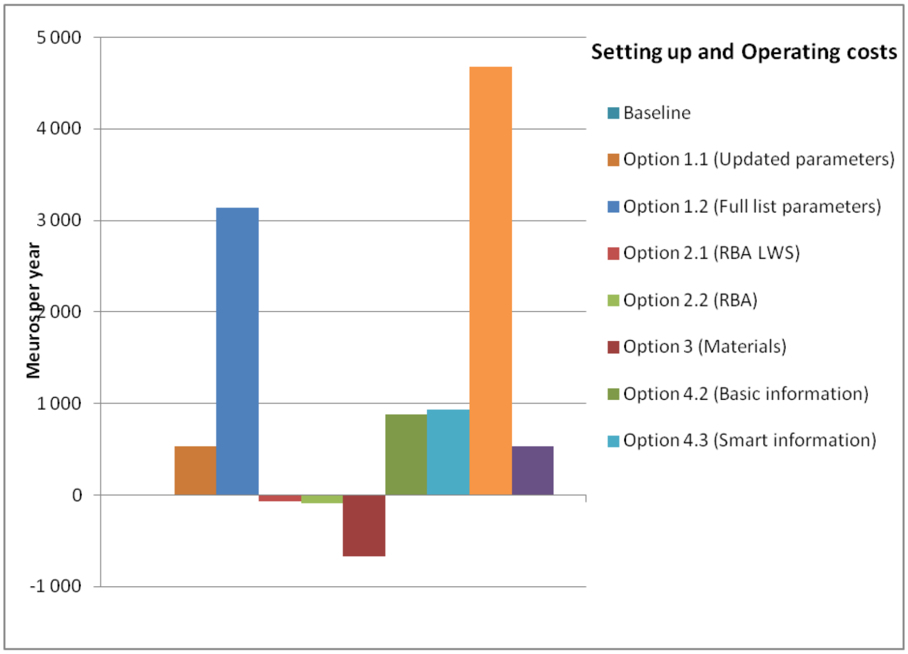


Figure 31. Setting up and operating costs of Policy Options as compared to the baseline situation

Table 16 compares the change in PPHR and the incremental costs as compared to baseline, estimating the ratio "cost per (additional) person protected by the Policy Option". While the cost per additional person protected is negative (cost-saving) and low for Policy Options 2.1 and 2.2, and for Policy Options 1.1, the cost per additional person protected are significant for Policy Option 5.1.

Table 16. Changes in PPHR, changes in costs and costs per additional person protected for the different Policy Options (green cells = most relevant outcome; orange cells = least relevant outcome)

Policy Option	Change in PPHR as compared to baseline (M inhabitants)	Incremental costs (M€/year) as compared to baseline (note: negative values represent cost saving)	Incremental cost (cost-saving) per additional person protected (€/person/year)
PO11	-6,6	535	81
PO12	**-14,7**	3137	213
PO21	-1.2	-74	-62
PO22	-1,5	-93	-61
PO3	**-0.9**	-669	947
PO42	-6,6	876	133
PO43	**-7,9**	934	119
PO51	-2,3	4678	2006
PO52	-0,6	530	956

These results are presented in the Figure below that help characterizing groups of policy options with similar PPHR and costs.

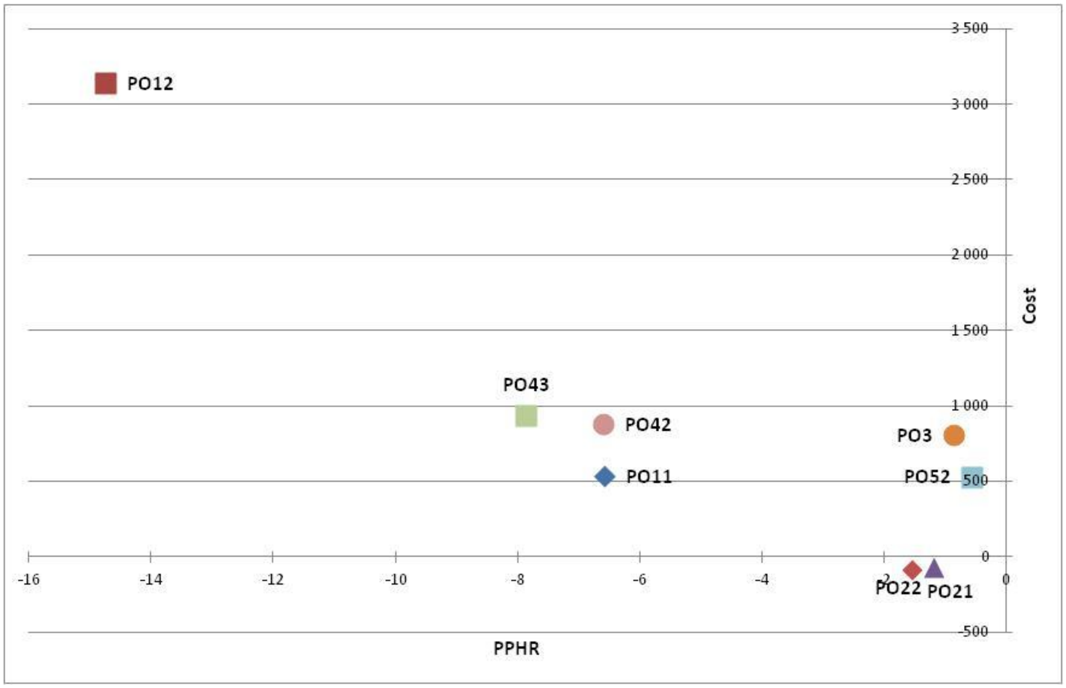


Figure 32. Position of the policy options in relation to Cost savings and PPHR vs. change in PPHR saved

8.2 Which Policy Option(s) rank best overall?

Table 17 extracts some of the main features of the analysis of impacts made for the different policy options, the overall ranking of the different options, and simplified aggregated diagrams of the 4 groups of impacts. Although the assessments are based on many assumptions, the table already helps identifying policy options that are worth developing and integrating into the current EU drinking water policy framework.

☺ The "I like"! Looking only at the number of "green scores" (option with the highest rank for an impact type). Overall, the **Policy Options promoting the wider use of RBA** and the establishment of WSP (Policy Options 2.1 and 2.2), along with **Policy Options promoting SMART information** to drinking water consumers, appear as rather interesting in terms of their balance between expected health impacts and costs (or costs savings)

☹ The "I like less"! Looking only at the number of "red scores" (options with the lowest rank for an impact type). Overall, **Policy Option 5.1 with significantly high costs and limited improvements in PPHR would appear as the least interesting Policy Option** investigated in the impact assessment.

Table 17. Summary of results of the analysis of impacts of policy options

	PO1.1 (updated list)	PO1.2 (long list)	PO2.1 (RBA for LWS)	PO2.2 (RBA for LWS and SWS)	PO3 (materials)	PO4.2 (basic online information)	PO4.3 (SMART information)	PO5.1 (water for all-PWS)	PO5.2 (water for all – self)
HEALTH IMPACT	**Medium**	**Large**	**Small**	**Small**	**Small**	**Medium**	**Medium**	**Small**	**Small**
Population at potential health risk at short and mid-term (%change in total PPHR to BL)	**-33%**	**-74%**	**-6%**	**-8%**	**-4.2%**	**-33%**	**-39%**	**-12%**	**-2.8%**
Population at potential health risk at long term (%change in marginal risk population to BL)	**-3%**	**-15%**	**0%**	**-1%**	**0%**	**-5%**	**-6%**	**0%**	**0%**
ECONOMIC IMPACT	Small	*Large*	*Savings*	*Savings*	*Large*			*Large*	Small
Change in annualized costs	535	**3 137**	**-74**	**-93**	-669	876	934	**4678**	530
Impact on SMEs and R&D	Small (+)	Medium (++)	No impact	No impact	Small (+)	Small (+)	Small (+)	**Large (+++)**	Medium (++)
Internal market and macro-economic impact	Small (+)	Medium (++)	Small (+)	Small (+)	**Large (+++)**	No impact	No impact	**Large (+++)**	Medium (++)
Change in employment	4 419	**24 378**	**-502**	**-873**	6 957	1 678	**2 055**	**67 152**	**28 301**
Change in health cost	-68	**-152**	**-14**	**-17**	**-14**	-80	**-91**	-27	**-9**
SOCIAL IMPACT									
Change in costs per household (Eur per year)	2,3	**13,6**	**-0,3**	**-0,4**	2,1	2,3	**1,4**	**21,9**	2,2
Affordability (share of income spent on DW)	0,92%	**0,97%**	**0,91%**	**0,91%**	0,93%	0,92%	0,92%	**1,08%**	0,93%
Confidence in water quality	Small (+)	Small (+)	Medium (++)	Medium (++)	Medium (++)	Medium (++)	**Large(+++)**	**Large(+++)**	**Large(+++)**
ENVIRONMENTAL IMPACT									
Water quality	Small (+)	Medium (++)	Medium (++)	Medium (++)	Medium (++)	Medium (++)	Medium (++)	Medium (++)	Medium (++)
Treating pollution at source	Slightly increase	Increase	Increase	Increase	No change	Increase	Increase	more	More
Importance of water treatment	Slightly increase	Increase	Decrease	Decrease	No change	Decrease	Decrease	more	More
Energy use	Small (+)	Medium (++)	Energy savings	Energy savings	No change	Small (+)	Small(+)	*No change*	*Moderate (++)*
IMPLEMENTABILITY									
Reduction of Adm. burden	No change	No change	Moderate	Medium	**High (---)**	**Low (++)**	**Low (++)**	No change	No change
Feasibility	**High**	Medium	**High**	Medium	Medium	**High**	Medium	Low	Medium
Health Economic Env. Social Administrative									
OVERALL RANKING	☺☺	☺☺	☺☺☺	☺☺☺	☺	☺☺	☺☺☺	☹	☺

The results of the IA presented in the table can also be aggregated and plotted on the spider diagram to illustrate the main health, economic, social, and environmental impacts (see figure below), each impact category being rated from 0 (no impact) to 3 (high impact) on the basis of the information provided in the table above.

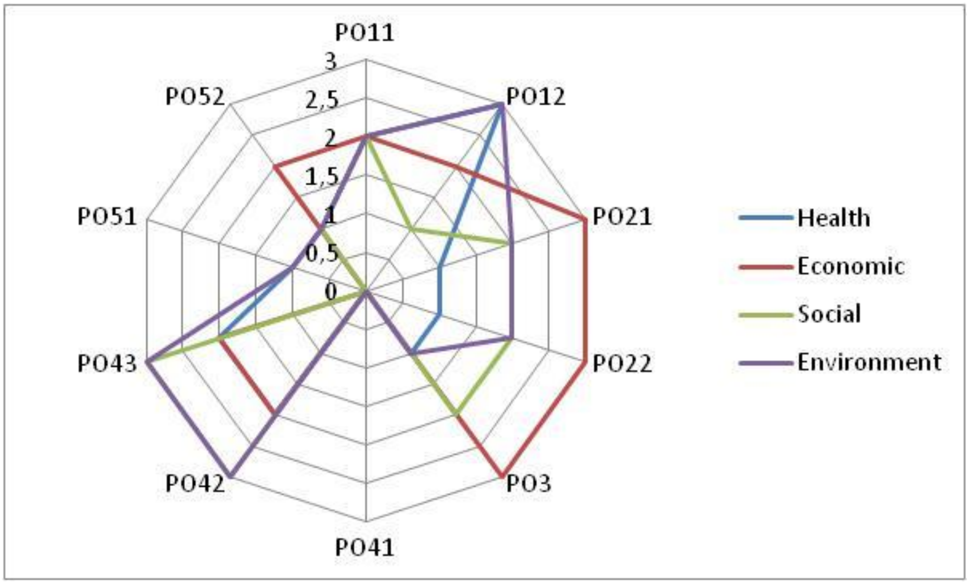


Figure 33. Spider diagram of the aggregated health, economic, social and environmental impacts for individual Policy Options (source: authors' own assessment)

8.3 Who will be affected?

In order to better understand results of the IA, three groups of actors/activities affected by proposed policy options have been investigated separately: citizens/consumers; supplier/water industry/operators; and public authorities in charge of the implementation of regulation. The following sections present the main impacts for each of these groups.

8.2.1 Impacts on Citizens/consumers

The main impacts of the proposed policy options for a EU citizen/ consumer will be the following: reduction of the chance of being at risk (PPHR) and health benefits/(costs) associated with that; reduction/(increase) of household cost and affordability of drinking water; (costs) savings from bottled water purchase; benefits from resource efficiency (decreased leakage rates); other benefits: being better informed, increased trust, environmental benefits from resource efficiency/use of water. The following figure shows the different impact of health risk and affordability for the different policy options that benefit to citizens/consumers. Interestingly, there is no correlation between the benefits in terms of reduction in health risk (PPHR indicator) and affordability, stressing that some Policy Options (in particular PO 5.1) can have limited improvements in PPHR but high increases in water tariffs (and thus affordability ratio estimated as the water bill as % of disposable income) associated.

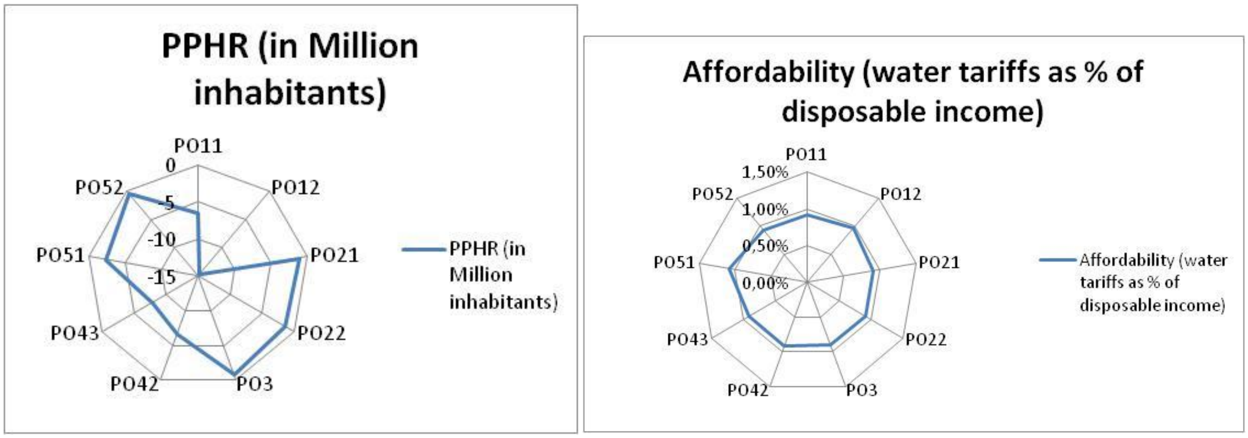


Figure 34. Key impacts on health risk and affordability for consumers/citizens (source: authors' data on the basis of the the results of the impact assessment)

Other impacts that have significance for a consumer include 'soft 'impacts, such as trust, environmental benefits. PO4.2 and 4.3 bring numerous environmental benefits as the consequence of voluntary reduction of water consumption by consumers and also reduction of leakage rates. Trust and enhanced awareness are another 'soft' impact that are significant in PO4.2, 4.3, 2.1 and 2.2 (see figure 35 below). The figures for these 'soft' impacts were calculated based on the summary of the assessment in the previous chapters, by using scales from 0 (nil) to 3 (high positive impact expected) for each category.

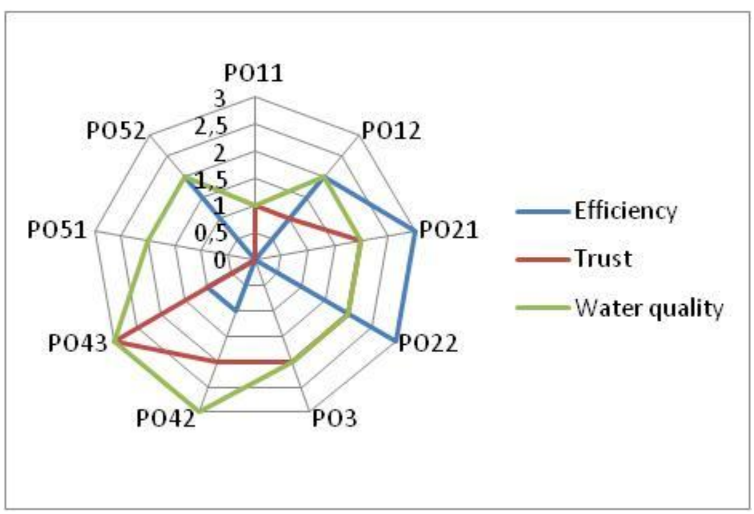


Figure 35. 'Soft' impacts significant for consumers/citizens (source: authors' data on the basis of the the results of the impact assessment)

8.2.2 Impacts on Supplier/water industry/operators

From the side of water suppliers the following impacts could be shown: setting up costs; costs for monitoring; costs of supplying information to consumers; costs of measures proposed for addressing pollution problems; and, (water industry) employment. The differences from the baseline for the impacts that are most significant for water suppliers are shown in the figure below.

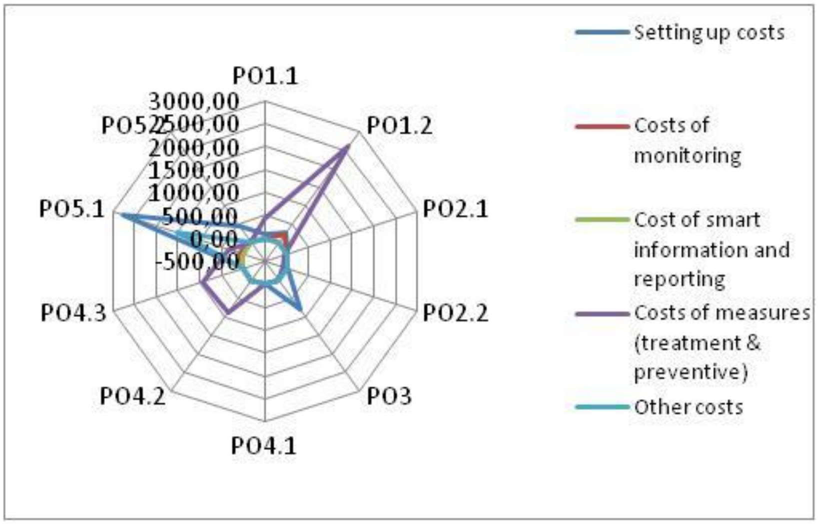


Figure 36. Cost implications of the different Policy Options for water suppliers (source: authors' data on the basis of the the results of the impact assessment)

Options 5.1 and PO1.2 are less attractive from the perspective of water supplier, as they bear significant costs (and PO1.2 in addition bears higher costs for monitoring). On the other hand, it is important to stress that PO5.1 brings around 20% more employment (not presented in the figure above) to the water industry. Options 1.2, 2.1 and 2.2, 3, 4.2 and 4.3 all bring additional benefits for employment development of WSP, extra costs for new technology for monitoring new emerging parameters, treatment technology, R&D, consultants, data managers. However, option 2.2 will be more difficult to implement for small water operators, as it requires time and resources for the development of a simplified WSP.

8.2.3 Impacts on public authorities

From the perspective of authorities the main impacts can be the following: reduction of administrative burden; feasibility and suitability; reporting; and, time frame for implementation. The following figure below shows the corresponding results for the proposed options, each category being rated from 0 to 3 on the basis of the assessment presented in the table above.

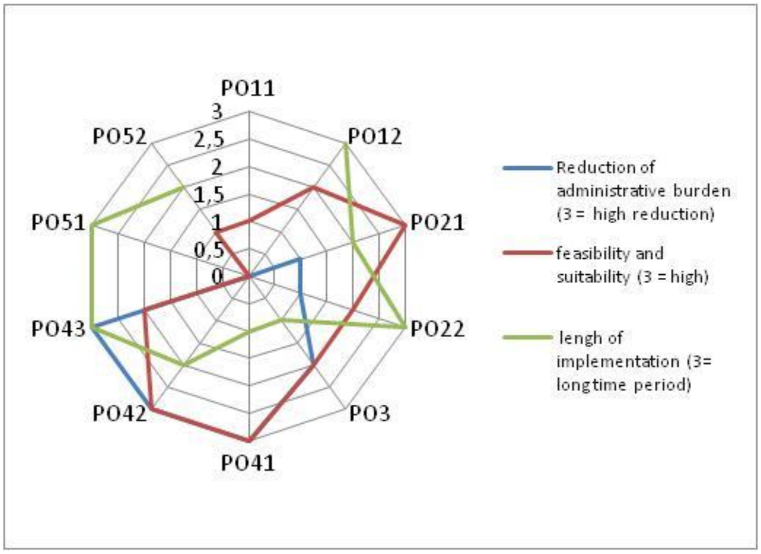


Figure 37. Impacts considered as significant for authorities

8.3 Combining policy options into the 'policy package'

Combining Policy Options might help combining the advantages of some options for creating a sound 'policy package' that could be proposed for the revision of the DWD. For example: if the reduction in the health risk is the prioritized objective, the policy package could combine Policy Option 1.2 with elements of Policy Option 2.1/2.2 and/or Policy Option 4.1/4.2 (ensuring cost-effectiveness and adaptability to account for local conditions). Likewise, if the objective is consumer satisfaction and affordability, then the policy package could include PO4.2/PO4.3 and PO5.1/ 5.2 in addition to PO1.1 or PO1.2. As some of the different Policy Options have similar direct and indirect impacts, it is not possible, however, to add the impacts presented in the summary table to easily estimate "combined impacts".

Two Policy Packages (PP)[198] that would combine Policy Options that appear as complementary in terms of expected impacts, have been further investigated[199]:

- **Policy Package 1** (PP1) = PO 1.1 + PO 2.1 + PO 3 + PO 4.2
- **Policy Package 2** (PP2) = PO 1.2 + PO 2.1 + PO 3 + PO 4.3 (considered as more ambitious)

[198] Additional Policy Packages could be further investigated. However, this is out of the scope of the assignment that focused on the ex-ante assessment of the impacts of individual Policy Options.

[199] In combining the PO there has been paid attention to a possibility for double-counting, the possible (an assumed incorrect) changes that would occur twice if PO are combined have been corrected for.

To calculate the combined impacts for each combination of Policy Options, assumptions from the policy options that constitute the policy package were updated to the most ambitious Policy Option considered. Tables 18 and 19 present the combined assumptions, avoiding in particular double counting of some of the impacts.

Table 18. Assumptions for combined policy package 1

	Combination 1
Connection to PWS	=
Individual systems	=
Water for all	=
RBA regulation and effective application (% of population connected to PWS)	Mandatory for LWS (will reach 92% of population connected to PWS)
Smart info (% of population)	Mandatory (will reach 95% in all MS)
Reporting	Automatized process
Standards materials	Harmonized
Nb of par. & Limit values	Update of the list ⇒approximately the same number of parameters ⇒limit values set according to WHO guidelines

	Combination 1
Average consumption of bottled water (liters per person and per year)	94 l/p/y bcse of the increase of smart info diffusion
Possibility for consumers to influence WS decisions	Yes, toward more treatments

Impacts on water quality	Combination 1
List A sub. in DW • > WHO guidelines * • > stricter limits	=BL 10 %
New list B sub. in DW • without RBA • with RBA	1,2 % 0,6 %
Supplementary list C sub. in DW • without RBA • with RBA	10,6 % 10,6 %
List A sub. in RW • > WHO guidelines • > stricter limits	=BL =BL
New list B sub. in RW	=BL
Supplementary list C sub. in RW	=BL

	Combination 1
Monitoring costs (average)	LWS newly applying RBA: 2.6 €/p/yr Other LWS: 2.7 €/p/yr SWS: 8.1 €/p/yr ⇒All increased by 15% bcse more substances to monitor
Treatments	WS applying RBA: 17.2 €/p/yr Other WS: 18 €/p/yr ⇒Treatments increase bcse consumers' influence (+10% compared to BL)
Measures at source	⇒Total higher than in BL bcse more WS apply RBA
Self-supply systems maintenance	=
RBA yearly audit	⇒Total higher than in BL bcse more WS apply RBA
Smart-information diffusion	Higher cost for smart-info: 0.021 €/p/yr
Reporting to EC	Automatic reporting costs less: 0.004 €/p/yr
Other operating costs (other than monitoring, treatments, measures at source, self-supply systems, info, reporting)	Unitary cost reduced by 1.3 €/pers as compared to BL bcse of the harmonized standards

Unitary costs (expressed per person supplied by the WS)	BL 2050
RBA implementation	Increased cost for large WS than in BL bcse it is « mandatory » RBA (+10%)
Materials and products certification	/
Individual supply systems equipment	/
Smart-info and auto-reporting systems development	0.01 €/pers
PWS extension	/
Monitoring and treatment machines	3.90 €/pers

Table 19. Assumptions for combined policy package 2

	Combination 2
Connection to PWS	=
Individual systems	=
Water for all	=
RBA regulation and effective application (% of population connected to PWS)	Mandatory for LWS (will reach 92% of population connected to PWS)
Smart info (% of population)	Mandatory with also info on performances (will reach 95% in all MS)
Reporting	Automatized process
Standards materials	Harmonized
Nb of par. & Limit values	Update and application of the precautionnary principle ⇒higher nb of parameters ⇒some limit values set to stricter thresholds than WHO guidelines

	Combination 2
Average consumption of bottled water (liters per person and per year)	88 l/p/y bcse of the increase of smart info diffusion
Possibility for consumers to influence WS decisions	Yes, toward more treatments and preventive emasures

Impacts on water quality	Combination 2
List A sub. in DW • > WHO guidelines * • > stricter limits	=BL 5 %
New list B sub. in DW • without RBA • with RBA	1,2 % 0,6 %
Supplementary list C sub. in DW • without RBA • with RBA	8,4 % 8,4 %
List A sub. in RW • > WHO guidelines • > stricter limits	8,3 % 18%
New list B sub. in RW	9%
Supplementary list C sub. in RW	=BL

	Combination 1
Monitoring costs (average)	LWS newly applying RBA: 2.6 €/p/yr Other LWS: 2.7 €/p/yr SWS: 8.1 €/p/yr ⇒All increased by 15% bcse more substances to monitor
Treatments	WS applying RBA: 17.2 €/p/yr Other WS: 18 €/p/yr ⇒Treatments increase bcse consumers' influence (+10% compared to BL)
Measures at source	WS applying RBA: 0.18 €/p/yr Other WS: 0.1 €/p/yr ⇒Preventive measures increase bcse of consumers' influence
Self-supply systems maintenance	=
RBA yearly audit	⇒Total higher than in BL bcse more WS apply RBA
Smart-information diffusion	Higher cost for smart-info and info on WS performances: 0.041 €/p/yr
Reporting to EC	Automatic reporting costs less: 0.004 €/p/yr
Other operating costs (other than monitoring, treatments, measures at source, self-supply systems, info, reporting)	Unitary cost reduced by 1.3 €/pers as compared to BL bcse of the harmonized standards

Unitary costs (expressed per person supplied by the WS)	BL 2050
RBA implementation	Increased cost for large and small WS than in BL bcse it is « mandatory » RBA (+10%)
Materials and products certification	/
Individual supply systems equipment	/
Smart-info and auto-reporting systems development	0.01 €/pers
PWS extension	/
Monitoring and treatment machines	11,70 €/pers

Health impacts of the two Policy Packages were calculated using the Excel model with the updated assumptions: As a result of PP 1, PPHR will decrease by 11,6 million inhabitants by 2050 in comparison to the baseline. Remaining PPHR is equal to 8,4 million people by 2050. PP2 will result in a larger impact on health risk – with the decrease of PPHR being equal to 15,3 million inhabitants as compared to the baseline, reaching the lowest level for the PPHR indicator out of all Policy Options and Policy Packages, i.e. 4.77 million people (see Figure 35 and Table 20). In addition, a subsequent reduction by 47 million people (PP1) and by 78 million people (PP2) will take place for the category "marginally at risk" with long-term health benefits from this combination of policy options. The Member States most affected by the Policy Packages will be Bulgaria, Luxembourg, Malta, Greece, and Spain.

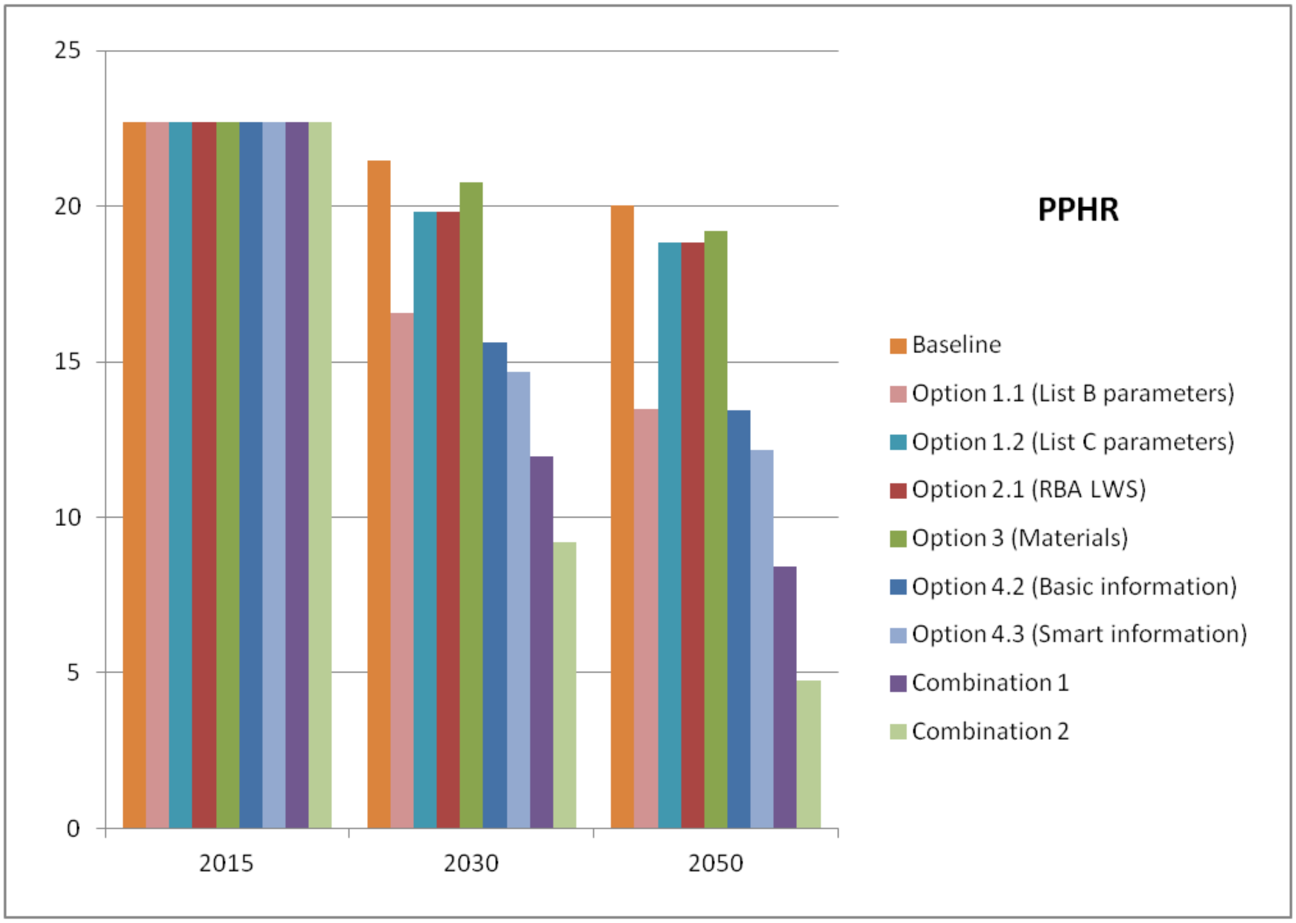


Figure 38. Health impacts (PPHR) for selected Policy Options and for their combination into Policy Packages 1 and 2

Table 20. PPHR for the proposed Policy Packages (in Million inhabitants)

PPHR	2015	2030	2050
Baseline	23	21	20,03
Option 1.1 (List B parameters)	23	17	13,46
Option 1.2 (List C parameters)	23	20	18.85
Option 2.1 (RBA LWS)	23	20	18,95
Option 3 (Materials)	23	21	19,18
Option 4.2 (Basic information)	23	16	13,44
Option 4.3 (Smart information)	23	15	12.17
Policy package 1 (PP1)	**23**	**12**	**8,42**
Policy Package 2 (PP2)	**23**	**9**	**4,77**

The assessments of the **costs of the two Policy Packages** stressed that:

- For PP1: The combination of these policy options will lead to an increase in set-up cost of 1989 million euro. Annual operating costs are expected to increase by 152 million euro in comparison with the baseline - including an increase of 830 million Euro of the costs of treatment. Cost of drinking bottled water will decrease by 336 million euro.

- For PP2: The combination of these policy options will lead to an increase in set-up cost of €5 923 million. Annual operating costs are expected to increase by €2 155 million in comparison with the baseline - including an increase of 2 598 of costs of treatment. Cost of drinking bottled water will decrease by €610 million.

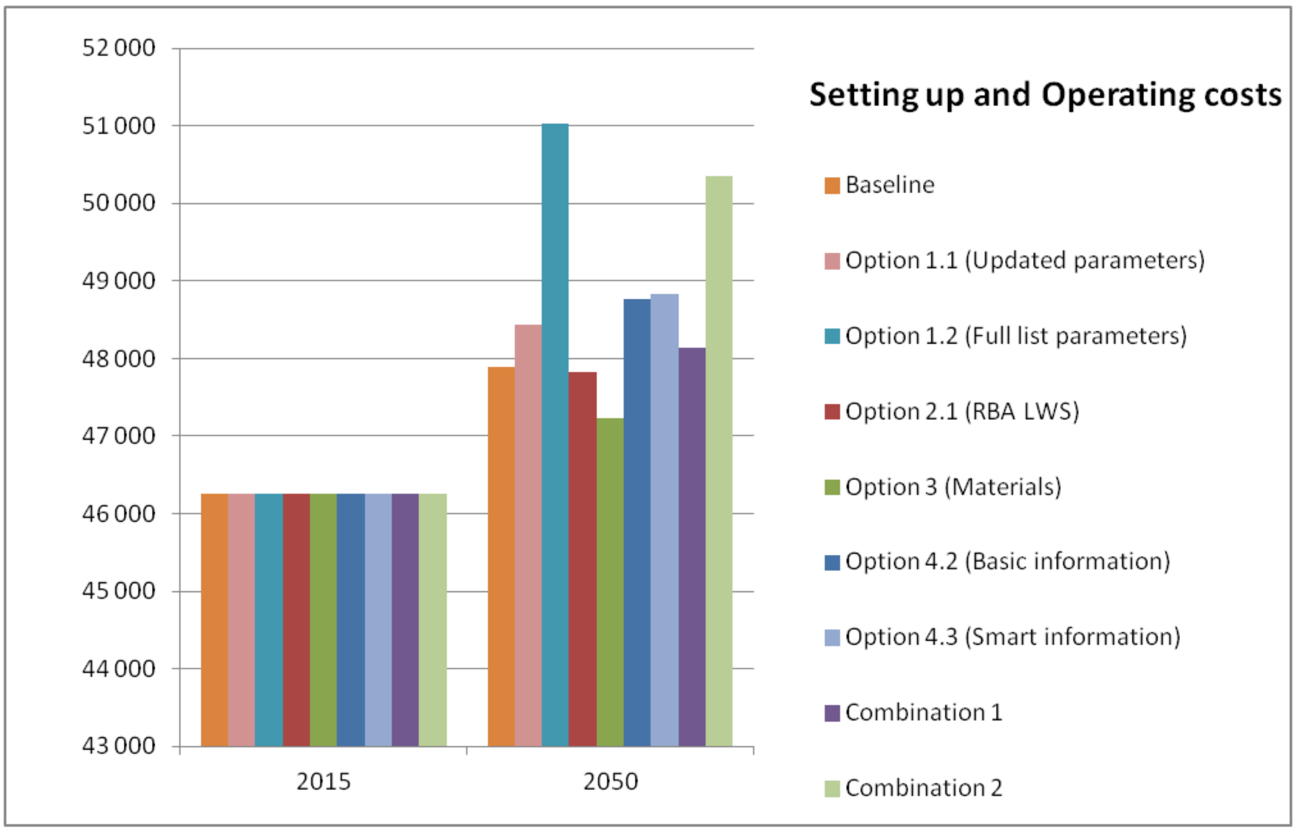


Figure 39. Setting up and operating costs of the combination policy packages 1 and 2 (in Million Euros)

Further assessments made for the two Policy Packages led to the following results

- For PP1: **Health costs** are expected to decrease in 2030 by 97 million and to **decrease further by 2050 to 125 million annually.** With regards to **affordability,** the policy package will increase the total cost per household by 0,4 Euro, ranging from an increase by 5 Euro for Luxembourg to a decrease by 2,70 Euro for Malta. **Employment** is expected to decrease as compared to the 2050 baseline by 1 460. Employment will mainly increase in the UK, and is expected to decrease in Bulgaria by roughly 300. **Social and environmental impacts** will include increased trust of consumers (as the water quality will be monitored by an updated list for all) LWS which supply on average 86% of the population connected to the PWS will be obliged to carry out a WSP, which will improve the water quality, raise awareness of people and allow to monitor the parameters that matter in particular area. Finally, the Policy Package will also have **an impact on decreasing administrative burden**.

- For PP2: **Health costs** are expected to decrease in 2030 by 121 million and to **decrease further to 157 million annually by 2050.** With regards to a**ffordability,** the Policy Package will increase the total cost per household by 8 Euro, ranging from + 16 Euro for Ireland to + 4 Euro for Hungary. **Employment** is expected to increase compared to the 2050 baseline by 13 490. Employment will mainly increase in the UK, France and Germany (e.g. size matters). Finally, **social and environmental impacts** and administrative burden are considered as similar as compared to Policy Package 1.

The combination of the PPHR and cost indicators helped assessing the **cost-effectiveness of each Policy Package,** as illustrated in the figure below that compares the cost-effectiveness ratio of the two Policy Packages as compared to the ratio of individual Policy Options. Overall, while **PP2 delivers the highest effectiveness** in terms of reduction of the indicator PPHR, PP1 is significantly more cost-effective than PP2.

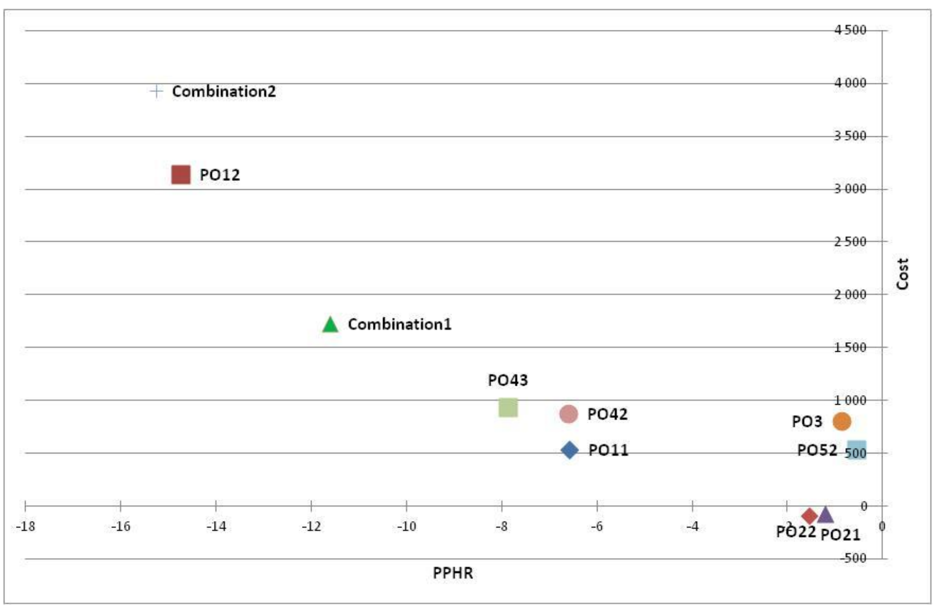


Figure 40. Cost effectiveness of the two Policy Packages investigated vs. individual policy options

The following table summarises very qualitatively the **comparison between the two PP** in terms of effectiveness (contribution to the reduction of inhabitants at health risk), efficiency (how do the Policy Packages provide the best combinations in terms of health, economic, social and environmental impacts?), coherence (with regards to other EU water policies, in particular the WFD implementation). Clearly, further work assessments would be required for refining the assessment of these Policy Packages[200] for these four different categories or of any other Policy Package that would be seen as more relevant on the basis of priorities among the different operational objectives fixed for the revision of the DWD.

Table 21. Summarising the assessment of the two Policy Packages

Policy Package	Effectiveness	Efficiency	Coherence	Proportionality
Policy package 1	**Indicator PPHR reduced by 11,6 million inhabitants as compared to baseline by 2050**	**Setting up costs of + 1 989 Million Euros Water tariffs as % of disposable income = 0,91% Employment: + 1 460 Social and environmental impacts similar to PP2**	**Increased coherence with WFD (as a result of RBA)**	**150 €/additional person protected from health risk**
Policy package 2	**Indicator PPHR reduced by 15,3 million inhabitants as compared to baseline by 2050**	**Setting up costs of + 5 923 Million Euros Water tariffs as % of disposable income = 0,95% Employment: + 13 490 Expected larger impact on management efficiency of water suppliers Social and environmental impacts similar to PP1**	**Increased coherence with WFD (as a result of RBA) + expected benefits in terms of resource efficiency of water suppliers as a result of SMART information to customers on wider range of management issues**	**257 €/additional person protected from health risk**

[200] And bring them to the level of the assessments carried out for individual Policy Options

ANNEXES

Annex 1: Stakeholder consultation

On the basis of the results of the *ex-post* evaluation, combined with the results of the baseline scenario, a broad list of policy options that are expected to address problems foreseen in the baseline scenario were developed.

In 2014, the Commission launched an EU-wide public consultation on the DWD, notably in view of improving access to quality drinking water in the EU. The aim of this consultation was to get a better understanding of citizens' views on the need and the possible range of actions which could be undertaken in order to improve the supply with high quality drinking water. The survey was opened from 23.06.2014 until 23.09.2014 at http://ec.europa.eu/eusurvey/ and was available in all EU languages. The report on the Public Consultation provided a valuable source of information for the evaluation. The report is available online as a separate document: "Analysis of the public consultation on the quality of drinking water".[201]

A first stakeholder workshop was organized 26.05.2015 for launching the DWD review initiative and guiding the review and *ex-post* evaluation process. The first stakeholder's consultation was attended by 60 stakeholders from different fields: water regulators, water utilities, industry and non-governmental organizations. The background information and synthesis of the workshop can be found http://www.safe2drink.eu/dwd-evaluation/.

A second stakeholder consultation was organized by DG Environment on December 8, 2015 for guiding the selection of policy options. This second workshop discussed the results of the *ex-post* evaluation and paved the way for the *ex-ante* assessment of policy options. Workshop involved around 60 key stakeholders and experts (see more information about this second stakeholders' workshop at www.safe2drink.eu).
As indicated above, the main objective of the second Stakeholder workshop (entitled Safe Water for Europe: Issues and options) was to present and discuss the first results of the *ex-post* evaluation of the EU Drinking Water Directive. This helped identifying areas where improvements would be required for enhancing its effectiveness and efficiency in line with current and future developments. More specifically, the workshop addressed the following questions:

- **Which areas of current DWD are in need of improvement?** This section presents contextual information and the main results of the *ex-post* evaluation of the current Drinking Water Directive (DWD) carried out since the first stakeholder's consultation which was held in May 2015.
- **Looking ahead: how is drinking water quality and the DWD likely to evolve in the future?** This section provides a forward looking view of the implementation of the DWD within what is defined as "baseline scenario" or reference scenario. It identifies key drivers that will or might impact the DWD implementation and its performance. General in nature, this information helps identifying how current problems might evolve over time (be solved, remain, or increase) and new problems that might emerge as a result of the implementation of the current DWD.

[201] Analysis of the public consultation on the quality of drinking water; Ecorys (2015); http://ec.europa.eu/environment/consultations/pdf/analysis_drinking_water.pdf

- **What could be changed – and how?** Building on the current and forthcoming challenges linked to the implementation of the DWD, a series of areas for improvements (or policy options) are identified and presented.
- **What could be the impacts associated with the policy options identified?** This section identifies in general terms potential positive and negative social, economic and environmental impacts one might expect as a result of the implementation of the policy options identified. In some cases, potential impacts identified might help thinking of adaptations in proposed options (e.g. providing exemptions, or targeting specific water supply services or social groups) to limit or eliminate negative impacts.

The agenda for the second Stakeholder's workshop and synthesis of the Workshop can be found on the website: www.safe2drink.eu. Also, a background document to the workshop, which includes information about the current state of the DWD implementation, the baseline scenario and components of possible policy options – storylines, has been produced and emailed to the participants of the workshop.

Comments from the four stakeholders' working groups and evaluation forms from Stakeholder workshop in Brussels on 8.12.2015, as well as comments from the MS expert group seminar on DWD (from 22.01.2016° have been analysed and the proposed policy options were revised according to these comments.

After the workshop the stakeholders had a chance to submit their responses in the form of the position papers, sent to ECORYS and ACTeon, or EC. These were also analysed.

The feedback and knowledge obtained from the stakeholders was used to refine and narrow down the scope of proposed policy options.

A revised list of policy options was presented at the expert workshop in Brussels on January 22, and discussed with regulators from MS. The revised list was sent to the EC for final remarks and comments, and validated for the (ex-ante) Impact Assessment.

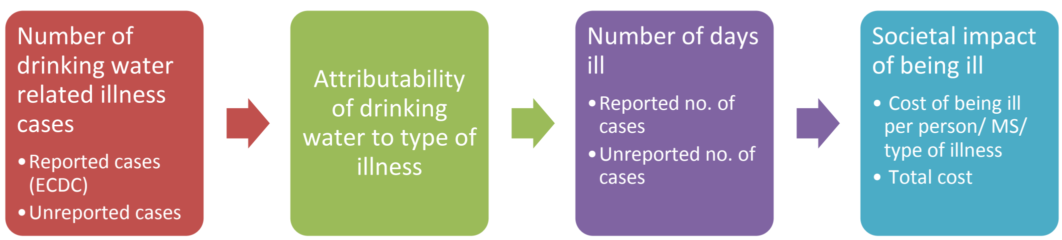
Annex 2. Health impacts and PPHR

Many EU citizens consume drinking water on a daily basis. European drinking water is of high quality due to a combination of monitoring on quality by drinking water suppliers and setting of parametric values, which are both enforced by national and European actions. The above introduced PPHR analytical model explained how to best estimate the number of EU citizens currently at risk. To complement that model and make a link between the population at risk and societal costs related to being sick (or not sick, thus leading to health benefits) is needed.[202]

This annex describes first the followed methodology to estimate the societal cost of being sick due to tap water consumption. This analysis is relevant to set a baseline from which we can determine impacts if in the future exogenous factors influence the quality of our drinking water (i.e. climate change or specific DWD policy options).The outcome, which should be seen as the lowest estimate of total cost of being sick as it does not include long-term health impacts, is afterwards linked to the number of people currently at risk according to the PPHR analysis. The third step in linking the PPHR outcome for various policy options to (financial) health impact combines the first two activities and provides for each policy option the result compared to the 2030 and 2050 baseline.

Cost estimation related to cases of illness due to consumption of drinking tap water

To analyse the societal cost of cases of illness related to the consumption of drinking tap water we follow the four-step methodology depicted below:



1. The European Centre for Disease Prevention and Control (ECDC) collects information from each MS regarding the yearly number of reported illness cases. This information is taken up for the years 2008-2012 in the Evaluation of the EU Drinking Water Directive study (Annex C). From this table one can observe that there are, on average, 17.000 reported cases of illness per MS that could be due to the consumption of drinking tap water. Furthermore, 86% of all cases are related to a case of Campylobacteriosis and most of the reported cases stem from the UK (32%).[203] However, not all cases of illness are generally reported. An ill person does not always reports to a general practitioner (in most cases since there is no need of urgency as he/ she is only ill for a short(er) period of time). As such, there is a need to estimate and include the number of unreported cases of illness.[204] The well documented case of an outbreak of Giardiosis in Norway has been used to roughly estimate the number of unreported cases versus the number of reported cases (COWI, 2009). From this specific Giardiosis outbreak we are able to determine that on average there are 2,5 cases of unreported illness (who are also much less longer sick) for each reported case. In this study we will use this result as a proxy for the six main types of water related illnesses.

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202 Even though there is strong monitoring and control some EU citizens will still get sick when consuming drinking water. Being sick has both direct and indirect cost for society.

203 From discussion with experts we found that the UK scores very well when it comes to reporting this type of information to the ECDC. The 32% of reported cases might as such be an overestimation – or an underestimation for other MS.

204 Note that we do not take underreporting in MS into account the numbers from the ECDC should be seen as minimum number of actual cases of illness.

2. Not all cases of illness taken up in the ECDC are due to the consumption of drinking tap water. The ECDC reports the sickness of a person, but (logically) no information is known as to the cause of falling ill, and as such not reported on. Based on an extensive literature study, combined with expert judgement (in the case that literature is not conclusive), the causal attributed share of becoming ill due to drinking tap water is estimated.

   The third step in our approach is to include the number of days a person falls ill in the case he/ she obtained a parasite/ virus/ other through the consumption of drinking tap water. This step is closely related to step two.[205] The final step in assessing the current societal cost related to the consumption of drinking tap water is related to the (financial) societal impact of being sick, mainly related to a combination of healthcare cost (on average €203 per day) and loss of productivity cost (on average €93 per day (if you are part of the working population)).

Causal attributable share and duration of cases of illness related to tap water

Cryptosporidium and drinking tap water

An infection of Cryptospridium has an incubation period of 7 to 10 days and the symptoms are in general diarrhoea. Infected people who have a well-functioning immunity system are on average sick for 2 to 3 weeks (it ranges from 4 days to over 4 weeks). In case an infected person does not have a well-functioning immunity system (aids-, transplant-, cancer patients etc.) the infection can last up to months, become a chronic disease and even be fatal. Mortality is in general very low (<0,01%), in case an infected person does not have a well-functioning immunity system chances are up to 50%. Small children are also a group that is more affected by this type of waterborne infection.

One can be infected by Cryptosporidium through various ways. When infected, the cause is often unclear. As such it is very difficult to show the contribution of drinking tap water to the reported number of Crypto cases. One can, however, make estimations using the QMRA approach. Sources of infection, related to drinking water consumption, are recreational water bodies, swimming pools, drinking water sources (river - and groundwater) after flooding, intense rainfall, meltwater and food. Small (private) water supplies can also be a source of the infection.

There are several studies that use the QMRA method to empirically show the chance of being infected with crypto through drinking water: A Chinese study estimated that the chance per 100.000 people is 8.31 x 10 -6 (range 0.34-30.93 x 10 -6) DALY per person per year. The findings of this study are higher than what is reported by the WHO and lower than the risk according to the US EPA.[206] In the UK, a country that has a strong focus on monitoring crypto, the risk of being infected comes for 50% from swimming pools and 20% from tap water. For this, in the EU we take 20% as upper limit. On the other end of the spectrum, in the Netherlands no cases of crypto infection related to consumption of drinking water are known, meaning that the method of water treatment and/ or quality of intake are important factors and determine the number of infections.

Campylobacteriosis and drinking tap water

Campylobacteriosis is known to be caused by: private water sources and rivers (especially after floods) and is carried in many cases by animals. Other contaminants are food, especially beef, chicken, various birds and shellfish, but also raw milk and vegetables.

The incubation period is somewhere between 1 to 7 days, 3 on average. When infected the patient has diarrhoea for up to 7 days, extended in 15% of the cases to a longer period. The chance of an infection through drinking water is roughly 5-10% of all cases and is mainly related to small(er) water supplies.

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[205] See the analysis below, where for all six drinking water related sickness the approach findings are shown.

[206] The burden of drinking water associated cryptosporidiosis in China; the large contribution of the immuno -deficient population identified by quantitative microbial risk assessment QMRA. Water Research volume 46 issue 13 september 2013 Shumin Xiao et. al.

E.coli and drinking tap water[207]

There is a common misconception regarding having E.coli in your drinking water, as E.coli is in itself not leading to any infections. E.coli is however an indicator parameter for a range of infections closely related to the E.coli bacteria, namely shigatoxic producing E.coli (STEC), verotoxic producing E. Coli (VTEC) and enterohemorrargic E.coli (EHEC). An infection of these three types of E.coli is almost always related to food consumption (raw vegetables such as tomato, cucumber, but also meat).

An infection of a type of E.coli bacteria is in most known cases not caused directly through drinking water consumption, but to some extent indirect through washing of food. We estimate chances of infection to be in the range of 0 to 5% for Europe. The incubation period of E.coli is between 1 and 14 days, roughly 3-4. A patient is on average 4 days sick when infected.

Giardiosis and drinking tap water

Giardiosis is an intestine infection caused by G.Lamblia. When infected the main symptoms are weight loss and diarrhoea. Overall the duration of the infection is two to three weeks, although in some cases it is reported to be longer and even chronic. In case a person is also infected by aids, underfed or elderly the infection can be fatal.

One can be infected through drinking tap water, swimming pools, spa's, open water bodies and in some cases also through food consumption. Overall infection is caused more often by open water when compared to groundwater sources. According to an American study 80% of the infections are caused by not treated water. [208] Based on expert judgment we estimate that the chance of being infected by consumption of drinking water is between 50 and 80 percent.

Shigellosis and drinking tap water

In general Shigellosis patients are infected through consumption of drinking water and food that is washed by infected water. Based on expert judgment the attributability of drinking tap water to the number of Shigellosis cases is between 70 and 80 percent. Patients infected by Shigellosis are having diarrheoa after an incubation period of 1-7 days and it lasts between 4-7 days. In selected cases, it is reported that the duration extends to several weeks. Normally being infected with Shigellosis is only fatal for the young, sick and elderly.

Legionella and drinking tap water[209]

There is one reason for being infected by Legionella, namely through inhaling of aerosols (in water vapour). Legionella causes a lung infection. Locations of infection are the shower, hot tubs, saunas and air condition systems. Drinking of water does not cause Legionella. Legionella becomes dangerous if it multiplies, which happens if water stands still for a longer period of time and reaches a temperature between 25 and 55 degrees. Mortality rates are relative high compared to other discussed infections, namely 2-10% (often elderly people). The value of a life is set at € 3.4 million. Although the number of mortal Legionella cases is low, it accounts for the highest social cost.

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207 According to the WHO, RIVM and the LCI guidelines for shigatoxic producing E.coli

208 Robertson LJ, Forberg T, Gjerde BK. Giardia cysts in sewage influent in Bergen, Norway 15-23 months after an extensive waterborne outbreak of giardiasis. *J Appl Microbiol*. 2008 Apr. 104(4):1147-52. [Medline].
Ryu H, Alum A, Mena KD, Abbaszadegan M. Assessment of the risk of infection by Cryptosporidium and Giardia in non-potable reclaimed water. *Water Sci Technol*. 2007. 55(1-2):283-90. [Medline].

209 www.dewatergroep.be and RIVM

The incubation period of a Legionella infection is 2 to10 days and in case infected a patient is sick from 2 days up to several weeks. Based on a discussion with RIVM we estimate the attributability of drinking water (water vapour, i.e. showering) to be 60 to 80% of the reasons for infection.

Table 22. Overview of attributability and duration of sickness

Case	Min	Max	Days sick	Additional sick days
Cryptosporidiosis	0%	20%	36	4
Campylobacteriosis	0%	5%	5	2
E.coli	0%	5%	9	2
Giardosis	50%	80%	14	2
Shigellasis	70%	80%	7	4
Legionella	60%	80%	10	2

Cost of being sick

The societal cost of being sick consist of two main components, namely the hospital and/ or general healthcare costs and the cost due to loss of production or productivity. The cost of being taken up in a hospital for an infectious disease (most similar to above causes of illness) has been estimated to cost € 2.676 for five days.[210] However, not all people who fall sick need hospital treatment and we used for our analysis the assumption that half of the cases need to be treated in the hospital. This assumption and simplifying over MS healthcare systems by calculating other MS healthcare cost using income per capita differences, shows that on average direct costs of falling ill are € 203. Next to healthcare costs society has cost when one falls sick if she/ he is part of the working group (65% of the population (EU28 2015 average)[211]). The costs for falling sick consist of salary for a replacement employee and loss of productivity.[212] On average the costs have been estimated at € 93.[213]

Total number of cases and societal cost of being sick

The table below is a culmination of the approach set out in the first section of this chapter and provides a rough indication of the current societal cost related to drinking tap water per MS. The societal cost of drinking tap water in Europe in 2015 is equal to € 220 million or € 0.43 per EU citizen and € 9.6 per person at risk.[214] These figures are a rough estimation of the current societal cost of consuming tap water: this value should be interpreted as the <u>lower</u> boundary. In this analysis possible (unknown) long term health impacts of water consumption are not taken into account.

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210 http://www.zorgwijzer.nl/zorgverzekering-2014/wat-kost-een-verblijf-en-behandeling-in-het-ziekenhuis

211 http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Population_age_structure_by_major_age_groups,_2005_and_2015_(%25_of_the_total_population)_YB16.png

212 http://www.mkbservicedesk.nl/10218/zieke-werknemer-kost-200-tot-400-euro.htm

213 We excluded cost of salary to the person who is sick, because this is rather a transfer. Values are EU weighted averages.

214 The societal cost, in the short-run, is ranging between €160 and €239 million.

Table 23. Societal cost of being sick (short-term)

Member State	Societal cost for being sick due to tap water	Total min (x mln)	Total max (x mln)	Causal days sick**	Cost per PPDW_RISK***
Austria	€ 386	€ 2,4	€ 3,3	3.055	€ 6,9
Belgium	€ 353	€ 5,3	€ 7,3	23.681	€ 8,6
Bulgaria	€ 139	€ 3,5	€ 4,5	34.468	€ 5,8
Croatia*	€ 139	€ 2,1	€ 2,1	20.681	€ 11,5
Cyprus	€ 244	€ 0,2	€ 0,3	107	€ 5,5
Czech R.	€ 252	€ 3,0	€ 4,5	8.758	€ 7,8
Denmark	€ 372	€ 1,6	€ 2,3	2.301	€ 11,4
Estonia	€ 227	€ 0,6	€ 0,8	3.706	€ 17,5
Finland	€ 330	€ 1,6	€ 2,2	2.875	€ 7,4
France	€ 319	€ 17,7	€ 23,4	12.584	€ 10,3
Germany	€ 375	€ 27,4	€ 39,7	82.822	€ 14,5
Greece	€ 216	€ 2,7	€ 3,6	772	€ 4,8
Hungary	€ 202	€ 2,5	€ 3,5	3.655	€ 7,1
Ireland	€ 400	€ 1,4	€ 2,2	4.086	€ 17,1
Italy	€ 287	€ 14,9	€ 19,8	1.549	€ 5,8
Latvia	€ 190	€ 0,5	€ 0,7	720	€ 7,0
Lithuania	€ 224	€ 0,8	€ 1,1	1.083	€ 5,3
Luxembourg	€ 406	€ 0,2	€ 0,3	377	€ 10,5
Malta	€ 257	€ 0,1	€ 0,2	131	€ 9,4
Netherlands	€ 390	€ 5,4	€ 7,1	8.097	€ 11,1
Poland	€ 202	€ 11,1	€ 14,7	28.085	€ 18,8
Portugal	€ 233	€ 2,5	€ 3,4	251	€ 4,6
Romania	€ 165	€ 5,4	€ 7,0	8.096	€ 3,8
Slovakia	€ 229	€ 2,1	€ 2,8	8.856	€ 8,5
Slovenia	€ 246	€ 0,6	€ 0,8	1.009	€ 8,5
Spain	€ 272	€ 12,3	€ 16,5	13.583	€ 5,0
Sweden	€ 367	€ 5,3	€ 7,3	25.139	€ 15,0
UK	€ 325	€ 24,6	€ 36,6	107.380	€ 41,2
EU total		€ 157,9	€ 218,5	407.906	
EU average	€ 298	€ 5,6	€ 7,8	14.568	€ 9,6

** the EDCD database did not include information on Croatia. Croatia has been set at 60% of Bulgaria to best assess total EU28 sick costs (due to differences in population). The societal cost per sick case are set equal for Bulgaria.*

*** **0.08% of the EU will on a yearly basis become 1 day sick due to drinking tap water**. For these figures the average of column 2 and 3 in Table 18 has been taken.*

*** the difference per MS corrects for the difference in actual sick cases (ECDC) and PPHR, see also box below.

Linking PPHR and causal attributed reported sick cases

The PPHR approach calculated the number of people at risk for the baseline (2015, 2030 and 2050) and for each of the policy options. Similar to the number of drinking water related sickness cases (based on the ECDC reported cases database) we found that there are considerable differences across MS for both the PPHR and number of sick cases. This section analyses to what extent a link exist between the PPHR approach and number of causal attributable sick cases at MS level.

On average 23 million people are annually at risk per MS, or roughly 5% of the EU population. A consumer is most at risk in Bulgaria (>10%) and least at risk in the UK (<2%), see figure below.

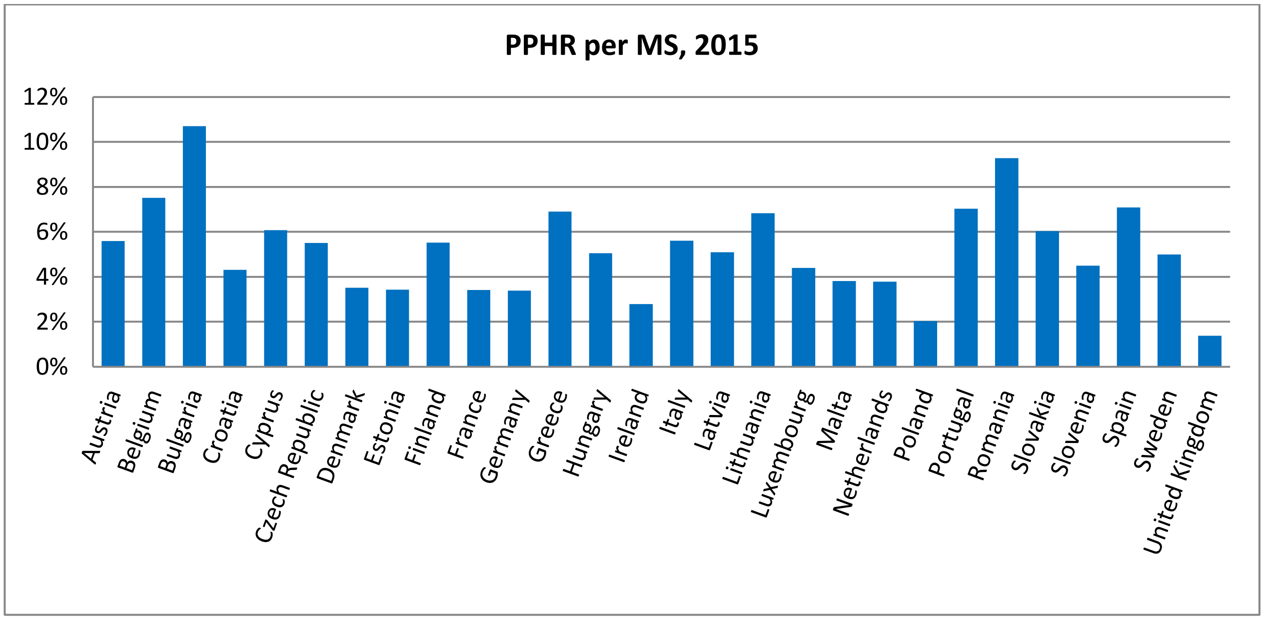

Figure 41. Population potentially at risk of being sick by MS, % annually

In order to compare the PPHR and number of causal sick cases we first took the chance of being at risk and chance of falling sick per MS and secondly calculated the share compared to the EU total chance of being at risk and causal sick chance summed over all MS. To graphically best depict what MS have a good correlation versus MS where the correlation is weaker we took the difference of the scaled result.

One should interpret the below figure in the following manner:
- If all MS have a value close to 2,8% -> there is a very strong correlation between the PPHR approach and the actual number of reported sick cases.
- If many MS are far away from the average of 2,8% -> there is a weak correlation and the PPHR approach or the ECDC information do not report the actual number of people at risk.[215]

[215] We note that we are aware that not all MS report equally to the ECDC database and we assume that option 1 (all MS near the 2,8% average) is an unlikely outcome of the analysis. This section is therefore more of a check and results are not impacting the overall analysis.

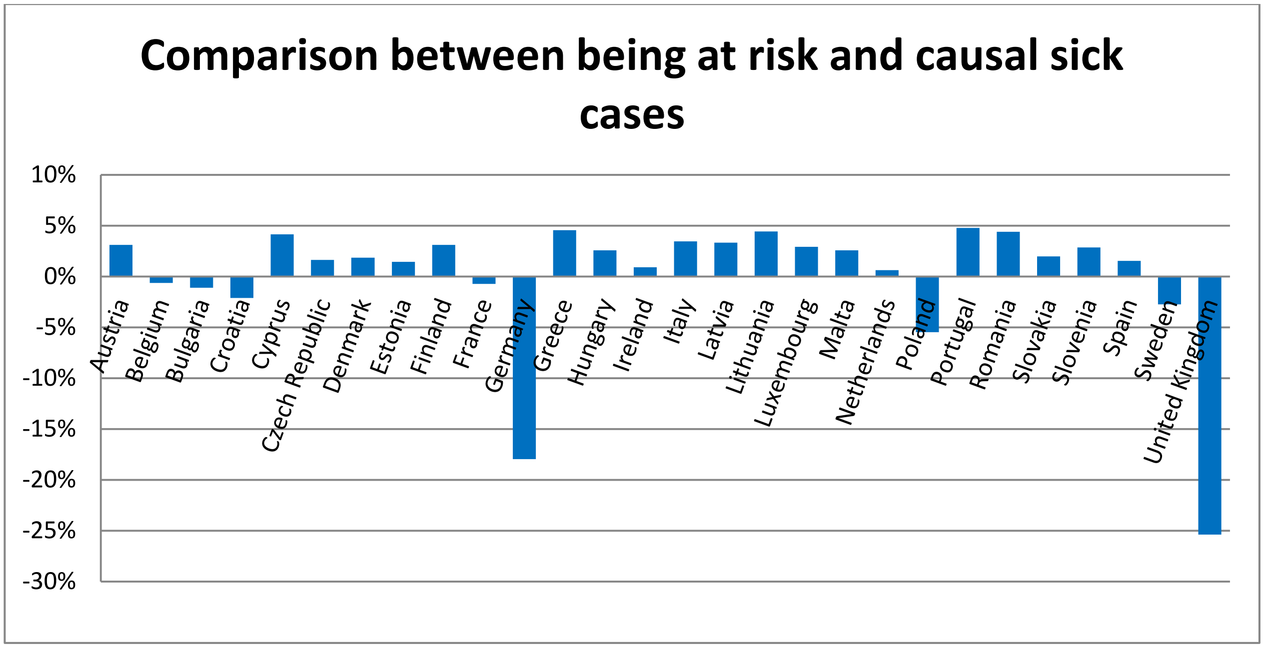

Figure 42. Linkage between being at risk and getting sick

The above figure shows that there is a relative strong link between both approaches for most MS. It also shows that the approach is relatively unreliable for Cyprus, Germany, Greece, Poland. Portugal, Romania and the United Kingdom. The expected main reason for inconsistencies in correlation between both approaches is related to the level of reporting on number of sick cases to the ECDC database by MS. Experts who often work with this database have informed us that the UK is very actively monitoring and reporting sick cases compared to some other MS. In light of this qualitative background we can conclude that for some MS the PPHR might be an underestimation and for others an overestimation. We conclude that it would be best to fall back to calculating PPHR costs at EU level compared to an approach where we link PPHR results to the number of reported sick cases for that MS.

Health benefits of policy options compared to the baseline

The above two paragraphs described the approach to estimate the cost of being sick due to drinking tap water and to what extend the result of this analysis can be linked to the PPHR outcome for the 2015 baseline. These sections showed that, on average, the chance of being at risk is 5%, current costs to society is at least € 220 million and the chance of falling 1 day ill due to drinking tap water is 0,08%. For the 2015 baseline there are 23 million people at risk. This means that the cost for every person at risk is on average € 9.6.

The resulting PPHR of each policy option for 2030 and 2050 can be multiplied with the above cost to show how that policy option offsets the increase in societal costs. This offset should be interpreted as the minimum health benefits (or cost) of a policy option. The table below shows the expected societal health cost of being sick due to drinking tap water for the 2030 and 2050 baseline –and the result for each policy option in 2030 and 2050.[216]

[216] The expected decrease in population at risk for 2030 and 2050, and the associated lower health cost, are mainly due to the autonomous increase of implementing RBA and thus an increase in water quality.

Table 24. Comparison of costs of being sick between baseline and policy options

Thema	2030	2050
Baseline (expected total cost)	€ 194	€ 188
Policy option 1.1	€ -46	€ -68
Policy option 1.2	€ -117	€ -152
Policy option 1.3	€ 56	€ 81
Policy option 2.1	€ -13	€ -14
Policy option 2.1	€ -17	€ -17
Policy option 3	€ -7	€ -14
Policy option 4.1	€ -	€ -5
Policy option 4.2	€ -64	€ -80
Policy option 4.3	€ -73	€ -91
Policy option 5.1	€ -19	€ -27
Policy option 5.2	€ 0	€ -9
COMBINATION 1	€ -97	€ -125
COMBINATION 2	€ - 121	€ -157

** Negative values indicate that there are positive health benefits compared to the 2030 or respective 2050 baseline. From this overview it comes apparent that option 1.2 has the largest short-term positive impact on society (due to less hospitalization cost and loss of production capacity).*

Annex 3. PPHR and Population facing potential long-term health risk for Baseline and the Policy options in 2030 and 2050 per MS

Table 25. PPHR and population facing potential long-term health risk for the situation in 2015

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	478 672	6%	1 918 882	22%
Belgium	851 232	8%	3 143 263	28%
Bulgaria	770 125	11%	2 373 117	33%
Croatia	182 329	4%	710 472	17%
Cyprus	53 049	6%	196 495	23%
Czech Republic	579 533	6%	2 804 336	27%
Denmark	198 895	4%	1 310 213	23%
Estonia	44 990	3%	171 753	13%
Finland	302 776	6%	1 319 335	24%
France	2 261 596	3%	11 749 819	18%
Germany	2 737 097	3%	18 341 809	23%
Greece	758 273	7%	2 995 097	27%
Hungary	498 648	5%	1 696 938	17%
Ireland	128 305	3%	754 101	16%
Italy	3 412 819	6%	14 451 986	24%
Latvia	101 007	5%	445 364	22%
Lithuania	197 953	7%	612 323	21%
Luxembourg	24 749	4%	128 605	23%
Malta	16 225	4%	115 815	27%
Netherlands	639 663	4%	3 589 344	21%
Poland	785 330	2%	6 327 632	16%
Portugal	728 038	7%	2 974 552	29%
Romania	1 846 478	9%	3 632 111	18%
Slovakia	326 787	6%	930 570	17%
Slovenia	92 823	4%	317 225	15%
Spain	3 287 727	7%	13 351 166	29%
Sweden	485 514	5%	2 066 146	21%
United Kingdom	888 851	1%	6 859 603	11%
EU total	**22 679 483**	**4%**	**105 288 072**	**21%**

Table 26. PPHR and population facing potential long-term health risk for the Baseline 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	524 453	6%	761 246	19%
Belgium	1 021 641	8%	265 508	29%
Bulgaria	755 773	12%	3 068 892	28%
Croatia	150 486	4%	1 570 486	26%
Cyprus	57 353	6%	171 306	14%
Czech Republic	556 884	5%	1 613 705	27%
Denmark	202 765	3%	14 110 295	20%
Estonia	32 892	3%	20 212 439	25%
Finland	324 297	6%	2 878 949	29%
France	2 045 934	3%	1 814 668	19%
Germany	2 555 172	3%	1 000 857	22%
Greece	651 578	6%	16 972 861	26%
Hungary	421 514	4%	385 474	24%
Ireland	110 158	2%	493 240	22%
Italy	3 398 245	5%	218 932	28%
Latvia	87 260	5%	145 386	32%
Lithuania	137 124	6%	4 369 872	25%
Luxembourg	38 581	5%	6 931 534	18%
Malta	23 719	5%	3 105 918	32%
Netherlands	638 688	4%	3 843 550	20%
Poland	874 413	2%	1 068 038	20%
Portugal	683 229	7%	345 501	17%
Romania	1 692 667	9%	13 712 820	31%
Slovakia	307 230	6%	2 721 845	25%
Slovenia	74 535	4%	9 003 136	13%
Spain	3 132 685	7%	119 523 951	23%
Sweden	568 730	5%	761 246	19%
United Kingdom	402 128	1%	265 508	29%
EU total	**21 470 133**	**4%**	**3 068 892**	**28%**

Table 27. PPHR and population facing potential long-term health risk for Baseline 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	513 554	5%	2 821 830	29%
Belgium	1 193 204	8%	5 068 278	34%
Bulgaria	715 438	12%	2 270 407	39%
Croatia	102 422	3%	782 827	20%
Cyprus	64 837	6%	375 973	36%
Czech Republic	540 292	5%	3 325 828	30%
Denmark	246 752	4%	1 745 156	27%
Estonia	19 287	2%	178 851	16%
Finland	281 029	5%	1 788 676	29%
France	1 402 404	2%	16 549 411	22%
Germany	2 487 622	3%	19 244 321	26%
Greece	522 664	6%	2 755 629	30%
Hungary	307 872	3%	1 951 041	21%
Ireland	110 961	2%	1 432 975	29%
Italy	3 228 417	5%	20 168 471	30%
Latvia	80 975	6%	352 752	24%
Lithuania	96 765	5%	437 439	23%
Luxembourg	62 602	6%	360 453	34%
Malta	25 967	6%	157 069	34%
Netherlands	558 708	3%	4 685 329	27%
Poland	882 907	3%	6 902 783	20%
Portugal	588 407	7%	3 103 043	35%
Romania	1 556 720	9%	4 060 185	23%
Slovakia	252 156	5%	1 115 051	23%
Slovenia	51 104	2%	378 639	18%
Spain	2 915 456	6%	14 680 742	32%
Sweden	665 035	5%	3 553 355	29%
United Kingdom	557 371	1%	10 846 416	14%
EU total	**20 030 927**	**4%**	**131 092 930**	**25%**

Table 28. PPHR and population facing potential long-term health risk for the PO 1.1 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	418 726	5%	2 151 889	23%
Belgium	955 856	7%	3 929 743	30%
Bulgaria	442 431	7%	1 891 816	29%
Croatia	149 916	4%	759 089	19%
Cyprus	54 346	6%	261 278	28%
Czech Republic	294 594	3%	2 028 020	19%
Denmark	125 552	2%	1 383 656	23%
Estonia	30 169	2%	145 857	12%
Finland	284 869	5%	1 536 206	26%
France	1 657 850	2%	12 705 885	18%
Germany	1 479 119	2%	17 740 217	22%
Greece	436 325	4%	2 338 201	23%
Hungary	405 722	4%	1 755 659	18%
Ireland	114 102	3%	1 012 754	22%
Italy	3 068 178	5%	16 356 302	26%
Latvia	71 419	4%	334 046	20%
Lithuania	126 497	6%	457 803	21%
Luxembourg	28 270	4%	200 970	26%
Malta	16 966	4%	140 249	31%
Netherlands	533 589	3%	4 139 703	24%
Poland	785 200	2%	6 600 419	18%
Portugal	640 963	7%	3 062 726	31%
Romania	1 679 454	9%	3 788 063	20%
Slovakia	306 041	6%	1 063 665	20%
Slovenia	74 700	4%	346 237	17%
Spain	1 606 886	4%	9 989 504	22%
Sweden	493 444	4%	2 512 288	23%
United Kingdom	294 286	0%	8 278 784	12%
EU total	**16 575 470**	**3%**	**106 911 027**	**21%**

Table 29. PPHR and population facing potential long-term health risk for the PO 1.1 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	355 314	4%	2 537 472	26%
Belgium	999 699	7%	4 930 029	33%
Bulgaria	307 162	5%	1 750 014	30%
Croatia	93 381	2%	752 932	20%
Cyprus	56 709	5%	371 059	36%
Czech Republic	219 094	2%	2 211 737	20%
Denmark	137 061	2%	1 500 149	23%
Estonia	15 335	1%	148 896	13%
Finland	225 845	4%	1 693 898	27%
France	694 888	1%	14 316 487	19%
Germany	1 358 756	2%	16 778 810	22%
Greece	305 089	3%	2 317 242	25%
Hungary	264 762	3%	1 818 519	19%
Ireland	109 652	2%	1 430 643	29%
Italy	2 626 069	4%	19 361 772	29%
Latvia	65 716	5%	303 045	21%
Lithuania	85 033	4%	400 421	21%
Luxembourg	42 654	4%	343 396	33%
Malta	19 336	4%	153 169	33%
Netherlands	394 838	2%	4 372 686	25%
Poland	805 827	2%	6 650 460	19%
Portugal	522 491	6%	3 056 037	34%
Romania	1 513 846	8%	3 909 867	22%
Slovakia	236 512	5%	1 069 222	22%
Slovenia	48 390	2%	368 241	18%
Spain	1 126 747	2%	11 176 406	25%
Sweden	489 201	4%	3 152 032	25%
United Kingdom	340 491	0%	9 547 164	12%
EU total	**13 459 896**	**3%**	**116 421 805**	**22%**

Table 30. PPHR and population facing potential long-term health risk for the PO 1.2 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	263 130	3%	1 174 727	13%
Belgium	441 553	3%	2 021 661	16%
Bulgaria	286 570	4%	601 970	9%
Croatia	118 727	3%	353 666	9%
Cyprus	34 133	4%	181 129	20%
Czech Republic	223 816	2%	808 647	8%
Denmark	32 100	1%	610 701	10%
Estonia	27 526	2%	96 088	8%
Finland	168 294	3%	908 270	15%
France	1 130 745	2%	3 831 441	5%
Germany	188 349	0%	7 722 075	10%
Greece	278 802	3%	1 243 960	12%
Hungary	300 720	3%	814 173	8%
Ireland	78 593	2%	745 693	16%
Italy	1 632 330	3%	9 486 328	15%
Latvia	61 107	4%	157 341	10%
Lithuania	107 693	5%	266 849	12%
Luxembourg	10 152	1%	108 591	14%
Malta	0	0%	85 555	19%
Netherlands	210 850	1%	1 977 525	11%
Poland	499 807	1%	3 017 909	8%
Portugal	281 283	3%	1 851 941	19%
Romania	1 573 080	8%	2 694 367	14%
Slovakia	249 278	5%	597 883	11%
Slovenia	63 304	3%	142 030	7%
Spain	947 549	2%	3 439 791	8%
Sweden	359 019	3%	1 395 359	13%
United Kingdom	44 613	0%	3 680 735	5%
EU total	**9 613 123**	**2%**	**50 016 404**	**10%**

Table 31. PPHR and population facing potential long-term health risk for the PO 1.2 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	152 912	2%	1 421 736	15%
Belgium	288 893	2%	2 678 536	18%
Bulgaria	173 310	3%	521 132	9%
Croatia	64 332	2%	335 525	9%
Cyprus	23 812	2%	266 402	26%
Czech Republic	141 205	1%	840 980	8%
Denmark	28 276	0%	617 474	10%
Estonia	12 777	1%	92 486	8%
Finland	93 921	2%	982 164	16%
France	130 199	0%	4 133 032	6%
Germany	72 370	0%	6 671 448	9%
Greece	136 374	1%	1 242 145	14%
Hungary	155 006	2%	800 975	9%
Ireland	49 761	1%	1 069 794	22%
Italy	749 380	1%	11 572 508	17%
Latvia	56 628	4%	145 787	10%
Lithuania	70 789	4%	218 239	11%
Luxembourg	3 574	0%	213 417	20%
Malta	0	0%	97 505	21%
Netherlands	29 326	0%	2 081 355	12%
Poland	482 080	1%	3 306 054	9%
Portugal	132 703	1%	1 908 703	22%
Romania	1 410 417	8%	2 753 489	15%
Slovakia	177 097	4%	594 976	12%
Slovenia	37 104	2%	144 883	7%
Spain	311 353	1%	4 031 087	9%
Sweden	309 081	2%	1 784 463	14%
United Kingdom	0	0%	3 648 117	5%
EU total	**5 292 682**	**1%**	**54 174 409**	**10%**

Table 32. PPHR and population facing potential long-term health risk for the PO 2.1 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	493 483	5%	2 330 445	25%
Belgium	1 021 641	8%	3 996 832	31%
Bulgaria	623 342	10%	2 150 646	33%
Croatia	145 172	4%	747 623	18%
Cyprus	54 051	6%	260 864	28%
Czech Republic	468 086	4%	2 721 369	25%
Denmark	165 562	3%	1 481 366	24%
Estonia	31 544	3%	160 241	13%
Finland	307 787	5%	1 582 265	27%
France	1 959 520	3%	13 798 472	20%
Germany	2 214 362	3%	19 430 620	24%
Greece	615 756	6%	2 789 954	28%
Hungary	406 860	4%	1 759 910	18%
Ireland	109 795	2%	1 000 400	22%
Italy	3 139 005	5%	16 491 202	26%
Latvia	83 065	5%	374 859	23%
Lithuania	131 928	6%	480 326	22%
Luxembourg	34 612	4%	212 019	27%
Malta	21 679	5%	143 834	32%
Netherlands	634 471	4%	4 360 637	25%
Poland	849 692	2%	6 865 706	18%
Portugal	649 470	7%	3 071 615	31%
Romania	1 672 969	9%	3 812 143	20%
Slovakia	301 770	6%	1 051 270	20%
Slovenia	74 045	4%	344 265	16%
Spain	2 659 083	6%	12 557 118	28%
Sweden	552 536	5%	2 678 728	24%
United Kingdom	402 128	1%	9 003 136	13%
EU total	**19 823 413**	**4%**	**115 657 865**	**22%**

Table 33. PPHR and population facing potential long-term health risk for the PO 2.1 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	490 353	5%	2 781 097	29%
Belgium	1 193 204	8%	5 068 278	34%
Bulgaria	592 036	10%	2 113 182	37%
Croatia	97 220	3%	769 298	20%
Cyprus	62 404	6%	374 502	36%
Czech Republic	458 745	4%	3 045 637	28%
Denmark	211 484	3%	1 666 921	26%
Estonia	18 431	2%	172 940	15%
Finland	270 920	4%	1 771 770	29%
France	1 354 515	2%	16 398 554	22%
Germany	2 295 873	3%	18 826 035	25%
Greece	503 361	6%	2 717 083	30%
Hungary	297 996	3%	1 920 681	21%
Ireland	109 788	2%	1 431 077	29%
Italy	2 978 698	4%	19 835 379	30%
Latvia	77 850	5%	344 350	24%
Lithuania	93 268	5%	428 976	22%
Luxembourg	58 808	6%	357 209	34%
Malta	24 817	5%	156 392	33%
Netherlands	553 376	3%	4 675 158	27%
Poland	870 113	2%	6 871 661	20%
Portugal	569 868	6%	3 089 887	35%
Romania	1 542 676	9%	4 031 305	22%
Slovakia	241 544	5%	1 085 626	22%
Slovenia	50 713	2%	377 431	18%
Spain	2 607 547	6%	14 077 504	31%
Sweden	662 662	5%	3 548 065	29%
United Kingdom	557 371	1%	10 846 416	14%
EU total	**18 845 644**	**4%**	**128 782 413**	**25%**

Table 34. PPHR and population facing potential long-term health risk for the PO 2.2 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	474 046	5%	2 286 225	25%
Belgium	1 013 940	8%	3 988 979	31%
Bulgaria	587 352	9%	2 099 251	32%
Croatia	143 809	4%	744 131	18%
Cyprus	53 506	6%	260 097	28%
Czech Republic	431 084	4%	2 576 558	24%
Denmark	165 562	3%	1 481 366	24%
Estonia	31 261	3%	157 916	13%
Finland	301 864	5%	1 570 989	27%
France	1 936 606	3%	13 715 788	19%
Germany	2 160 908	3%	19 307 997	24%
Greece	560 760	6%	2 653 322	26%
Hungary	398 714	4%	1 729 475	18%
Ireland	109 607	2%	1 000 162	22%
Italy	3 076 437	5%	16 374 954	26%
Latvia	79 016	5%	364 614	22%
Lithuania	127 670	6%	469 743	21%
Luxembourg	34 289	4%	211 457	27%
Malta	21 539	5%	143 728	32%
Netherlands	634 471	4%	4 360 637	25%
Poland	835 763	2%	6 828 614	18%
Portugal	646 126	7%	3 068 217	31%
Romania	1 650 555	9%	3 776 406	20%
Slovakia	299 207	6%	1 043 399	20%
Slovenia	74 045	4%	344 265	16%
Spain	2 553 484	6%	12 299 431	28%
Sweden	552 536	5%	2 678 728	24%
United Kingdom	397 509	1%	8 972 107	13%
EU total	**19 351 667**	**4%**	**114 508 553**	**22%**

Table 35. PPHR and population facing potential long-term health risk for the PO 2.2 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	474 905	5%	2 753 975	28%
Belgium	1 182 316	8%	5 060 499	34%
Bulgaria	563 251	10%	2 076 507	36%
Croatia	96 159	3%	766 539	20%
Cyprus	61 889	6%	374 190	36%
Czech Republic	427 857	4%	2 939 508	27%
Denmark	211 484	3%	1 666 921	26%
Estonia	18 267	2%	171 805	15%
Finland	266 721	4%	1 764 746	29%
France	1 334 568	2%	16 335 718	22%
Germany	2 272 490	3%	18 775 027	25%
Greece	467 254	5%	2 644 982	29%
Hungary	291 786	3%	1 901 591	20%
Ireland	109 087	2%	1 429 942	29%
Italy	2 937 950	4%	19 781 026	29%
Latvia	74 935	5%	336 514	23%
Lithuania	90 572	5%	422 447	22%
Luxembourg	58 412	6%	356 870	34%
Malta	24 716	5%	156 333	33%
Netherlands	553 376	3%	4 675 158	27%
Poland	863 065	2%	6 854 514	20%
Portugal	569 411	6%	3 089 563	35%
Romania	1 525 367	8%	3 995 711	22%
Slovakia	237 425	5%	1 074 202	22%
Slovenia	50 486	2%	376 728	18%
Spain	2 539 641	6%	13 944 466	31%
Sweden	648 051	5%	3 515 498	28%
United Kingdom	551 491	1%	10 811 187	14%
EU total	**18 502 929**	**4%**	**128 052 165**	**24%**

Table 36. PPHR and population facing potential long-term health risk for the PO 3 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	507 366	5%	2 350 724	25%
Belgium	987 057	8%	3 933 353	31%
Bulgaria	729 830	11%	2 308 268	36%
Croatia	148 648	4%	753 385	18%
Cyprus	55 540	6%	257 207	28%
Czech Republic	537 760	5%	3 003 990	28%
Denmark	192 420	3%	1 541 641	25%
Estonia	32 525	3%	168 103	14%
Finland	314 152	5%	1 581 185	27%
France	1 994 025	3%	13 932 186	20%
Germany	2 413 435	3%	19 837 650	25%
Greece	627 246	6%	2 819 945	28%
Hungary	414 708	4%	1 786 468	18%
Ireland	107 895	2%	974 703	21%
Italy	3 279 274	5%	16 577 036	26%
Latvia	85 840	5%	381 037	23%
Lithuania	135 352	6%	487 082	22%
Luxembourg	36 773	5%	214 057	27%
Malta	22 411	5%	141 917	31%
Netherlands	612 742	3%	4 279 159	24%
Poland	854 720	2%	6 821 807	18%
Portugal	658 338	7%	3 041 481	31%
Romania	1 687 277	9%	3 819 591	20%
Slovakia	303 652	6%	1 054 116	20%
Slovenia	74 095	4%	343 411	16%
Spain	3 005 236	7%	13 453 420	30%
Sweden	555 594	5%	2 678 374	24%
United Kingdom	379 323	1%	8 804 949	12%
EU total	**20 753 236**	**4%**	**117 346 243**	**23%**

Table 37. PPHR and population facing potential long-term health risk for the PO 3 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	491 025	5%	2 766 320	28%
Belgium	1 142 579	8%	4 994 471	34%
Bulgaria	686 030	12%	2 240 273	39%
Croatia	100 249	3%	775 032	20%
Cyprus	61 950	6%	364 121	35%
Czech Republic	517 678	5%	3 260 973	29%
Denmark	234 094	4%	1 712 353	27%
Estonia	18 879	2%	175 976	16%
Finland	269 463	4%	1 754 588	28%
France	1 332 279	2%	16 360 373	22%
Germany	2 354 619	3%	18 920 070	25%
Greece	498 348	5%	2 704 255	30%
Hungary	298 964	3%	1 921 392	21%
Ireland	107 070	2%	1 393 506	28%
Italy	3 072 513	5%	19 714 086	29%
Latvia	79 736	5%	349 038	24%
Lithuania	95 373	5%	433 123	23%
Luxembourg	59 032	6%	352 092	33%
Malta	24 678	5%	153 954	33%
Netherlands	527 383	3%	4 589 424	26%
Poland	863 092	2%	6 792 322	19%
Portugal	562 189	6%	3 041 748	34%
Romania	1 550 778	9%	4 036 348	22%
Slovakia	247 572	5%	1 100 498	23%
Slovenia	50 334	2%	375 643	18%
Spain	2 765 680	6%	14 445 911	32%
Sweden	643 050	5%	3 496 477	28%
United Kingdom	525 230	1%	10 586 543	14%
EU total	**19 179 869**	**4%**	**128 810 911**	**25%**

Table 38. PPHR and population facing potential long-term health risk for the PO 4.2 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	387 577	4%	1 945 225	21%
Belgium	817 572	6%	3 471 849	27%
Bulgaria	639 669	10%	2 128 280	33%
Croatia	129 745	3%	509 880	12%
Cyprus	36 700	4%	229 899	25%
Czech Republic	386 564	4%	2 575 472	24%
Denmark	123 897	2%	1 236 659	20%
Estonia	28 256	2%	123 551	10%
Finland	238 722	4%	1 333 083	23%
France	1 565 261	2%	9 441 648	13%
Germany	1 478 537	2%	16 017 879	20%
Greece	482 984	5%	2 436 096	24%
Hungary	338 020	3%	1 199 786	12%
Ireland	72 851	2%	847 655	19%
Italy	2 349 639	4%	13 852 079	22%
Latvia	75 082	5%	307 476	19%
Lithuania	120 619	5%	388 619	18%
Luxembourg	24 881	3%	182 821	23%
Malta	13 324	3%	132 678	29%
Netherlands	404 458	2%	3 360 804	19%
Poland	605 615	2%	4 641 282	12%
Portugal	499 833	5%	2 737 173	28%
Romania	1 614 092	8%	3 130 612	16%
Slovakia	268 299	5%	772 611	15%
Slovenia	66 784	3%	208 108	10%
Spain	2 340 199	5%	11 885 618	27%
Sweden	454 982	4%	2 153 599	20%
United Kingdom	67 540	0%	4 780 728	7%
EU total	**15 631 700**	**3%**	**92 031 170**	**18%**

Table 39. PPHR and population facing potential long-term health risk for the PO 4.2 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	348 764	4%	2 389 432	25%
Belgium	914 175	6%	4 572 728	31%
Bulgaria	592 372	10%	2 124 253	37%
Croatia	81 062	2%	551 636	14%
Cyprus	33 844	3%	351 286	34%
Czech Republic	357 694	3%	2 838 164	26%
Denmark	153 880	2%	1 411 605	22%
Estonia	13 723	1%	123 105	11%
Finland	188 553	3%	1 500 663	24%
France	813 983	1%	11 802 837	16%
Germany	1 446 543	2%	15 414 097	21%
Greece	364 945	4%	2 367 851	26%
Hungary	218 224	2%	1 378 368	15%
Ireland	45 273	1%	1 274 773	26%
Italy	1 938 014	3%	17 321 872	26%
Latvia	69 783	5%	284 562	20%
Lithuania	83 661	4%	344 671	18%
Luxembourg	37 027	4%	327 689	31%
Malta	14 442	3%	146 611	31%
Netherlands	300 767	2%	3 740 218	21%
Poland	592 858	2%	4 864 226	14%
Portugal	399 018	5%	2 820 190	32%
Romania	1 476 198	8%	3 407 577	19%
Slovakia	209 708	4%	859 571	18%
Slovenia	42 707	2%	243 995	12%
Spain	2 084 150	5%	12 886 186	28%
Sweden	504 878	4%	2 977 529	24%
United Kingdom	110 548	0%	6 386 836	8%
EU total	**13 436 795**	**3%**	**104 712 531**	**20%**

Table 40. PPHR and population facing potential long-term health risk for the PO 4.3 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	360 286	4%	1 874 260	20%
Belgium	795 552	6%	3 438 762	27%
Bulgaria	590 128	9%	2 012 194	31%
Croatia	123 656	3%	489 312	12%
Cyprus	35 611	4%	227 691	25%
Czech Republic	346 197	3%	2 321 980	22%
Denmark	111 020	2%	1 191 969	20%
Estonia	26 812	2%	110 521	9%
Finland	223 457	4%	1 304 215	22%
France	1 507 093	2%	9 019 003	13%
Germany	1 341 419	2%	15 503 337	19%
Greece	443 368	4%	2 304 229	23%
Hungary	334 196	3%	1 165 692	12%
Ireland	69 721	2%	843 311	19%
Italy	2 253 889	4%	13 587 687	21%
Latvia	66 996	4%	286 774	18%
Lithuania	112 411	5%	368 639	17%
Luxembourg	23 335	3%	178 560	23%
Malta	12 465	3%	132 136	29%
Netherlands	388 392	2%	3 299 889	19%
Poland	562 623	1%	4 535 593	12%
Portugal	480 950	5%	2 716 541	28%
Romania	1 500 076	8%	2 841 766	15%
Slovakia	258 267	5%	733 632	14%
Slovenia	64 509	3%	201 335	10%
Spain	2 162 113	5%	11 074 494	25%
Sweden	401 562	4%	2 037 424	19%
United Kingdom	57 422	0%	4 605 381	7%
EU total	**14 653 527**	**3%**	**88 406 328**	**17%**

Table 41. PPHR and population facing potential long-term health risk for the PO 4.3 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	308 557	3%	2 320 376	24%
Belgium	880 354	6%	4 541 820	31%
Bulgaria	531 534	9%	2 000 232	35%
Croatia	73 477	2%	525 755	14%
Cyprus	31 796	3%	349 911	34%
Czech Republic	300 227	3%	2 555 758	23%
Denmark	135 380	2%	1 358 423	21%
Estonia	11 837	1%	107 466	10%
Finland	169 601	3%	1 472 421	24%
France	722 179	1%	11 281 519	15%
Germany	1 312 360	2%	14 966 979	20%
Greece	322 606	4%	2 267 022	25%
Hungary	211 460	2%	1 337 008	14%
Ireland	39 908	1%	1 271 871	26%
Italy	1 814 949	3%	17 109 778	26%
Latvia	60 180	4%	259 093	18%
Lithuania	76 289	4%	325 018	17%
Luxembourg	34 118	3%	324 448	31%
Malta	13 614	3%	146 723	31%
Netherlands	279 621	2%	3 673 072	21%
Poland	552 991	2%	4 779 600	14%
Portugal	380 270	4%	2 811 128	32%
Romania	1 319 904	7%	2 989 085	17%
Slovakia	193 765	4%	813 367	17%
Slovenia	39 268	2%	231 599	11%
Spain	1 874 610	4%	12 175 320	27%
Sweden	385 404	3%	2 777 713	22%
United Kingdom	94 001	0%	6 161 062	8%
EU total	**12 170 261**	**2%**	**100 933 567**	**19%**

Table 42. PPHR and population facing potential long-term health risk for the PO 5.1 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	439 068	5%	2 374 953	26%
Belgium	1 021 641	8%	3 996 832	31%
Bulgaria	747 057	12%	2 336 219	36%
Croatia	103 377	3%	743 703	18%
Cyprus	57 353	6%	265 508	29%
Czech Republic	473 103	4%	2 989 951	28%
Denmark	185 284	3%	1 557 276	26%
Estonia	25 513	2%	153 901	13%
Finland	279 403	5%	1 564 789	27%
France	2 012 342	3%	14 060 043	20%
Germany	2 502 903	3%	20 167 575	25%
Greece	573 204	6%	2 820 095	28%
Hungary	421 514	4%	1 814 668	19%
Ireland	96 466	2%	912 398	20%
Italy	3 336 891	5%	16 913 470	26%
Latvia	34 467	2%	369 183	23%
Lithuania	75 081	3%	469 915	21%
Luxembourg	38 502	5%	218 854	28%
Malta	23 719	5%	145 386	32%
Netherlands	638 688	4%	4 369 872	25%
Poland	427 863	1%	6 692 515	18%
Portugal	660 805	7%	3 069 349	31%
Romania	986 204	5%	3 486 862	18%
Slovakia	289 366	5%	1 027 401	19%
Slovenia	55 818	3%	339 550	16%
Spain	3 132 685	7%	13 712 820	31%
Sweden	430 630	4%	2 570 235	23%
United Kingdom	402 128	1%	9 003 136	13%
EU total	**19 471 076**	**4%**	**118 146 457**	**23%**

Table 43. PPHR and population facing potential long-term health risk for the PO 5.1 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	408 884	4%	2 794 492	29%
Belgium	1 193 204	8%	5 068 278	34%
Bulgaria	704 726	12%	2 265 717	39%
Croatia	49 252	1%	768 227	20%
Cyprus	64 837	6%	375 973	36%
Czech Republic	435 538	4%	3 224 842	29%
Denmark	225 248	4%	1 728 211	27%
Estonia	8 873	1%	161 162	14%
Finland	223 605	4%	1 739 251	28%
France	1 349 642	2%	16 487 888	22%
Germany	2 432 488	3%	19 195 705	26%
Greece	435 318	5%	2 702 736	30%
Hungary	307 872	3%	1 951 041	21%
Ireland	85 818	2%	1 301 093	26%
Italy	3 147 238	5%	20 101 585	30%
Latvia	32 084	2%	333 138	23%
Lithuania	36 863	2%	420 164	22%
Luxembourg	62 444	6%	360 333	34%
Malta	25 967	6%	157 069	34%
Netherlands	558 708	3%	4 685 329	27%
Poland	457 803	1%	6 629 115	19%
Portugal	561 073	6%	3 068 213	35%
Romania	730 490	4%	3 656 097	20%
Slovakia	220 832	5%	1 071 652	22%
Slovenia	27 975	1%	372 726	18%
Spain	2 915 456	6%	14 680 742	32%
Sweden	440 395	4%	3 362 923	27%
United Kingdom	557 371	1%	10 846 416	14%
EU total	**17 700 002**	**3%**	**129 510 119**	**25%**

Table 44. PPHR and population facing potential long-term health risk for the PO 5.2 2030

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	508 606	5%	2 418 456	26%
Belgium	1 021 641	8%	3 996 832	31%
Bulgaria	755 514	12%	2 340 189	36%
Croatia	153 351	4%	759 293	19%
Cyprus	57 353	6%	265 508	29%
Czech Republic	559 348	5%	3 068 597	28%
Denmark	203 243	3%	1 570 256	26%
Estonia	33 449	3%	171 070	14%
Finland	325 327	6%	1 613 135	27%
France	2 047 327	3%	14 111 550	20%
Germany	2 556 497	3%	20 215 119	25%
Greece	653 370	6%	2 879 090	29%
Hungary	421 514	4%	1 814 668	19%
Ireland	110 828	2%	1 000 818	22%
Italy	3 400 491	5%	16 973 320	26%
Latvia	83 736	5%	390 502	24%
Lithuania	132 502	6%	499 984	23%
Luxembourg	38 583	5%	218 935	28%
Malta	23 719	5%	145 386	32%
Netherlands	638 688	4%	4 369 872	25%
Poland	893 800	2%	6 927 695	18%
Portugal	683 868	7%	3 107 302	32%
Romania	1 621 073	9%	3 956 352	21%
Slovakia	309 369	6%	1 068 370	20%
Slovenia	75 633	4%	344 871	17%
Spain	3 132 685	7%	13 712 820	31%
Sweden	571 963	5%	2 719 959	25%
United Kingdom	402 128	1%	9 003 136	13%
EU total	**21 415 606**	**4%**	**119 663 085**	**23%**

Table 45. PPHR and population facing potential long-term health risk for the PO 5.2 2050

Member states	PPHR (inhabitants)	PPHR (% of national population)	Population facing a potential long-term health risk (inhabitants)	Population facing a potential long-term health risk (% of national population)
Austria	487 508	5%	2 849 783	29%
Belgium	1 193 204	8%	5 068 278	34%
Bulgaria	714 777	12%	2 271 229	39%
Croatia	87 331	2%	798 787	21%
Cyprus	64 837	6%	375 973	36%
Czech Republic	528 795	5%	3 339 591	30%
Denmark	246 149	4%	1 746 033	27%
Estonia	19 856	2%	178 586	16%
Finland	279 269	5%	1 790 917	29%
France	1 403 808	2%	16 550 888	22%
Germany	2 489 015	3%	19 246 672	26%
Greece	516 582	6%	2 763 470	30%
Hungary	307 872	3%	1 951 041	21%
Ireland	111 660	2%	1 433 135	29%
Italy	3 220 741	5%	20 179 191	30%
Latvia	66 091	5%	368 988	25%
Lithuania	76 287	4%	459 679	24%
Luxembourg	62 604	6%	360 458	34%
Malta	25 967	6%	157 069	34%
Netherlands	558 708	3%	4 685 329	27%
Poland	775 738	2%	7 025 143	20%
Portugal	588 970	7%	3 104 412	35%
Romania	1 220 456	7%	4 437 404	25%
Slovakia	254 238	5%	1 115 374	23%
Slovenia	43 517	2%	386 695	19%
Spain	2 915 456	6%	14 680 742	32%
Sweden	658 746	5%	3 561 336	29%
United Kingdom	557 371	1%	10 846 416	14%
EU total	**19 475 554**	**4%**	**131 732 617**	**25%**

Annex 4. Economic impacts on total operating cost, percentage of population at low/medium/high risk, employment, households and associated health cost per MS

The tables below presents the economic impact on drinking water providers, on consumers (population), on employment, cost change per household and the associated health risk per MS for each policy option. The information presented in the tables show how information on total impact is derived from bottom-up MS information. The information is visualized in the main section of the report using maps as they clearly indicate the increase –or decrease of the selected indicator across MS.

Table 46. 2015 Baseline

MS	Annual operating cost in (*1 million)	People at Risk (in % of total population)	Health cost in (*1 million)	Employment in fte	Cost per household
Austria	1.011	5,6%	3,3	2.563	280
Belgium	1.228	7,5%	7,4	6.193	289
Bulgaria	298	10,7%	4,5	18.794	116
Croatia	231	4,3%	2,1	9.931	172
Cyprus	57	6,1%	0,3	427	200
Czech Republic	811	5,5%	4,5	19.648	187
Denmark	647	3,5%	2,3	2.456	246
Estonia	88	3,4%	0,8	1.495	155
Finland	556	5,5%	2,3	2.883	217
France	6.352	3,4%	23,6	44.848	237
Germany	9.260	3,4%	39,9	38.121	264
Greece	712	6,9%	3,6	7.368	177
Hungary	612	5,1%	3,5	21.036	171
Ireland	559	2,8%	2,2	3.032	336
Italy	5.406	5,6%	20,0	31.180	245
Latvia	117	5,1%	0,7	1.922	155
Lithuania	196	6,8%	1,1	6.193	159
Luxembourg	140	4,4%	0,3	607	627
Malta	33	3,8%	0,2	471	255
Netherlands	1.761	3,8%	7,1	5.659	235
Poland	2.404	2,0%	14,8	35.345	192
Portugal	746	7,0%	3,4	13.882	220
Romania	978	9,3%	7,1	37.267	152
Slovakia	379	6,0%	2,8	12.493	206
Slovenia	157	4,5%	0,8	4.485	196
Spain	3.978	7,1%	16,7	43.567	243

Sweden	1.123	5,0%	7,3	4.175	236
United Kingdom	6.423	1,4%	36,8	43.508	236
EU total	46.261	4,5%	219,9	419.548	

Table 47. 2030 Baseline

MS	Annual operating cost in (*1 million)	People at Risk (in % of total population)	Health cost (*1 million)	Employment in fte	Cost per household
Austria	1.086	6,1%	3,6	2.753	277
Belgium	1.385	9,0%	8,8	6.974	287
Bulgaria	264	10,5%	4,4	16.704	114
Croatia	219	3,6%	1,7	9.447	170
Cyprus	59	6,6%	0,3	446	198
Czech Republic	821	5,3%	4,3	19.898	185
Denmark	686	3,6%	2,3	2.604	243
Estonia	80	2,5%	0,6	1.361	153
Finland	591	5,9%	2,4	3.065	215
France	6.694	3,1%	21,1	47.234	235
Germany	9.059	3,2%	37,1	37.283	261
Greece	648	5,9%	3,1	6.706	175
Hungary	594	4,3%	3,0	20.424	169
Ireland	547	2,4%	1,9	32	333
Italy	5.622	5,6%	19,7	32.444	242
Latvia	95	4,4%	0,6	1.567	153
Lithuania	147	4,7%	0,7	4.657	158
Luxembourg	194	6,9%	0,4	148	622
Malta	35	5,6%	0,2	500	252
Netherlands	1.817	3,8%	7,1	5.829	233
Poland	2.319	2,3%	16,4	34.100	190
Portugal	693	6,6%	3,2	12.902	217
Romania	924	8,5%	6,5	35.225	150
Slovakia	368	5,7%	2,6	12.136	204
Slovenia	160	3,6%	0,6	4.579	198
Spain	3.779	6,8%	15,8	41.375	241
Sweden	1.260	5,9%	8,5	1.317	234
United Kingdom	6.937	0,6%	16,6	46.924	233
EU total	47.086	4,2%	193,6	408.633	

Table 48. 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk (in % of total population)	Health cost in (*1 million)	Employment in fte	Cost per household
Austria	1.137	5,4%	3,6	2.877	276
Belgium	1.585	6,9%	10,3	7.959	286
Bulgaria	234	13,1%	4,1	14.754	113
Croatia	204	3,9%	1,2	8.773	168
Cyprus	67	5,5%	0,4	499	197
Czech Republic	840	5,0%	4,2	20.323	184
Denmark	725	3,2%	2,8	2.753	242
Estonia	74	2,9%	0,3	1.267	152
Finland	618	5,3%	2,1	3.200	214
France	7.049	2,8%	14,5	49.566	234
Germany	8.454	3,4%	36,1	34.671	259
Greece	585	7,1%	2,5	6.028	174
Hungary	572	4,5%	2,2	19.543	168
Ireland	594	2,2%	1,9	3.222	331
Italy	5.849	5,1%	18,7	33.606	240
Latvia	84	6,0%	0,6	1.384	152
Lithuania	127	7,2%	0,5	4.015	157
Luxembourg	260	3,7%	0,7	1.120	620
Malta	35	5,1%	0,2	509	251
Netherlands	1.801	3,7%	6,2	5.773	232
Poland	2.141	2,5%	16,6	31.358	189
Portugal	624	7,7%	2,7	11.581	215
Romania	870	9,4%	5,9	33.030	149
Slovakia	335	6,3%	2,1	11.035	202
Slovenia	159	3,6%	0,4	4.524	197
Spain	3.851	6,9%	14,7	42.018	239
Sweden	1.424	4,6%	10,0	5.286	233
United Kingdom	7.596	0,5%	22,9	51.330	233
EU total	47.894	4,1%	188,4	412.002	

Table 49. Impact PO1.1 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	12	-2%	-1,2	28	2,7
Belgium	17	-1%	-0,2	75	2,8

Bulgaria	3	-7%	-2,6	162	1,4
Croatia	3	0%	-0,7	89	1,8
Cyprus	1	-1%	-0,0	6	2,1
Czech Republic	10	-3%	-2,6	214	2,0
Denmark	8	-2%	-0,7	32	2,6
Estonia	1	0%	-0,3	14	1,7
Finland	7	-1%	-0,7	35	2,3
France	79	-1%	-14,0	475	2,3
Germany	92	-2%	-17,4	404	2,5
Greece	7	-2%	-1,7	51	1,8
Hungary	7	0%	-1,1	156	1,7
Ireland	6	0%	-0,0	0	3,4
Italy	66	-1%	-4,5	392	2,3
Latvia	1	-1%	-0,2	13	1,6
Lithuania	1	-1%	-0,3	39	1,7
Luxembourg	3	-2%	0,0	2	5,9
Malta	0	-1%	-0,0	4	2,4
Netherlands	20	-1%	-2,7	65	2,5
Poland	26	0%	-1,3	279	2,0
Portugal	7	-1%	-0,7	117	2,2
Romania	10	0%	-0,7	250	1,5
Slovakia	4	0%	-0,6	109	2,2
Slovenia	2	0%	-0,2	48	2,1
Spain	44	-4%	-10,1	491	2,4

Sweden	15	-1%	-1,2	15	2,4
United Kingdom	84	0%	-2,5	547	2,5
EU total	535	-1%	-68,1	4.112	

Table 50. Impact PO1.2 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	73	-4%	-2,6	171	16,4
Belgium	101	-6%	-6,3	453	16,4
Bulgaria	19	-9%	-3,4	1.002	7,8
Croatia	15	-1%	-1,0	549	10,7
Cyprus	5	-4%	-0,2	32	12,2
Czech Republic	57	-4%	-3,2	1.303	11,9
Denmark	45	-3%	-2,0	171	14,9
Estonia	5	-1%	-0,4	81	9,7
Finland	40	-3%	-1,7	203	13,6
France	463	-2%	-19,8	2.894	13,7
Germany	536	-3%	-36,0	1.994	14,3
Greece	43	-4%	-2,5	379	11,3
Hungary	42	-2%	-1,9	1.153	10,3
Ireland	37	-1%	-1,0	2	20,3
Italy	388	-4%	-15,4	1.933	13,3
Latvia	6	-2%	-0,2	87	9,9
Lithuania	9	-1%	-0,4	253	10,0
Luxembourg	15	-6%	-0,4	11	34,7
Malta	2	-6%	-0,2	27	13,7
Netherlands	114	-3%	-6,8	363	14,5
Poland	151	-1%	-7,4	1.896	11,7
Portugal	42	-5%	-2,5	672	12,5
Romania	60	-1%	-1,1	1.923	9,1
Slovakia	23	-2%	-1,1	686	12,7
Slovenia	11	-1%	-0,3	284	12,4
Spain	257	-6%	-14,2	2.543	14,1
Sweden	89	-3%	-3,9	92	14,4
United Kingdom	488	-1%	-16,6	3.198	14,5
EU total	3.137	-3%	-152,2	24.353	

Table 51. Impact PO1.3 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	-26	2%	1,1	-61	-5,8
Belgium	-34	2%	3,7	-159	-5,6
Bulgaria	-7	2%	0,3	-385	-2,9
Croatia	-5	2%	0,3	-204	-3,8
Cyprus	-2	2%	0,1	-10	-4,3
Czech Republic	-20	1%	1,1	-477	-4,3
Denmark	-15	1%	1,1	-54	-5,0
Estonia	-2	2%	0,1	-28	-3,4
Finland	-14	2%	0,5	-70	-4,8
France	-164	2%	9,9	-1.048	-4,8
Germany	-184	1%	7,4	-581	-4,9
Greece	-17	2%	0,2	-165	-4,4
Hungary	-15	2%	0,6	-488	-3,8
Ireland	-13	2%	1,3	-1	-7,1
Italy	-135	2%	6,1	-574	-4,6
Latvia	-2	0%	-0,0	-36	-3,7
Lithuania	-3	2%	-0,0	-98	-3,7
Luxembourg	-5	1%	0,4	-4	-11,7
Malta	-1	0%	0,0	-10	-4,7
Netherlands	-39	2%	2,3	-118	-4,9
Poland	-55	0%	0,2	-758	-4,3
Portugal	-15	2%	0,3	-230	-4,3
Romania	-22	1%	0,4	-828	-3,4
Slovakia	-8	2%	0,3	-259	-4,6
Slovenia	-4	2%	0,2	-102	-4,4
Spain	-90	2%	3,1	-798	-4,9
Sweden	-31	2%	4,7	-32	-5,0
United Kingdom	-167	1%	35,3	-1.100	-5,0
EU total	-1.095	1%	80,8	-8.679	

Table 52. Impact PO2.1 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	-0	0%	-0,1	-4	-0,1
Belgium	0	0%	1,5	-3	0,0
Bulgaria	-1	-2%	-0,9	-69	-0,4
Croatia	-1	0%	-0,6	-39	-0,6

Cyprus	-0	0%	0,0	0	-0,3
Czech Republic	-3	-1%	-0,7	-76	-0,5
Denmark	-3	-1%	0,1	-9	-1,0
Estonia	-0	0%	-0,2	-2	-0,2
Finland	-1	0%	-0,4	-4	-0,2
France	4	0%	-6,1	-45	0,1
Germany	-14	0%	-3,3	18	-0,4
Greece	1	0%	-0,5	-19	0,2
Hungary	-0	0%	-0,8	-73	-0,1
Ireland	-0	0%	0,0	-0	-0,2
Italy	-22	0%	-2,3	-39	-0,8
Latvia	-0	0%	-0,1	-5	-0,3
Lithuania	-0	0%	-0,2	-15	-0,3
Luxembourg	-0	0%	0,2	-0	-1,0
Malta	-0	0%	0,0	-2	-0,4
Netherlands	-0	0%	-0,9	2	-0,1
Poland	-1	0%	0,1	-96	-0,1
Portugal	-1	0%	-0,5	-22	-0,4
Romania	0	0%	-0,5	-117	0,1
Slovakia	-1	0%	-0,5	-45	-0,6
Slovenia	-0	0%	-0,2	-3	-0,0
Spain	-6	0%	-2,2	-4	-0,3
Sweden	0	0%	1,5	-0	0,1
United Kingdom	-0	0%	6,3	-4	-0,0
EU total	-52	0%	-11,4	-674	

Table 53. Impact PO2.2 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	-3	0%	-0,3	-7	-0,6
Belgium	0	0%	1,5	-5	0,0
Bulgaria	-1	-3%	-1,1	-79	-0,5
Croatia	-1	0%	-0,6	-44	-0,7
Cyprus	-0	0%	0,0	0	-0,4
Czech Republic	-4	-1%	-1,0	-98	-0,8
Denmark	-3	-1%	0,1	-9	-1,0
Estonia	-0	0%	-0,3	-3	-0,3
Finland	-1	0%	-0,4	-6	-0,5
France	-5	0%	-7,2	-55	-0,1
Germany	-17	0%	-3,8	11	-0,4
Greece	-2	-1%	-0,9	-27	-0,4

Hungary	-1	0%	-0,9	-87	-0,3
Ireland	-1	0%	-0,0	-0	-0,7
Italy	-26	0%	-2,6	-55	-0,9
Latvia	-0	0%	-0,1	-8	-0,7
Lithuania	-1	0%	-0,2	-22	-0,7
Luxembourg	-0	0%	0,2	-0	-1,1
Malta	-0	0%	0,0	-2	-0,4
Netherlands	-0	0%	-0,9	2	-0,0
Poland	-5	0%	-0,2	-117	-0,4
Portugal	-1	0%	-0,5	-22	-0,4
Romania	-2	0%	-0,6	-156	-0,3
Slovakia	-2	0%	-0,6	-57	-0,9
Slovenia	-0	0%	-0,2	-4	-0,1
Spain	-8	-1%	-2,8	-17	-0,4
Sweden	-1	0%	1,2	-1	-0,2
United Kingdom	0	0%	6,4	-16	0,0
EU total	-85	0%	-15,9	-883	

Table 54. Impact PO3 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	-18	0%	-0,2	-42	-4,0
Belgium	-31	0%	1,0	-142	-5,0
Bulgaria	-10	-1%	-0,4	-560	-4,2
Croatia	-6	0%	-0,6	-235	-4,4
Cyprus	-2	0%	0,0	-12	-5,1
Czech Republic	-17	0%	-0,3	-392	-3,5
Denmark	-9	0%	0,4	-32	-3,0
Estonia	-1	0%	-0,2	-23	-2,8
Finland	-8	0%	-0,4	-41	-2,8
France	-151	0%	-7,4	-970	-4,5
Germany	-177	0%	-2,9	-558	-4,7
Greece	-16	0%	-0,7	-163	-4,3
Hungary	-19	0%	-0,9	-604	-4,8
Ireland	-7	0%	-0,1	-0	-3,6
Italy	-162	0%	-1,9	-706	-5,6
Latvia	-2	0%	-0,1	-32	-3,3
Lithuania	-2	0%	-0,2	-77	-2,9
Luxembourg	-2	0%	0,2	-2	-4,9
Malta	-1	0%	0,0	-14	-6,6
Netherlands	-26	0%	-1,2	-77	-3,2

Poland	-59	0%	-0,2	-815	-4,6
Portugal	-18	0%	-0,6	-290	-5,4
Romania	-22	0%	-0,5	-798	-3,2
Slovakia	-8	0%	-0,5	-236	-4,2
Slovenia	-3	0%	-0,2	-84	-3,7
Spain	-93	0%	-1,8	-831	-5,1
Sweden	-16	0%	1,1	-16	-2,6
United Kingdom	-117	0%	5,1	-773	-3,5
EU total	-1.005	0%	-13,5	-8.525	

Table 55. Impact PO4.1 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	0,00	0,0%	-0,08	-0	0
Belgium	0,01	0,0%	1,48	-3	0
Bulgaria	0,00	0,0%	-0,23	-14	0
Croatia	0,00	0,0%	-0,55	-7	0
Cyprus	0,00	0,0%	0,04	1	0
Czech Republic	0,00	0,0%	-0,13	-8	0
Denmark	0,00	0,0%	0,50	3	0
Estonia	0,00	0,0%	-0,24	0	0
Finland	0,00	0,0%	-0,32	1	0
France	0,04	0,0%	-6,65	-19	0
Germany	0,03	0,0%	-0,98	76	0
Greece	0,00	0,0%	-0,61	-13	0
Hungary	0,00	0,0%	-0,80	-45	0
Ireland	0,00	0,0%	0,01	-0	0
Italy	0,02	0,0%	-0,99	73	0
Latvia	0,00	0,0%	-0,04	-2	0
Lithuania	0,00	0,0%	-0,22	-4	0
Luxembourg	0,00	0,0%	0,25	0	0
Malta	0,00	0,0%	0,02	-1	0
Netherlands	0,01	0,0%	-0,89	3	0
Poland	0,01	0,0%	0,16	-50	0
Portugal	0,01	0,0%	-0,44	-0	0
Romania	0,00	0,0%	-0,52	-80	0
Slovakia	0,00	0,0%	-0,47	-9	0
Slovenia	0,00	0,0%	-0,20	-0	0
Spain	0,02	0,0%	-1,09	67	0
Sweden	0,00	0,0%	1,44	0	0
United Kingdom	0,05	0,0%	6,39	-5	0

EU total	0,23	0,0%	-5,14	-35	

Table 56. Impact PO4.2 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	15	-2%	-1,2	36	3,5
Belgium	18	-2%	-0,9	77	2,9
Bulgaria	2	-2%	-0,9	88	0,8
Croatia	2	-1%	-0,8	75	1,6
Cyprus	1	-3%	-0,1	5	1,7
Czech Republic	12	-2%	-1,5	277	2,6
Denmark	12	-1%	-0,6	48	4,0
Estonia	1	0%	-0,3	19	2,2
Finland	11	-2%	-1,0	55	3,6
France	75	-1%	-12,7	451	2,2
Germany	76	-1%	-16,1	348	2,0
Greece	6	-2%	-1,4	39	1,5
Hungary	4	-1%	-1,4	55	0,9
Ireland	10	-1%	-1,1	1	5,4
Italy	33	-2%	-8,5	232	1,1
Latvia	1	-1%	-0,1	14	1,7
Lithuania	2	-1%	-0,3	49	2,1
Luxembourg	4	-2%	-0,0	3	9,1
Malta	0	-2%	-0,1	1	0,8
Netherlands	30	-1%	-3,7	99	3,8
Poland	21	-1%	-5,3	217	1,6
Portugal	5	-2%	-1,3	72	1,3
Romania	8	0%	-0,8	189	1,2
Slovakia	4	-1%	-0,8	121	2,4
Slovenia	2	0%	-0,3	57	2,5
Spain	38	-2%	-5,3	432	2,1
Sweden	24	-1%	-1,0	25	3,9
United Kingdom	124	-1%	-12,0	806	3,7
EU total	540	-1%	-79,7	3.889	

Table 57. Impact PO4.3 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	12	-2%	-1,5	28	2,8
Belgium	11	-2%	-1,2	46	1,7

Bulgaria	0	-3%	-1,3	-4	0,1
Croatia	1	-1%	-0,9	33	0,8
Cyprus	0	-3%	-0,1	3	0,7
Czech Republic	11	-2%	-2,0	243	2,3
Denmark	12	-2%	-0,8	48	4,0
Estonia	1	-1%	-0,4	17	2,0
Finland	11	-2%	-1,1	56	3,7
France	40	-1%	-13,7	234	1,2
Germany	22	-2%	-18,0	154	0,6
Greece	2	-2%	-1,6	8	0,6
Hungary	-2	-1%	-1,5	-89	-0,4
Ireland	10	-1%	-1,2	1	5,3
Italy	-20	-2%	-9,2	-23	-0,7
Latvia	1	-1%	-0,2	9	1,2
Lithuania	1	-1%	-0,3	39	1,7
Luxembourg	4	-3%	-0,0	3	8,3
Malta	-0	-3%	-0,1	-4	-1,4
Netherlands	31	-2%	-4,0	99	3,9
Poland	8	-1%	-6,0	52	0,6
Portugal	-0	-2%	-1,4	-3	-0,1
Romania	3	-1%	-1,4	8	0,4
Slovakia	3	-1%	-1,0	86	1,7
Slovenia	2	-1%	-0,3	46	2,0
Spain	16	-2%	-6,3	222	0,9
Sweden	24	-2%	-2,7	25	3,9
United Kingdom	121	-1%	-12,7	791	3,6
EU total	325	-1%	-91,0	2.128	

Table 58. Impact PO5.1 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	148	-1%	-0,8	349	33,5
Belgium	-	0%	1,5	-3	-
Bulgaria	11	0%	-0,3	587	4,6
Croatia	105	-1%	-1,2	3.982	76,5
Cyprus	-	0%	0,0	1	-
Czech Republic	183	-1%	-0,9	4.184	38,0
Denmark	59	0%	0,3	221	19,3
Estonia	42	-1%	-0,4	684	81,9
Finland	136	-1%	-0,7	694	46,4
France	210	0%	-7,2	1.303	6,2

Germany	157	0%	-1,8	638	4,2
Greece	132	-1%	-1,0	1.181	34,6
Hungary	-	0%	-0,8	-46	-
Ireland	199	-1%	-0,4	11	108,0
Italy	184	0%	-1,5	953	6,3
Latvia	66	-3%	-0,4	990	109,3
Lithuania	92	-3%	-0,5	2.719	106,3
Luxembourg	0	0%	0,3	0	1,0
Malta	-	0%	0,0	-1	-
Netherlands	-	0%	-0,9	3	-
Poland	867	-1%	-7,8	11.115	67,2
Portugal	71	0%	-0,6	1.128	20,9
Romania	1.342	-5%	-3,7	44.534	201,6
Slovakia	134	-1%	-0,7	4.039	74,2
Slovenia	60	-1%	-0,4	1.602	69,9
Spain	-	0%	-1,1	67	-
Sweden	440	-2%	-1,9	450	70,7
United Kingdom	-	0%	6,4	-5	-
EU total	4.639	0%	-26,6	81.381	

Table 59. Impact PO5.2 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	10	0%	-0,3	23	2,2
Belgium	-	0%	1,5	-3	-
Bulgaria	1	0%	-0,2	42	0,4
Croatia	12	0%	-0,7	438	8,5
Cyprus	-	0%	0,0	1	-
Czech Republic	17	0%	-0,2	371	3,4
Denmark	4	0%	0,5	19	1,4
Estonia	5	0%	-0,2	77	9,2
Finland	12	0%	-0,3	63	4,1
France	14	0%	-6,6	67	0,4
Germany	8	0%	-1,0	106	0,2
Greece	11	0%	-0,6	86	2,9
Hungary	-	0%	-0,8	-46	-
Ireland	17	0%	0,0	1	9,1
Italy	10	0%	-1,0	123	0,4
Latvia	8	-1%	-0,1	113	12,6
Lithuania	10	-1%	-0,3	299	11,8
Luxembourg	0	0%	0,3	0	0,0

Malta	-	0%	0,0	-1	-
Netherlands	-	0%	-0,9	3	-
Poland	87	0%	-1,9	1.067	6,7
Portugal	5	0%	-0,4	78	1,4
Romania	163	-2%	-1,8	5.353	24,6
Slovakia	13	0%	-0,4	397	7,4
Slovenia	5	0%	-0,3	145	6,4
Spain	-	0%	-1,1	67	-
Sweden	40	0%	1,3	41	6,4
United Kingdom	-	0%	6,4	-5	-
EU total	453	0%	-9,3	8.926	

Table 60. Impact PP1 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	4	-3%	-2,1	10	1,0
Belgium	1	-3%	-2,6	2	0,2
Bulgaria	-6	-8%	-2,9	-314	-2,3
Croatia	-2	-1%	-0,9	-96	-1,7
Cyprus	-1	-4%	-0,2	-3	-1,6
Czech Republic	-2	-3%	-3,0	-50	-0,4
Denmark	2	-3%	-1,5	10	0,7
Estonia	-0	-1%	-0,4	-0	-0,0
Finland	4	-2%	-1,4	19	1,2
France	-5	-1%	-17,2	-50	-0,1
Germany	-22	-3%	-28,4	-3	-0,6
Greece	-3	-4%	-2,2	-44	-0,9
Hungary	-7	-1%	-1,6	-258	-1,8
Ireland	5	-1%	-1,1	0	2,7
Italy	-64	-3%	-12,0	-234	-2,2
Latvia	-0	-1%	-0,2	-7	-0,6
Lithuania	-0	-1%	-0,3	-8	-0,2
Luxembourg	2	-4%	-0,2	2	5,4
Malta	-0	-4%	-0,1	-6	-2,7
Netherlands	10	-2%	-5,2	35	1,3
Poland	-15	-1%	-6,3	-248	-1,2
Portugal	-6	-3%	-1,7	-103	-1,9
Romania	-3	-1%	-0,9	-185	-0,5
Slovakia	-2	-1%	-0,9	-55	-0,8
Slovenia	0	0%	-0,3	2	0,1
Spain	-19	-5%	-12,1	-118	-1,1

Sweden	12	-2%	-2,9	13	2,0
United Kingdom	36	-1%	-16,6	230	1,1
EU total	-82	-2%	-125,2	-1.461	

Table 61. Impact PP2 compared to 2050 Baseline

MS	Annual operating cost in (*1 million)	People at Risk	Health cost in (*1 million)	Employment in fte	Change in cost per household
Austria	38	-4%	-2,1	118	11,3
Belgium	46	-6%	-2,6	283	10,2
Bulgaria	3	-10%	-2,9	312	2,5
Croatia	4	-1%	-0,9	248	4,9
Cyprus	1	-4%	-0,2	16	5,8
Czech Republic	26	-4%	-3,0	818	7,5
Denmark	25	-4%	-1,5	125	10,8
Estonia	2	-1%	-0,4	54	6,5
Finland	24	-3%	-1,4	157	10,5
France	195	-2%	-17,2	1.699	8,1
Germany	196	-3%	-28,4	1.107	7,7
Greece	16	-4%	-2,2	193	6,0
Hungary	9	-2%	-1,6	426	4,1
Ireland	23	-1%	-1,1	2	16,1
Italy	82	-4%	-12,0	786	5,1
Latvia	2	-2%	-0,2	50	5,7
Lithuania	4	-2%	-0,3	160	6,4
Luxembourg	10	-6%	-0,2	9	27,9
Malta	0	-6%	-0,1	9	4,6
Netherlands	69	-3%	-5,2	282	11,2
Poland	50	-1%	-6,3	924	5,9
Portugal	11	-5%	-1,7	285	5,3
Romania	22	-2%	-0,9	993	4,9
Slovakia	9	-2%	-0,9	389	7,3
Slovenia	5	-1%	-0,3	187	8,2
Spain	91	-6%	-12,1	1.366	7,4
Sweden	58	-4%	-2,9	75	11,8
United Kingdom	285	-1%	-16,6	2.417	11,0
EU total	1.844	-3%	-125,2	13.490	

Annex 5. Model validation/Sensitivity analysis

In order to test the robustness of the results on PPDWHR and direct costs, a sensitivity analysis was conducted for the 5 most uncertain parameters. Sensitivity of the PPDWHR indicator and of total direct costs (operating and annualized setting-up costs - but without bottled-water costs) were analyzed through their difference with baseline (that was also modified according to the hypothesis tested). Effects of the 5 parameters variations were tested separately, which means that the interaction effects have not been tested because of the complexity of such an analysis. In the following the sensitivity of results for parameter "water for all" on one side and for other parameters variations on the other side are analyzed separately. Hypothesis of variation tested are detailed in table 62.

Table 62. Assumptions for sensitivity analysis

	reference	hyp -	hyp +
Info (+effect on tap water consumption)	an additional 20% of the population supplied by large water suppliers in 2050 will also profit from an access to smart-information on water quality --> 4% less drinking bottled water except in 4.2 and 4.3: 95% of population connected to PWS will have access to smart-information on water quality --> 10% and 15% less drinking bottled water	an additional 5% of the population supplied by large water suppliers in 2050 will also profit from an access to smart- information on water quality --> no change in bottled water consumption except in 4.2 and 4.3: 75% of population connected to PWS will have access to smart-information on water quality --> 5 % less drinking bottled water	an additional 50% of the population supplied by large water suppliers in 2050 will also profit from an access to smart- information on water quality --> 8% less drinking bottled water except in 4.2 and 4.3: 100% of population connected to PWS will have access to smart-information on water quality --> 15% less drinking bottled water
prevention	water suppliers with no RBA will replace 5% of treatments by measures at source & WS with RBA 10%; and in 4.3: an additional 5% of treatments replaced by measures at source	water suppliers with no RBA will replace 0% of treatments by measures at source & WS with RBA 5%; and in 4.3: no additional treatments replaced by measures at source	water suppliers with no RBA will replace 15% of treatments by measures at source & WS with RBA 30%; and in 4.3: an additional 10% of treatments replaced by measures at source
reduction of contamination associated with RBA (with no change in monitoring and treatment efforts)	unchanged for list A substances; reduced by half for new list B substances; unchanged for supplementary list C substances	unchanged for currently-listed substances; unchanged for high priority substances of emerging concern; unchanged for others substances of emerging concern	unchanged for currently-listed substances; reduced by 2/3 for high priority substances of emerging concern; reduced by 1/3 for others substances of emerging concern
water for all	100% in PO5.1 connected to PWS	95% (minimum) in PO5.1 connected to PWS	/

application of RBA on a voluntary basis in baseline	…2015	…2050		…2050		/
		large	small	large	small	
	0%	50%	25%	25%	0%	
	<50%	75%	50%	50%	25%	
	<100%	90%	75%	75%	50%	
	100%	100%	100%	100%	100%	

Concerning connection rate to PWS in policy option 5.1, we firstly made the assumption that 100% of the population in all MS would be connected to water networks. Here we tested the hypothesis of a minimum of 95% of connection rate to PWS networks (or more if already more in 2015 in some MS). It results, that ranking of policy options regarding costs would not be modified under this assumption as costs of PWS development are still really high and superior to all other costs increase in other policy options. But PPDWHR would be impacted and reduced as compared to the 100% assumption, and this would result in an inversion of PO 2.2 and PO 5.1 - that would become approximately similar in terms of PPDWHR - regarding to their rank in terms of PPDWHR reduction as compared to baseline.

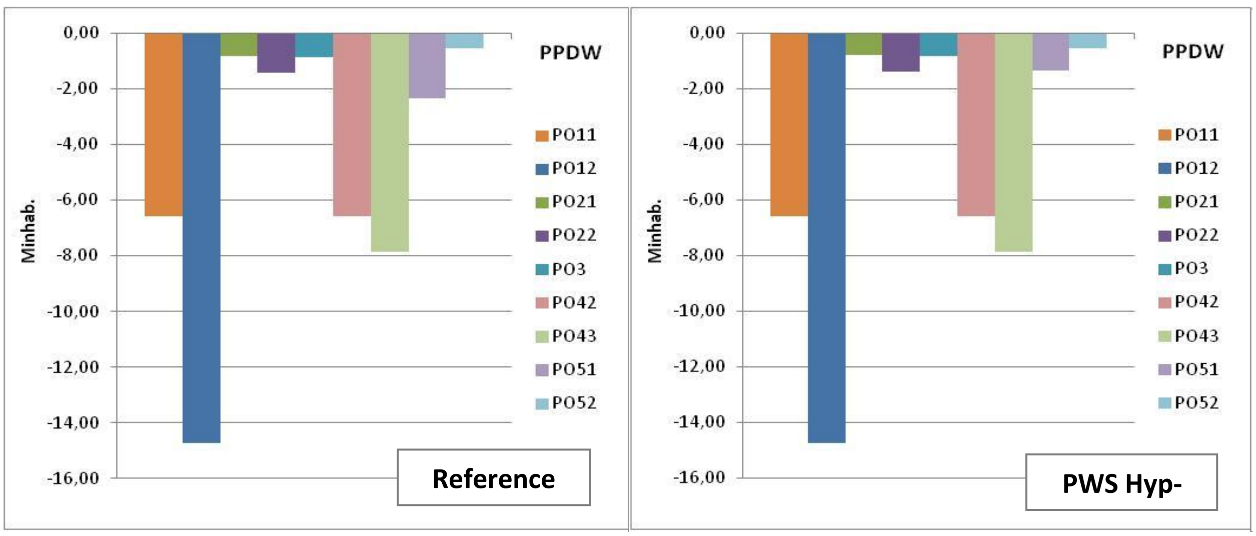

Figure 43. Comparison of the PPDWHR indicator results across policy options (in difference with baseline 2050) for PWS connection hypothesis

Concerning PPDWHR sensitivity, it results that only the parameters “reduction of contamination associated with RBA” and “voluntary RBA adoption” have an effect on results in terms of ranking of the different policy options regarding their efficiency to reduce population at potential health risk (PPDWHR). Figure 1 show on graphs the PPDWHR reduction associated with each PO for each scenario.

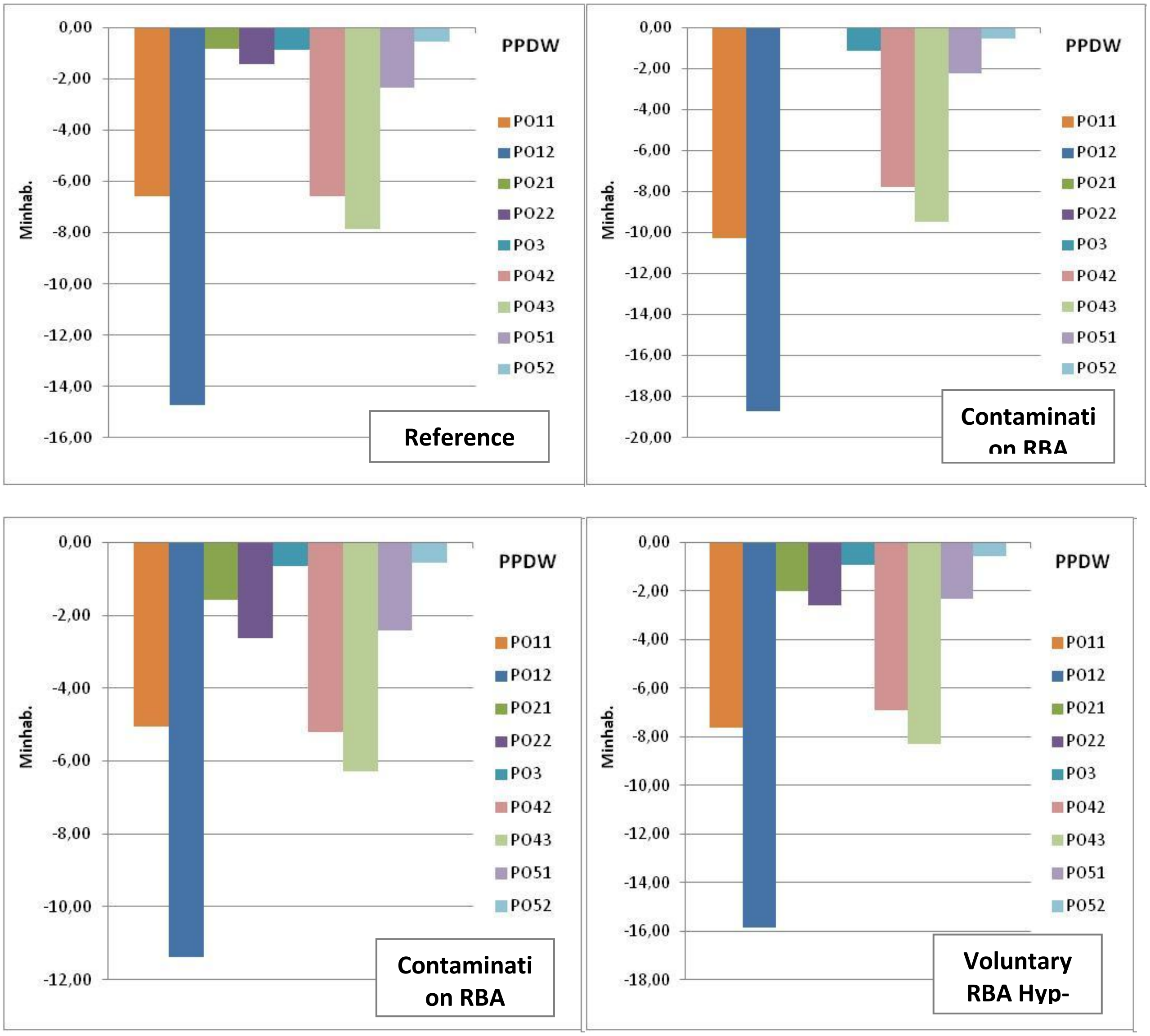

Figure 44. Comparison of the PPDWHR indicator results across policy options (in difference with baseline 2050) for different hypothesis tested

Even though absolute values change a bit, we only regard the ranking of POs. Policy options 2.1 and 2.2 are the most sensitive to variations in assumptions made on RBA: PPDWHR reduction could be improved if less water suppliers adopt voluntary RBA in baseline and other options as compared to POs 2.1 and 2.2 which seems logical; and PPWHR reduction could be lowered or increased if de-contamination associated with RBA is assumed higher or lower. This would results in slight changes in the ranking of POs but the most efficient ones stay unchanged - ie 1.2, 4.3, 4.2 and 1.1.

Concerning direct costs sensitivity, it results that only the parameter "implementation of measures addressing pollution at source" has an effect on results in terms of ranking of the different policy options regarding to their associated cost increase. Figure 2 show on graphs the costs variation associated with each PO for each scenario.

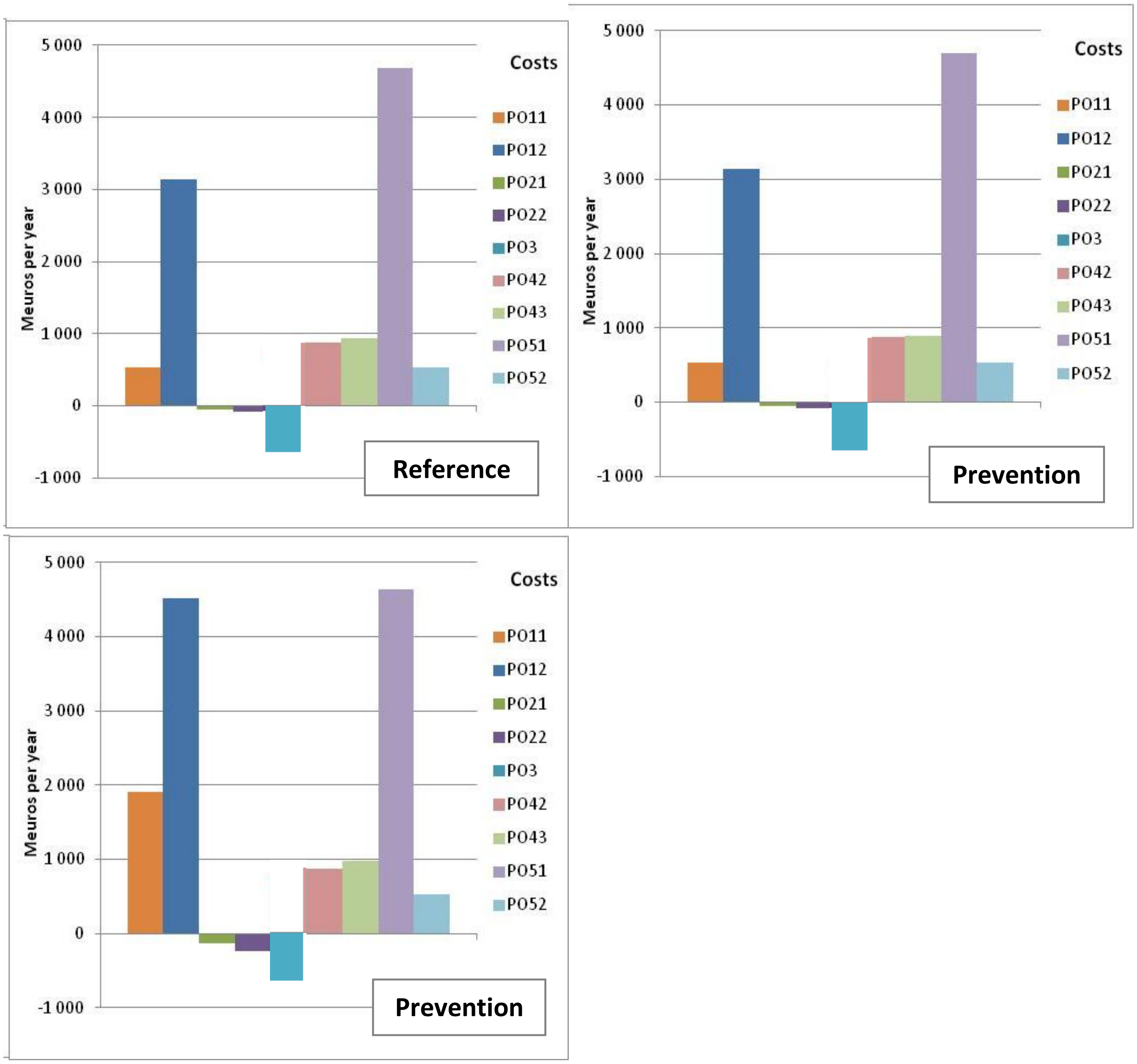

Figure 45. Comparison of the direct costs results across policy options (in difference with baseline 2050) for different hypothesis tested

The adoption of more or less measures that address pollution at source to replace curative treatments on water for drinking impacts, the costs associated with drinking water - and thus the difference of costs between baseline and each policy option. Policy options 1.1 and 1.2 are the most sensitive to variations on this assumption as they are mostly concerned by treatment costs increased that would occur whatever the importance of measures at source adopted. Even though in hyp+ direct costs increase (in difference with baseline) for PO 1.2 would become similar to cost increase for PO 5.1, ranking would not be changed or just slightly.