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STUDY ON WATER PERFORMANCE OF BUILDINGS

Final Report
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Contents

Executive Summary 5
Abbreviations 11
1. Introduction 13
   1.1. Report structure 13
   1.2. Key definitions 14
       1.2.1. Building 14
       1.2.2. Water use in buildings and system boundary 14
       1.2.3. Building categorisation 15
       1.2.4. Water performance of buildings 16
   1.3. Background 17
       1.3.1. Public water supply in Europe 17
   1.4. Water use in buildings 21
       1.4.1. Residential buildings 21
       1.4.2. Commercial and public buildings 23
       1.4.3. Industrial buildings 30
       1.4.4. Agricultural buildings 31
   1.5. Water saving opportunities in buildings 32
       1.5.1. Improving water use efficiency of water products used in buildings 32
       1.5.2. Commercial and public buildings 40
       1.5.3. Rainwater harvesting 46
       1.5.4. Grey water reuse 47
   1.6. Synthesis of literature and data review 47
       1.6.1. Estimation of water consumption within buildings 48
       1.6.2. Scope definition 49
       1.6.3. Metrics 50
       1.6.4. Water saving potential 50
       1.6.5. Identification of key issues for policy makers 53
2. WPB policy tools and initiatives 57
   2.1. Existing policy measures 57
       2.1.1. Classification of water performance policy measures 59
       2.1.2. Assessment approach, focus and limitations 60
       2.1.3. Characterisation of policy measures and indicator selection 64
3. Analysis of existing WPB initiatives 70
   3.1. Existing WPB measures 71
       3.1.1. Voluntary measures 71
       3.1.2. Eco-labels 82
       3.1.3. Mandatory instruments 83
       3.1.4. Standards 90
       3.1.5. Other instruments 90
3.2. Analysis of methodologies

3.2.1. Measurement of the water performance of buildings 92
3.2.2. Metrics 99
3.2.3. Types of buildings 101
3.2.4. Regional and national approaches 102
3.2.5. Assessment costs 103
3.2.6. Summary 103

3.3. Comparative analysis

3.3.1. Information vs. regulation instruments 107
3.3.2. Voluntary vs. mandatory instruments 107
3.3.3. Single issue vs. multiple issue 107
3.3.4. Single instruments vs. policy-mixes 108

3.4. Synthesis of analysis of existing instruments 110

4. Need for an EU-wide WPB approach

4.1. EU action on the water scarcity issue

4.1.1. General interest for EU action 114
4.1.2. Specific interest of EU action as regards water scarcity 116
4.1.3. Are MS actions enough to tackle the problem? 117
4.1.4. Summary 120

4.2. Analysis of possible approaches

4.2.1. Analysis of options 121

4.3. Is there space and sufficient interest for a WPB approach?

4.3.1. Specific interests of building performance schemes 129
4.3.2. Specific difficulties for building performance schemes 130
4.3.3. Is there a need for methodological work to establish water performance? 131
4.3.4. Questionnaire replies 133
4.3.5. Are the building and product approaches compatible? 133
4.4. Synthesis: pros and cons of possible EU options for a building approach 135

5. Conclusions and recommendations

5.1. Assessment of the need for EU WPB action 138
5.2. Further work 140

5.2.1. Define global water strategy, particularly for water using products and buildings 140
5.2.2. Implementation stages 142

6. References

7. Appendices

Appendix 1: Overview of basic policy measures and corresponding sub-categories 150
Appendix 2: Fact sheets of some schemes 151
Appendix 3: Tables summarizing existing schemes and their water requirements 157
Appendix 4: Estimation of potential water savings related to policy options 160
EXECUTIVE SUMMARY

➢ Background

Water scarcity and droughts affect many regions of Europe. Climate change and population growth are predicted to make existing water resource problems even worse in many regions. In recognition of the acuteness of the water scarcity and drought challenges in Europe, the European Commission (EC) adopted a Communication addressing the challenge of water scarcity and droughts in the European Union (EU). This Communication provides a fundamental and well-developed first set of policy options for future action, within the framework of EU water management principles, policies and objectives. The Commission is exploring the ways in which the EU can address water scarcity and droughts, and a number of recommendations regarding these issues have already been made in the Communication. Amongst various identified policy options, one proposal suggests analysing the potential of introducing requirements related to the water performance of buildings (WPB) at EU level. This option requires further assessment, in terms of feasibility and implementation approaches, and hence the purpose of this study is to provide such an assessment.

➢ Objectives and methodology

This study aims to analyse the need for introduction of water performance of buildings requirements at EU level and discuss the potential advantages and disadvantages of such an approach, based on existing evidence from EU Member States (MS) and beyond.

Stakeholder consultation was carried out, targeting MS and other relevant stakeholders, to collect information on existing regulations or other initiatives at the national and sub-national levels, within and outside Europe, that have introduced water efficiency requirements for buildings. This was achieved through a dedicated questionnaire and website. A number of telephone interviews were also conducted with a range of experts and other key stakeholders (e.g. research institutes). A desk study reviewing relevant publications and internet sources was also carried out.

➢ Water consumption within buildings

Literature review was undertaken to assess water consumption within buildings and to build an understanding of the variable uses of water amongst different building types. This proved to be a difficult task, due to the lack of detailed data than the “domestic” or “urban water” categories used in global water statistics. Therefore, the study reviewed and used more localised data, resulting from real measurement campaigns or expert calculations to illustrate the water use patterns in different types of buildings.

Two main uses dominate the water consumption in buildings: domestic uses (for sanitary and comfort needs) and productive function uses (such as cooling, washing of
products, as a solvent for chemical reactions). Such functions drive different consumption patterns for different building types; issues for residential buildings and offices are much closer in nature than buildings that have greater production-orientated use of water. From existing data, and without any presumption to accurately represent reality, an attempt to assess water consumption from the public supply system shows that the dominant consumption of water comes from residential dwellings, i.e. approximately two thirds of the total consumption, followed by offices and other diverse uses (including leakage and small productive uses drawn from the supply system). Buildings, unsurprisingly, account for the main consumption of water from supply systems, of which domestic uses account for approximately 70 to 80%. Therefore a building approach, with a focus on domestic uses, appears to be a promising route to achieve water savings.

Within the water saving potential in buildings, the potentials of buildings’ key fixtures are also analysed. Technical solutions for efficient water using products, such as toilets, showerheads, taps and washing machines, are available at affordable prices.

- **Existing policy instruments addressing the water performance of buildings**

Existing initiatives in MS and third countries are presented and were analysed. Very few existing instruments specifically address the water performance of buildings, and most of them are environmental information instruments, such as labels and certificates, where water is often a part of a global “green building” analysis. During the last few years, some governments have started to consider buildings as a means to tackle water scarcity, and have started to devise and implement mandatory instruments. The UK is currently the most advanced and ambitious example in the EU, as regards tackling water scarcity through improving the water performance of buildings. The UK example illustrates that it is possible to set up a building based approach, and it provides precious learning experience for possible actions in other MS.

Most of the identified schemes exist in countries affected by water shortage and drought problems (Italy, Spain, Portugal, Australia, and some parts of France and the UK).

All main types of buildings included in the present study are covered by some instrument or scheme, whether mandatory or voluntary. This is a positive finding, as it demonstrates that the water performance of all building types can be improved. On the other hand, as this study mainly focused on residential buildings, not many instruments on agricultural buildings and industrial buildings were identified.

- **Methodological issues**

Approaches to devise water reduction targets at the building level are not straightforward. Three possible approaches for policies on water performance of buildings policies have been identified. The first is a “pragmatic” approach, by setting requirements on the main water consuming fixtures used in buildings, and is similar to the instruments for water efficient products.
The second approach to address water performance of buildings is through water management plans, through which water efficiency actions could be derived. This approach, focusing on improvements, avoids the requirement for precise measurement of performance.

The third approach is a rating tool, such as the UK Code for Sustainable Homes, which prescribes quantitative requirements for buildings as a system, including those for efficient water consumption. In order to answer the question “How well is a building performing in terms of water consumption?” several steps are needed, as discussed below:

- **Define performance and relevant metric to measure it**: in general, abstraction from the water supply system is a parameter measured often, but some tools also cover sewage water outflow. The amount of water consumed is divided by the number of inhabitants per dwelling, by the square meter of floor space, per capita for offices, or per bed for hostels, so as to build a relevant metric to make this consumption comparable. Very few studies attempt to illustrate the impact of the chosen metrics, although it is an important element and should be statistically assessed.

- **Model water consumption within the building**: all rating tools take into account the main uses of water, such as toilets and washing. Outdoor uses are often considered as well. Water performance of the fixtures and devices is defined and multiplied by an assumed number of uses, to calculate overall water consumption in a building.

- **Differentiate between fixed and variable parameters**: some tools allow assessors to modify parameters used in the water consumption calculations, such as number of uses per day, and thus an assessor can influence the consumption pattern of different fixtures. This choice has to be made in light of the requirements set by the instrument: with a predefined consumption level to calculate in litres/day/capita for instance, keeping consumption patterns fixed is necessary to avoid the possibility of reducing the “number of uses” assumption, instead of improving the water efficiency of products (BREEAM (UK) case for instance). Having a system that works on a percentage water reduction enables construction of a model such as HQE (FR).

- **Find standard data for fixed parameters and a reference building**: reference data can come from published studies, from expertise within working groups, or from modelling calculations. All schemes use data from different sources. Data gaps can also be a problem when implementing these schemes, and often need updating. Harmonising such data under an EU approach would be challenging, especially considering the fact that use patterns have a high variability across Europe. Reference values are of particular importance, for schemes which monitor improvements and for the schemes which calibrate the possible levels of efficiency.
• **Set up performance categories to classify buildings**: with the parameters discussed above and technically feasible water saving potential, categories can be defined to classify buildings in different performance categories.

Methodologies used in different rating tools are rather similar, and it appears that consensus can be achieved on the method to measure a building’s water performance. However, it is still a difficult to define reference values. Specific investigation would be needed to support decisions on the different possible options, and especially to verify the possible impact and distortion caused by the metric used and the calculation methodology. Harmonisation of consumption pattern assumptions is also a real challenge.

- **General gaps and limitations of existing schemes and programmes**

As most of the WPB initiatives are rather recent, sufficient data or feedback on the impacts of existing requirements was rarely available. A rough estimate made for a few countries shows that, apart from UK, if no significant changes occur in undergoing policies and trend, the total amount of water saved via these requirements will remain around or below 1% of the total water abstracted from water supply systems, and buildings account for approximately 80% of this.

Indeed, the move toward more water efficient buildings or products is surprisingly slow when considering all the evidence pushing for the implementation of first stage savings (as technical solutions already exist and we have estimated that simple and effective improvement options have a payback period of around one year) and potential environmental benefits are evident.

Some barriers acting against such changes are: difficulties in implementation, data gaps, investor-users issue, etc.

Several other reasons appear more relevant in explaining this situation. Lack of concern among the public and building stakeholders is probably the main cause, water being a renewable public good. Water continues to be a cheap commodity in most areas of Europe, therefore payback periods will be rather lengthy even for investments of hundreds of Euros. Water is perceived as abundant in large areas of Europe and water scarcity and droughts are mainly seen as occasional events. Changes in climate are not easy to model, and the uncertainty of forecasts may hinder effective water scarcity planning and awareness-raising. Water quality aspects and agricultural abstraction seem to hold the centre stage in the field of water management.

- **Specific gaps and limitations of WPB programs**

Specific gaps related to the performance of the buildings approach have also been identified. Building rating schemes are more complex and expensive to implement, as they require each building to be assessed against a ranking criteria. This often means additional costs to comply with the specific criteria. Assessment costs for offices can range between 2 000 to 10 000 € for offices smaller than 4 000 m², and more than 20 000 € for buildings larger than 10 000 m². In such costs, it is difficult to distinguish the design cost and the part related to water, as these assessments take into account
overall environmental performance. Costs would probably be higher with a building approach, due to training and administrative requirements, than a key fixture approach.

Another specific difficulty identified is the possibility that consumers may easily change key water-using fixtures, such as taps or showerheads, if they are not satisfied with the performance of water-efficient models. Within the buildings approach context, this could be a particular risk if developers have sought to attain a high ranking through specification of ultra-efficient fixtures that do not meet consumer expectations. A fixtures approach could avoid this eventuality by specifying both maximum water consumption and user performance standards.

Need for an EU approach and future work

This analysis reveals that EU action could bring further benefits, and that there is potential to achieve more ambitious water savings within buildings. Several options are studied in the report; one focusing on water using products approach and three on buildings approaches (mandatory rating for sold or refurbished buildings; minimal performance standard at building level; and water management plan for larger and public buildings). This study focuses on assessing comparative advantages of selected options, rather than discussing all possible options in depth. Mandatory options were chosen because reaching significant water savings, which is the main driver for further EU action, will require mandatory policy measures.

The analysis of options shows that the best savings could be reached with the use of water efficient products (building fixture standards) and this could result in saving of 10 to 15% in ten years, through a 20% reduction of current maximum water consumption standards. The effectiveness of the fixtures approach is due to high renewal rates and saving potential of new fixtures. Achieving water savings through a buildings approach is unlikely to be as effective, as participation may not be as widespread and may grow comparatively slowly. Water savings would also be more costly through the implementation of a building approach, as methodological studies and building assessments would be required to establish and maintain the scheme. Public acceptance of building approaches is likely to be lower, with labelling or minimal standard requirements on buildings being potentially opposed to a greater degree by building owners, whereas product approaches will place a burden on water fixture manufacturers.

As it appears to be a more straightforward route to achieve higher savings from water supply systems within the short term, developing efficiency standards for water-using products is recommended as a priority action. Apart from the general benefits of an EU-wide action (to provide a level playing field and minimise cost), the quantitative and qualitative elements quoted above strongly support the call for EU-wide action. The ambition of water saving targets could be a major factor in making this decision. However, the impacts of such a decision on manufacturers and existing water efficiency initiatives should be investigated before taking any action.
A water performance of buildings approach also has some distinct benefits:

- Building approaches involve building managers more in the process, as this approach provides the managers with tools and consumption pattern data to allow management of water at their building level.
- The involvement of building managers could improve behavioural awareness, which is needed to ensure passive savings from fixtures changes are achieved, and has the potential to further increase savings.
- Using building-oriented changes would be needed if further savings are to be targeted further in the long-term. Such changes may be expensive and need to be anticipated from now on.
- Implementation costs of WPB approaches could be lowered by integrating them in existing regulation, such as the Directive for Energy Performance of Buildings. Adding water to the existing audit process would avoid creating a new system.

Furthermore, actions on buildings are complementary to WES approaches, even if stringent WES on fixtures are needed to achieve water efficiency in buildings. WPB approaches generally raise awareness in comparison to WES approach and therefore help to transform the market.

The EU could take one of several levels initiative toward higher water performance of buildings: the first one is setting a supportive framework for building initiatives (such as water metering, water pricing for improved efficiency, water using product requirements, harmonising work on the sanitary issues associated with rainwater and greywater reuse, etc.). A step forward could be the development of a non-mandatory rating tool at the EU level, such as the eco-label, or through European standards. Under these policy options, the WPB approach could be a secondary objective to achieve further savings.

If the targeted objectives on water savings are to be more ambitious, then building approaches could become increasingly necessary from the point of view of achieving higher savings. EU action could lead to the integration of WPB into the Directive on Energy Performance of Buildings, or having a comparable approach parallel to it, which would impose rating obligations for buildings at different stages (construction, purchase, renovation, etc.). A step further would, for instance, be for the EU to commission work on reviewing methodology to provide best practice guidelines. Lastly, the EU could set up a mandatory requirement, with a specific methodology or approach. This last position would need a large amount of preparatory work, to address methodological issues associated with such a wide scope and need for aggregation.
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AC</td>
<td>Air Conditioning</td>
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<tr>
<td>AECB</td>
<td>Association for Environment Conscious Building (UK)</td>
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<tr>
<td>BREEAM</td>
<td>Building Research Establishment Environmental Assessment Method</td>
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<tr>
<td>CAP</td>
<td>Common Agricultural Policy of the EU</td>
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<tr>
<td>CEN</td>
<td>European Committee for Standardisation</td>
</tr>
<tr>
<td>CIRIA</td>
<td>Construction Industry Research and Information Association (UK)</td>
</tr>
<tr>
<td>CODEMA</td>
<td>City of Dublin Energy Management Agency</td>
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<tr>
<td>CSH</td>
<td>Code for Sustainable Homes (UK)</td>
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<tr>
<td>CTE</td>
<td>Código Técnico de Edificación (ES)</td>
</tr>
<tr>
<td>ECAs</td>
<td>Enhanced Capital Allowances (UK)</td>
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<tr>
<td>EuPs</td>
<td>Energy-using Products</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization (UN)</td>
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<tr>
<td>GBCA</td>
<td>Green Building Council Australia</td>
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<tr>
<td>GSBC</td>
<td>German Sustainable Building Certification</td>
</tr>
<tr>
<td>H&amp;E</td>
<td>Habitat &amp; Environnement (FR)</td>
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<tr>
<td>HQE</td>
<td>Haute Qualité Environnementale (FR)</td>
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<tr>
<td>IHIE</td>
<td>International Hotels Environmental Initiative</td>
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<tr>
<td>IPPC</td>
<td>Integrated Pollution Prevention and Control</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design (USA)</td>
</tr>
<tr>
<td>MPS</td>
<td>Minimum Performance Standard (UK)</td>
</tr>
<tr>
<td>MTP</td>
<td>Market Transformation Programme</td>
</tr>
<tr>
<td>NABERS</td>
<td>National Australian Built Environmental Rating System</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Service (UK)</td>
</tr>
<tr>
<td>OECD</td>
<td>Office of Community and Economic Development</td>
</tr>
<tr>
<td>SAGE</td>
<td>Schéma d’Aménagement et de Gestion des Eaux (FR)</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nation Environment Program</td>
</tr>
<tr>
<td>WC</td>
<td>Water Closet</td>
</tr>
<tr>
<td>WES</td>
<td>Water Efficiency Standard (for water-using products)</td>
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WMP  Water Management Plan
WPB  Water Performance of Buildings
WuPs  Water-using Products
1. INTRODUCTION

1.1. REPORT STRUCTURE

This document is the final report of the study on “Water performance of buildings” commissioned by DG Environment of the European Commission (Service Contract 070307/2008/520703/ETU/D2). The main objective of this study is to analyse existing water performance requirements for buildings in Europe and other countries, and assess the need and feasibility for adoption of an EU wide approach. It is based on literature review and stakeholder consultation through questionnaires and personalised interviews.

Chapter 1 provides a general background to this study, in particular definitions related to the water performance of buildings (WPB) and definition of system boundaries. It also summarises the water scarcity problem in Europe, water abstraction and use trends, and existing policy actions at EU level addressing the efficiency of water use in different economic sectors. Relevant information is given on the current water use in different categories of buildings and water using fixtures used in these buildings. This provides a clear view of water consumption drivers and patterns, in order to identify potential avenues for water savings.

Chapter 2 details the existing WPB initiatives and requirements, covering both voluntary and mandatory instruments, incentive schemes and standards. Current methodologies and metrics used to assess buildings’ water performance are discussed and analysed.

Chapter 3 describes key issues related to the development of an assessment framework for WPB, and highlights the benefits and limitations of existing requirements. A comparative analysis of the policy tools and WPB assessment methodologies is made to highlight pros and cons, and trade-offs.

Chapter 4 considers whether an EU wide WPB approach is needed, and analyses potential options for implementation and their potential success. Lastly, it assesses the need for further work on WPB methodology.

Chapter 5 presents the conclusions of the study, identifies future work to investigate some of the issues associated with WPB and makes recommendations for an EU WPB initiative and its implementation.
1.2. KEY DEFINITIONS

1.2.1. BUILDING

In its most basic form, a building can be described as a roofed construction having walls. A ‘building’ may refer to the structure as a whole, or parts thereof that have been designed or altered to be used separately. 

Building can be divided into two major categories according to their end-use:

- Dwelling: offering a warm, convenient and clean area to live in. Residential dwellings also include features such as private gardens, particularly, which are considered in this study as within the scope of this residential function.

- Housing of production activity: providing an area to enable efficient and secure production (protected from weather and noise, for example). Industrial plants and agricultural buildings such as stables enter the scope of this definition. As production generally needs human presence, domestic functions can also be present in these buildings dedicated to production.

1.2.2. WATER USE IN BUILDINGS AND SYSTEM BOUNDARY

Following are the common ways in which water can be consumed in a building, and will be addressed in this study:

- **Within the building**: water used through sanitary, bathroom, kitchen fixtures and equipment, etc.

- **Outdoors water use when taken from a building water supply**: garden irrigation, swimming pool, etc.

- **Leakages within the building’s plumbing system**

- **Water needed for cooling and/or heating of the building**

The water supply network external to the building is considered beyond the system boundary of this study. Thus, issues leakages in the water supply networks will not be covered.

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1 Based on the definition used in the Directive 2002/91/EC of the European parliament of 16 December 2002 on the energy performance of buildings
1.2.3. **BUILDING CATEGORISATION**

Water needs for each category of building respond to different drivers and uses. Human needs include sanitary, drinking, and leisure uses and these rely on a limited number of relatively similar devices. The functions of the second category, productive uses, respond predominantly to technical and economic forces and process inputs. Water using devices used for process functions are more diversified and complex.

The proposed categorisation (see Figure 1) derives from this functional approach and from the water use needs of the buildings:

- **Residential Buildings**: It covers detached residential households, that frequently have high consumption patterns due to outdoors water use, and multi-residential households, for example high-rise flats.

- **Buildings with production functions** can be sub-categorised into:
  - Those where water use relies mainly on human needs
    - Commercial: offices, shops, hotel, restaurants, leisure centres, etc.
    - Public: administration offices, cultural buildings, hospital, clinics, educational buildings, etc.
  - Those where production processes are the main use of water
    - Industrial: most industrial plants enter under this category, where water consumed within the building depends mainly on process needs. Sanitary features and drinking water are provided to workers, but account only for a minimal part of the total water consumption.
    - Agricultural: stables and greenhouses.

![Figure 1 - Buildings Categorisation](image-url)
1.2.4. WATER PERFORMANCE OF BUILDINGS

The word ‘performance’ can have several connotations (from sportsman’s performance to performance management). All of them describe the capabilities of a machine, product or human being to fulfil a function. These capabilities are given by measurement of a characteristic of the system. For example, ‘performance management’ can be described as the measurement of system characteristics in order to evaluate and move toward defined objectives. These two main features of ‘performance’ are important to bear in mind when talking about the performance of a system: the measurement of a characteristic of a system, on the basis of a chosen metric, and its comparison to a given target for the system.

For the objective of reducing water use in buildings, the most direct and obvious performance parameter would be the total water consumption in a building. But we need to keep in mind that buildings vary widely in functions and in size. For example, if a residential building consumes 100 m$^3$ of water per annum, it does not mean that it is performing better than another building that consumes 150 m$^3$ of water per annum, as the number of people living in each of them may be different.

Thus, water performance of a building has to be defined by a more precise metric, and the total water consumption needs to be correlated with another parameter that is influencing water use. For example, litres per capita per day (l/c/d), provides a good indication of the water performance of a building. But it may not be appropriate for all building types, as their functions may be very different. This was the reason a categorisation of buildings was made in the preceding section, as it will justify the choice of relevant metrics in relation to the type of building under assessment (litres per bed per day is, for example, more suitable when measuring the water performance of a hospital).

Finding an effective metric that encompasses total consumption, which would assess water performance parameters related solely to a building’s physical characteristics, is not straightforward. One consideration is to go beyond the mere notion of ‘performance’ (a measured level), to measure ‘performance improvement’: measures that allow a reduction in the water consumption parameter, individual behaviour being constant. In other words, this would mean improving the building’s water use efficiency.

One of the major difficulties with this definition is that variability exists between the consumption of individuals within the measured building and between consumption characteristics for building types within and across Member States. With the same equipment (e.g. shower head), some people will need more water for their comfort than others depending upon the cultural and historical background, climatic conditions, social status, etc. This means that water consumption in buildings depends not only on physical characteristics of the building, but also strongly on individual behaviour of its inhabitants. A good level of performance may be the result of special care taken by inhabitants to reduce water consumption, or it could also mean that the inhabitants are only fulfilling very basic needs of water.
To summarise, when analysing the water performance of buildings, it is important to consider:

- The relevance of the metric used in relation to the building type
- Individual behaviour encompassed by this chosen metric

The individual behaviour is a key route to reducing water consumption and this aspect will be kept in mind throughout this study and particularly during the drafting of recommendations. However, it can be tackled mostly via awareness raising initiatives and therefore will not be the core of this study. The main focus of this study will be mainly on water reduction mechanisms in buildings based on their physical characteristics.

1.3. BACKGROUND

1.3.1. PUBLIC WATER SUPPLY IN EUROPE

Among the different water sources for buildings, the public water supply system is by far the most developed and commonly used within EU, as it ensures good quality water and convenient delivery.

Figure 2 – Water abstraction for public water supply (million m$^3$/year) in EU (Robert et al., 2009)

![Figure 2](image)

Figure 2 shows a decline in water abstraction for public water supply between the early 1990s and the period 2001-2005 in the eastern countries of Europe (Bulgaria, Czech
Republic, Hungary, Poland, Romania, Slovak Republic, and Slovenia). This trend is attributed to the introduction of metering and higher water prices in the 1990s. Water abstraction for public water supply in Western Europe has also decreased for the same reasons. However, in Southern European countries an increasing demand for tourism has led to a significant growth in water abstraction.

Data from EUROSTAT on “water use in urban areas” are relevant to consider here as a proxy for water supply system consumption: in different MS, the per capita public water supply volume ranges between 50 to 150 m³ per capita per annum. These values should be looked upon with caution, as the technical performance of the different supply systems vary widely among different EU Member States, with different leakage rates, hence distorting the reliability of the metric in indicating true consumption. However, it is usually considered that 60 to 80% of the public water supply system is used by residential households, with personal hygiene and toilet flushing accounting for about 60% of this proportion.
FAO Aquastat database defines domestic water use as the total water withdrawn by the public supply network and it can include consumption by industrial sites connected to the network. Figure 3 demonstrates the significant variation across MS in the proportion of water abstracted by the public supply network.

Figure 3 – Sectoral water abstraction in some MS

Eurostat defines urban water as water abstracted for use in urban areas, which includes domestic uses (households), small industries, municipal services, and public gardening. Figure 4 presents trends in urban per capita water use in certain regions of Europe.

- **National water use vs. water use in buildings**

Previous paragraphs indicate a possible confusion when using the terms ‘urban’ and ‘domestic’ water use. In fact, most of the data presented above relate to the public water supply systems.

A ‘top-down’ approach for measuring water use in buildings might use the global per capita water use indicators. However, global data on public water supply generally includes water uses which are beyond the system boundary defined for this study, for instance leakages in the public network. Hence, the use of national data on water use for estimating water consumption in buildings can be misleading. For this reason, this study mainly uses the data from local case studies from different Member States, based on metering of water use within buildings.
1.4. WATER USE IN BUILDINGS

As explained in the preceding section, a top-down approach does not give an insight into realistic water consumption levels or patterns in buildings. This section therefore derives information gathered from local case studies in different MS. Extrapolating such data to MS or EU levels, or transferring it to evaluate other specific cases, will indeed introduce uncertainty to the analysis. However, this approach has been adopted and the results are thoroughly cross-checked. Stakeholder consultation also provided the opportunity to gather a maximum of information from MS. It has to be noted that the purpose of these data is not to establish real water consumption in buildings in EU, but to form a basis on which the requirements of WPB assessment and improvement can be evaluated.

1.4.1. RESIDENTIAL BUILDINGS

Table 1 provides per capita household demand in some regions of Western, Southern and Eastern European MS.

Table 1 - Household water demand in some regions of Western, Southern and Eastern EU

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>Average household water consumption (l/c/d)</th>
<th>Consumption range (l/c/d)</th>
<th>Data source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprus</td>
<td>all areas</td>
<td>174</td>
<td>107 – 466</td>
<td>Pashardes et al., 2001</td>
<td>-</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Sofia</td>
<td>133</td>
<td>105 – 378</td>
<td>Sofyska Voda, 2005</td>
<td>individual boiler supplied hot water</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Sofia</td>
<td>186</td>
<td>106 – 378</td>
<td>Sofyska Voda, 2005</td>
<td>centrally supplied hot water</td>
</tr>
<tr>
<td>Poland</td>
<td>Bytom</td>
<td>123</td>
<td>-</td>
<td>Kloss-Trebczkwicz et al., 2001</td>
<td>decreased from 195 l/c/d in 1990</td>
</tr>
<tr>
<td>Poland</td>
<td>Sosnowiec</td>
<td>178</td>
<td>-</td>
<td>Kloss-Trebczkwicz et al., 2001</td>
<td>decreased from 365 l/c/d in 1992</td>
</tr>
<tr>
<td>Portugal</td>
<td>Guadiana</td>
<td>210</td>
<td>-</td>
<td>Water Strategy Manual, 2003</td>
<td>-</td>
</tr>
<tr>
<td>Portugal</td>
<td>Algarve</td>
<td>184</td>
<td>-</td>
<td>Water Strategy Manual, 2003</td>
<td>-</td>
</tr>
<tr>
<td>England</td>
<td>Portsmouth</td>
<td>153</td>
<td>74 – 252</td>
<td>Portsmouth Water, 2005</td>
<td>peak 3 month period 177-317 l/c/d</td>
</tr>
<tr>
<td>Italy</td>
<td>Sardinia</td>
<td>175</td>
<td>-</td>
<td>EURISLES, 2002</td>
<td>peak 3 month period 235-315 l/c/d</td>
</tr>
</tbody>
</table>

Although outdoor water use might be expected to be higher in Southern Europe due to the warmer climate, the data in Table 1 does not provide such evidence. The data from Cyprus and peak 3 months demand in England and Italy, however, show that higher...
outdoor water use increases significantly only during the summer months, which is not revealed in the average annual consumption volumes.

- **Water use patterns**

Figure 5 shows the breakdown of the water consumption within households in some Member States. This data suggests that following facilities and appliances account for the majority of water use in residential buildings: personal washing (showers and baths), toilet flushing, clothes washing machines, dishwashers, drinking and outdoor use.

![Figure 5 - Household water use in some Member States](image)

Based on data from the following sources:
- France: CI eau website (Centre d’information sur l’eau) [http://www.cieau.com/toutpubl/sommaire/index_flash.htm](http://www.cieau.com/toutpubl/sommaire/index_flash.htm)
- Germany: Fraunhofer, ISI (2007), Determinants of Residential Water Demand in Germany
- Italy: University of Padova, Italy [http://tulanepadova.pbwiki.com/Water+Resources+in+Italy](http://tulanepadova.pbwiki.com/Water+Resources+in+Italy)
- Finland: Institute of Environmental Engineering and Biotechnology (IEEB), Tampere University of Technology (TUT), (2002), Household water consumption and demand management in Finland
Main drivers of water use

A number of studies indicate that the key determining factor affecting indoor water demand in residential buildings is the number of occupants. Portsmouth Water in Southern England has run a comprehensive household water demand monitoring database since 1991. Among other things, it showed that single person households use 70% more water per person than those in four person households (Portsmouth Water, 2005).

Also, higher household income is linked to greater water consumption and ownership of more water consuming appliances (e.g. showers, toilets, water heaters, dishwashers, washing machines, sprinklers, swimming pools) (OECD, 2002). However, a counter argument can be that households with higher incomes can afford water-efficient appliances which could result in reduced water consumption.

Climate is another major factor affecting water consumption in households. Warmer weather fosters higher water consumption because of more showers, drinking water, and cooling. Outdoor water use also increases during sunny and hot weather.

There are other drivers which can affect water use in households (age, habits, etc.) but no concrete results were found correlating these factors with water consumption in households.

1.4.2. COMMERCIAL AND PUBLIC BUILDINGS

The variability in characteristics of commercial and public buildings and respective water use represents a challenge to make useful comparison between different building types. Some studies in the USA, Australia, and Europe have aimed at standardising commercial and public buildings. A study in the East Bay Municipal Utility District (East Bay Municipal Utility District, 2007) identified 20 types of common businesses that have 70 different water efficient equipment and processes in 14 water end-use categories. In Australia, the Department of Natural Resources, Mines’ Water efficiency guide for commercial and public buildings identified 15 types of buildings, whilst in the UK, the BREEAM standard, developed from a survey of international commercial and public buildings, has so far develop assessor manual for 8 different types of building. Table 2 below provides a list of building types included for the three building standards.
Table 2 - Classification of commercial and public buildings for schemes in the USA, Australia and Europe

<table>
<thead>
<tr>
<th>East Bay Municipal Utility District Study, USA</th>
<th>Water efficiency grid, Department of Natural Resources, Mines, Australia</th>
<th>BREEAM standard, UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices, Schools, Restaurants and fast food, Retail, Hotel/Motel, Grocery, Hospitals, Laboratories, Coin laundries, Industrial laundries, Dry cleaning, Vehicle washes, Beverage manufacturers, Bakery shops, Industrial bakery, Auto repair, Service stations, Printing, Metal finishing, Paper manufacturing</td>
<td>Shops supermarket, Sit down restaurant, Fast food Drive-in shopping, Motel, Hotel, Education/Kindergarten, Education/primary, Education/secondary, Education/university, Commercial office, Hotel (pub) tavern, Welfare institution, Hospital/convalescence, Swim centre</td>
<td>Courts, Education, Industrial, Healthcare, Offices, Retail, Prisons, Multi-residential buildings</td>
</tr>
</tbody>
</table>

1.4.2.1 Offices

The commercial office building sector uses a significant amount of water and office water use can account for 10% of a city's water consumption (data from SAGE Gironde statistical review). A moderate size building of 10,000 m² typically consumes over 20,000 litres per day, i.e. more than 7 million litres per year – enough to supply 40 average sized houses – and experience has shown that water savings of 30-40% are often achievable (Department of the Environment and Heritage, AU, 2006).

In terms of water volumes, the Watermark study of offices in the UK identifies a water consumption benchmark of 9.3 m³ per person per annum and a best practice target of 6.4 m³ per person per annum (Defra, 2006). Translated at an occupant density of 1 per 18 m² these figures become 0.52 kl/m² and 0.36 kl/m² respectively. Where water is used in air conditioning systems, consumption can be evaluated by consideration of "cooling degree days" (as explained in Department of the Environment and Heritage, AU, 2006).

Another approach to benchmark water use in an office is provided in a guidance document produced by CIRIA (CIRIA, 2005). This approach advises on improving water efficiency and uses two scales of water use per employee, and water use per square metre in offices, as shown in Figure 6 below.
Figure 6 - Water efficiency guide for offices using two scales of water use per employee, and water use per square metre (CIRIA, 2005)
1.4.2.2 Hotels

For hotels, the information shown in Figure 7 and Figure 8 has been adapted by CIRIA, the UK construction industry research and information association, from the International Hotels Environmental Initiative (IHIE – now known as International Tourism Partnership) to cover hotels in general, although this organisation generally covers larger hotel chains.

Figure 7 - Benchmarking for hotels without swimming pools (CIRIA, 2005)
Table 3 presents the results of a study on water consumption in 8 hotels in Sofia, Bulgaria (Sofiyska Voda, 2005) and provides a comparison with the international hotel benchmarking system developed by CIRIA shown in Figure 7 above.

### Table 3 - Results of a survey of water use in 8 hotels in Sofia, Bulgaria

<table>
<thead>
<tr>
<th>№</th>
<th>Address</th>
<th>Average water consumption measured by data loggers</th>
<th>Average water consumption measured by water meters</th>
<th>Water losses $Q_{AVE}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pliska Hotel</td>
<td>269 l/bed/d</td>
<td>368 l/bed/d</td>
<td>33.17 %</td>
</tr>
<tr>
<td>2</td>
<td>Kempinski</td>
<td>342 l/bed/d</td>
<td>324 l/bed/d</td>
<td>35.47 %</td>
</tr>
<tr>
<td>3</td>
<td>Down Town Hotel</td>
<td>142 l/bed/d</td>
<td>156 l/bed/d</td>
<td>0 %</td>
</tr>
<tr>
<td>4</td>
<td>Rila Hotel</td>
<td>343 l/bed/d</td>
<td>255 l/bed/d</td>
<td>31.55 %</td>
</tr>
<tr>
<td>5.6</td>
<td>Rodina Hotel.</td>
<td>177 l/bed/d</td>
<td>208 l/bed/d</td>
<td>0 %</td>
</tr>
<tr>
<td>7</td>
<td>Hemus Hotel</td>
<td>259 l/bed/d</td>
<td>264 l/bed/d</td>
<td>49.20 %</td>
</tr>
<tr>
<td>8</td>
<td>Ambasador Hotel</td>
<td>385 l/bed/d</td>
<td>393 l/bed/d</td>
<td>68.07 %</td>
</tr>
</tbody>
</table>
Data shown in Table 3 above illustrates that water consumption in the 8 hotels ranges from 156 to 393 l/bed/d. However, the survey reveals that up to 68.07% of water consumption in these hotels and 62.08% in the case of hospitals was due to leakage losses, mostly attributed to faulty sanitary fittings.

### 1.4.2.3 Hospitals

The water use data for hospitals shown in Erreur ! Source du renvoi introuvable. below are from the Audit Commission in the UK who conducted a survey in 1993 to investigate the potential for water savings in the National Health Service (NHS). Through surveys of about 300 hospitals, a set of performance criteria was developed.

#### Table 4 - Water use in hospitals (NHS, 1993)

<table>
<thead>
<tr>
<th>Water use efficiency</th>
<th>Acute hospitals with more than 100 beds (m³/m²/annum)</th>
<th>Long stay hospitals with more than 25000 patient days per annum (m³/m²/annum)</th>
<th>Long stay hospitals with less than 25 000 patient days per annum (m³/m²/annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>&lt; 10.75</td>
<td>&lt; 6.69</td>
<td>&lt; 4.40</td>
</tr>
<tr>
<td>Average</td>
<td>10.75 - 14.40</td>
<td>6.69 - 8.92</td>
<td>4.40 - 6.02</td>
</tr>
<tr>
<td>Poor</td>
<td>14.40 - 23.08</td>
<td>8.92 - 13.92</td>
<td>6.02 - 7.89</td>
</tr>
<tr>
<td>Very poor</td>
<td>&gt; 23.06</td>
<td>&gt; 13.97</td>
<td>&gt; 7.69</td>
</tr>
</tbody>
</table>

A study of water consumption in three hospitals in Sofia, Bulgaria (Sofiyska Voda, 2005), in Erreur ! Source du renvoi introuvable. provides “m³/m²/annum” data that can be used to roughly compare performance with the UK’s NHS data presented in Erreur ! Source du renvoi introuvable., although direct comparison is not possible without more detailed information on bed/patient day numbers. The water losses due to faulty plumbing fittings and sanitary furniture, shown in the right-hand column, were determined by the repeated minimum 5-minute night consumption by taking into account the pressure drop during the day. Water loss expressed in percentage of the average daily consumption, recorded by the data loggers, is also given in the table below.

#### Table 5 - Study of water consumption and losses in three hospitals in Sofia, Bulgaria

<table>
<thead>
<tr>
<th>№</th>
<th>Address</th>
<th>Average water consumption measured by data loggers</th>
<th>Average water consumption measured by water meters</th>
<th>Water losses Q_{AVE}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>m³/day</td>
<td>m³/m²/annum</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>Medical Centre of Oncology</td>
<td>64.99</td>
<td>4.36</td>
<td>5.19</td>
</tr>
</tbody>
</table>

*4 Assuming a patient density of 1 per 18 m²
5 Assuming a patient density of 1 per 18 m²
### 1.4.2.4 Other commercial buildings

Another example of water use in commercial buildings is a survey undertaken by WS Atkins at a major UK leisure park. The data from this survey is shown below.

- **Total water delivered** – 138 000 m³/annum
- **Lake + water rides area** – 37 000 m²
- **Number of visitors** – 2 million per annum
- **Number of Staff** – 350 (average)
- **Specific water consumption** – 69 l/visitor/day

Water was used primarily for topping up of lakes and water rides and flushing of lavatories and there was no systematic use of water for irrigation. The water use in the leisure park was 3.73 m³/m²/annum.

### 1.4.2.5 Public buildings

For public buildings, the water consumption is generally higher than the commercial ones – the public building sector includes a large number of buildings that provide good opportunities for water savings (30-40% achievable) (Department of the Environment and Heritage, AU, 2006). As with office buildings, there appears to be a shortage of international precedents for water consumption benchmarking for such buildings. This Australian study further indicates that the benchmark for public buildings should be set at 3.34 kl/m² per annum with a best practice guideline of 2 kl/m² per annum. The UK Watermark programme also provides benchmarks that might be used when assessing water consumption in other types of public building:

- Museum and art galleries benchmark 0.332 kl/m², best practice 0.181 kl/m².

---

<table>
<thead>
<tr>
<th>№</th>
<th>Address</th>
<th>Average water consumption measured by data loggers</th>
<th>Average water consumption measured by water meters</th>
<th>Water losses $Q_{AVE}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$m^3$/day</td>
<td>$m^3/m^2$/annum</td>
<td>$m^3/m^2$/annum</td>
</tr>
<tr>
<td>2</td>
<td>Medical Centre of Oncology</td>
<td>104.39</td>
<td>7.01</td>
<td>9.54</td>
</tr>
<tr>
<td>3</td>
<td>Medical Centre of Oncology</td>
<td>33.72</td>
<td>2.26</td>
<td>1.63</td>
</tr>
</tbody>
</table>

The water losses estimated on the basis of data logger records were 7.8%, 58.51% and 62.01% of the average daily water consumption. The relative water consumption range, i.e. 215-672 l/bed/d, indicates that water consumption in all three hospitals was much higher than the average rate of 115 l/bed/d due to the water used in the kitchen serving all patients, polyclinics, and X-ray department (which operates 24 hours a day).
1.4.3. **INDUSTRIAL BUILDINGS**

Assessing and comparing water consumption in different industrial buildings is a challenging task. Firstly, the sources of water abstraction for such pseudo-building system varies, i.e. water is taken from both the public water supply and directly from the local natural water resources. Secondly, there are varied water uses both within the system, to supply water to various devices within the building, and across the systems – there exist a large variety of industrial processes, hence their water consumption is heterogeneous in comparison to standard fittings and appliances used in residential, commercial and public buildings. Thirdly, if productivity of industrial buildings is used as a parameter to compare water performance, this would not take into account other parameters, such as price of water and production process water consumption that can have an impact on productivity, hence rendering any productivity-based water performance metric inaccurate.

The Water Efficiency Standards (WES) study (*BIO Intelligence Service, 2009*) gives some examples of industrial WuPs, ranging from boilers to high pressure hydro lasers. These industrial uses are regulated and, increasingly, metered. Water consumption levels are high (see figure 3) and variable across industries and MS, and also between plants of the same industry. Fixture technology and price are likely to be higher priorities than water efficiency. Thus, their water performance is not ascribed to the building itself, but more to the WuP characteristics and to the productive water needs of the processes used in the industrial building.

A secondary waster use in industrial buildings is to meet everyday human needs of the workers. Offices in industrial sites, housing managerial, technical, and administrative staff, consume water for sanitary, cleaning, and drinking purposes. However, very little data was found to evaluate this type of water consumption in the case of industrial buildings, so a rough estimate is provided in the following table.

**Table 6 – Estimation of water consumption for domestic needs in industrial buildings**

<table>
<thead>
<tr>
<th>INDUSTRIAL BUILDINGS</th>
<th>Number of positions&lt;sup&gt;6&lt;/sup&gt;</th>
<th>Average estimated on-site water consumption</th>
<th>Total amount of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million positions</td>
<td>m³ / annum</td>
<td>Million m³ / annum</td>
<td></td>
</tr>
<tr>
<td>Industrial workers</td>
<td>38.5</td>
<td>9</td>
<td>347</td>
</tr>
</tbody>
</table>

1.4.4. Agricultural Buildings

Assessing water consumption in agricultural buildings also poses the challenges similar to the industrial ones. Agricultural buildings can be roughly categorised into two types based on their function: stables and greenhouses.

- **Stables**

Water demand in stables is driven by production needs (drinking water for livestock) and sanitary requirements (cleaning). Water is often taken from the water supply system, but is also sometimes abstracted from surface or groundwater sources.

EU water consumption for livestock has been calculated using a first proxy so that abstraction of water for livestock needs could be estimated from average animal consumption multiplied by average European herd size. The table below gives a rough estimate of daily and annual water consumption of major European herds calculated with this proxy.

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Flocks</th>
<th>Average daily consumption per animal</th>
<th>Average total daily consumption per animal</th>
<th>Cleaning water</th>
<th>Total annual water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>cattle, dairy cows</td>
<td>24.5</td>
<td>100</td>
<td>2.45</td>
<td>0.50</td>
<td>1 074.93</td>
</tr>
<tr>
<td>cattle, other</td>
<td>64.4</td>
<td>45</td>
<td>2.90</td>
<td>0</td>
<td>1 056.95</td>
</tr>
<tr>
<td>pigs</td>
<td>152</td>
<td>25</td>
<td>3.80</td>
<td>0</td>
<td>1 387.00</td>
</tr>
<tr>
<td>sheep</td>
<td>103</td>
<td>6</td>
<td>0.62</td>
<td>0</td>
<td>225.57</td>
</tr>
<tr>
<td>goats</td>
<td>11.7</td>
<td>6</td>
<td>0.07</td>
<td>0</td>
<td>25.62</td>
</tr>
<tr>
<td>poultry</td>
<td>1.45</td>
<td>0.19</td>
<td>0.00</td>
<td>0</td>
<td>0.10</td>
</tr>
<tr>
<td>TOTAL</td>
<td>357.0</td>
<td>9.8</td>
<td>0.5</td>
<td></td>
<td>3 770.2</td>
</tr>
</tbody>
</table>

The main drivers of water consumption in stables, linked to agro-technical choices and climate factors, are:

- Targeted production
- Feed (dry or wet feeds)
- Temperature

In stables, some of the drinking areas are equipped with floating systems, maintaining a constant level of water (for outside use, especially for sheep). For cattle and pigs, a drinking bowl is commonly used, which requires the animal pressure from his muzzle to get drinking water. These systems, apart from potential pipe leakages and some

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7 Data source: European Economic Statistics, EUROSTAT (2005) + BIO synthesis from different sources
evaporation, are highly efficient if well tuned and deliver the right amount of water to be consumed by the herd without significant wastage.

**Greenhouses**

Water consumption in greenhouses is mainly to fulfil irrigation needs and for cleaning of products or tools. These kinds of uses are driven exclusively by productive functions and linked to the level of production objectives and to the management of irrigation systems. No evidence was found on the impact of the design of greenhouses on water consumption. Water management practices or performance management systems play major role in water consumption in greenhouses.

1.5. **WATER SAVING OPPORTUNITIES IN BUILDINGS**

1.5.1. **IMPROVING WATER USE EFFICIENCY OF WATER PRODUCTS USED IN BUILDINGS**

The following section discusses the types of WuP used in different types of buildings and their improvement potential.

1.5.1.1 **Residential buildings**

Water consumption data of commonly used WuPs in households in some Member States were collected in the WES study (*BIO Intelligence Service, 2009*), and is summarised in Table 8 below.

<table>
<thead>
<tr>
<th>WuP</th>
<th>Average water consumption per use</th>
<th>Frequency of use per day</th>
<th>Average water consumption per day (l/household/day)</th>
<th>Range of water consumption per day (l/household/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCs</td>
<td>6.0 - 9.5 l/flush</td>
<td>7.0 - 11.6</td>
<td>101.8</td>
<td>84.8 - 118.8</td>
</tr>
<tr>
<td>Showers</td>
<td>25.7 - 60 l/shower</td>
<td>0.75 - 2.5</td>
<td>91.8</td>
<td>37.5 - 146</td>
</tr>
<tr>
<td>Taps</td>
<td>2.3 - 5.8 l/use</td>
<td>10.6 - 37.9</td>
<td>74.6</td>
<td>61.9 - 87.2</td>
</tr>
<tr>
<td>Clothes washers</td>
<td>39.0 - 117.0 l/use</td>
<td>0.6 - 0.8</td>
<td>65.6</td>
<td>48.6 - 82.6</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>21.3 - 47.0 l/use</td>
<td>0.5 - 0.7</td>
<td>24.3</td>
<td>15.1 - 33.4</td>
</tr>
<tr>
<td>Outdoor use†</td>
<td>0 - 48.5 l/use</td>
<td>0 - 0.89</td>
<td>21.8</td>
<td>0 - 43.5</td>
</tr>
</tbody>
</table>

The data presented in Table 8 above, indicate that average household water use in Europe is around 380 l/hh/d, with a range of 247 – 511 l/hh/d. Assuming an average occupancy rate of 2.5 persons per household, this equates to 153 litres per capita per day (l/c/d) with a range of 99 – 204 l/c/d.

An inventory of water using products (WuPs) used in residential buildings is presented below which provides a review of current market trends and options for improving

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*The range for outdoor water use is 3-10% (source: OFWAT (2002))"
water use efficiency. For more detailed technical explanations the reader is suggested to consult the WES report (BIO Intelligence Service, 2009).

**WCs**

Water closets (WCs) or toilets can consume from 14 litres per flush for the older style single flush models to an average of 5.5 litres for the now common ‘6/3’ dual flush toilet or even less for the recent 4.5/3 litres, dual-flush model. Table 9 below presents results from experiments with some of the water efficient WCs in the UK, and respective water consumptions.

<table>
<thead>
<tr>
<th>WC Type</th>
<th>Expected average volume/flush</th>
<th>Actual average volume/flush</th>
<th>Notes</th>
<th>Trial name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/2 litres dual-valve</td>
<td>2.4 litres</td>
<td>4.6 litres (3.1-6.1)</td>
<td>Sticking mechanism not identified during trial</td>
<td>Holmewood (Bradford)</td>
</tr>
<tr>
<td>6/3 dual-valve</td>
<td>3.6 litres</td>
<td>4.6 litres (3.7-5.4)</td>
<td>Sticking mechanism not identified during trial</td>
<td>Holmewood (Bradford)</td>
</tr>
<tr>
<td>4/2 litres dual valve</td>
<td>2.4 litres</td>
<td>3.83 litres</td>
<td>5 years trial, valve jammed twice</td>
<td>Portsmouth Water Co.</td>
</tr>
<tr>
<td>6/3 litres dual-valve</td>
<td>3.6 litres</td>
<td>6.1 litres</td>
<td>Women’s WCs only</td>
<td>Portsmouth Water Co.</td>
</tr>
<tr>
<td>6/3 litres dual-valve</td>
<td>3.6 litres</td>
<td>8.6 l male 6.5 l female</td>
<td>Problems identified during analysis of data logger</td>
<td>Millennium Dome Water Cycle Experiment</td>
</tr>
<tr>
<td>6/3 litres dual-valve</td>
<td>3.6 litres</td>
<td>5.4 l male 5.1 l female</td>
<td>Jamming mechanism fixed</td>
<td>Millennium Dome Water Cycle Experiment</td>
</tr>
<tr>
<td>6 litres single siphon flush initial</td>
<td>6 litres</td>
<td>6.2 l male 5.2 l female</td>
<td></td>
<td>Millennium Dome Water Cycle Experiment</td>
</tr>
<tr>
<td>6 litres single siphon flush after retrofit</td>
<td>6 litres</td>
<td>5.5 l male 5.5 l female</td>
<td>Water levels adjusted</td>
<td>Millennium Dome Water Cycle Experiment</td>
</tr>
</tbody>
</table>

Analysis of state-of-the-art technologies shows that, with good pan design, full flush volumes down to 4 litres do not present a problem in terms of ‘normal’ drains and sewers being able to dispose of the solid and liquid wastes (Lillywhithe et al., 1987). This can be achieved with a leak-free siphon-operated WC, which avoids the risks of wastage associated with valve-operated WCs. Recent studies in the UK (Water wise, 2008) have used WCs imported from Sweden and led to the development of the Ifö Cera ES4, a 4 litre siphon-flush suite, initially as a stopgap to meet the old UK Water Byelaws. It has been suggested that if the siphon goes out of order, then significant water wastage could occur from leaking toilets. Scandinavian WCs are available with 4 and 2 litre dual flush, and this should theoretically beat a 4-litre single flush WC. Technical solutions to problems such as button-operated siphons or leak-detecting...
valves are available, but seem unlikely to be used unless driven by regulations or water-use labelling schemes (Elemental Solutions, 1999).

There are three basic types of WC cisterns: Gravity tank, Flush-valve operated, and pressurised tank. Gravity tank WCs comprises a bowl or pan with a tank connected by a flush pipe. The tank is integrated with the pan on modern WCs; older styles can have the tank 2m above the pan. Gravity tank cisterns are relatively inexpensive and are most commonly found in residential and lower grade commercial and public buildings. They rely on the volume of water in the tank to flush waste and usually require water pressure of no more than 70-100 kPa to operate properly. Low pressure means longer tank refill periods, and this increase in cycle time can be an issue when utilisation is frequent as in the case of public toilet facilities (e.g. museums, libraries, etc.). Gravity tank cisterns have either valves or siphons to control the inlet of water into the WC. There is evidence that valve controlled cisterns are more prone to leakage than siphon operated models, and can lead to water wastage as high as 60–120 litres per WC per day. Sixty litres per day is a lot of water but only equals 2.5 litres per hour (or 0.04 litres/min), which is below the starting flow of domestic water meters. When this 0.04 litres/minute leak is simulated the resulting flow down the pan is not noticeable to common users (Elemental Solutions, 1999).

The WES report indicates that average flush volumes in households in EU range from 9.5 l/flush to 6 l/flush, composing on average 27% of total household demand, although for some MS WCs water consumption account for between 30-40%. Older style high-cistern gravity tank toilets can use up to 20 litres of water for every flush.

A classification scheme for functional characteristics of WCs, developed from WC design and efficiency perspective, is provided in Table 10.

<table>
<thead>
<tr>
<th>Function</th>
<th>Options</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flushing mechanism</td>
<td>Gravity tank</td>
<td>- Least expensive option</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Longer refill times so less suitable for some commercial buildings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Minimum required pressure 70–100 Kpa</td>
</tr>
<tr>
<td></td>
<td>Flush-valve</td>
<td>- No requirement for cistern filling so can be used more frequently, and suitable for commercial and public buildings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Risk of poor bowl-cleaning when retrofitting existing WCs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Actual flush volumes may exceed theoretical flush volumes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Minimum required pressure 175-275 Kpa</td>
</tr>
<tr>
<td></td>
<td>Pressurised</td>
<td>- May not be suitable as a retrofit option</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Longer refill times so less suitable for commercial/public buildings with frequent use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Good bowl-cleaning results even with very low flush volumes</td>
</tr>
</tbody>
</table>
Instead of a complete replacement of the WC, there are three ways in which toilet flush volumes in residential buildings can be reduced through retrofitting, depending on the age and suitability of the existing cistern:

1. Install a retrofit device to convert the existing cistern to dual flush;
2. Fit a new dual-flush cistern; or,
3. Fit cistern-displacement device.

In general, options 1 and 2 are more permanent and satisfactory than option 3. Replacement of older cisterns can lead to highest savings, but are expensive. Similarly, close-coupled WC’s and slim line models impose restrictions. For valve operated cisterns, a check should be made for leaks using either a dye or dry paper test.

Results of empirical studies of WC usage in four MS are presented in Table 11. These results are further compared with a representative study from the USA.

<table>
<thead>
<tr>
<th>Function</th>
<th>Options</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet control</td>
<td>Siphon</td>
<td>Widely considered to be the best inlet control option for eliminating WC leakage</td>
</tr>
<tr>
<td>Valve</td>
<td></td>
<td>Cause of actual flush volumes exceeding theoretical flush volumes due to ‘flow-through’ whilst flushing</td>
</tr>
<tr>
<td>Flush type</td>
<td>Single</td>
<td>Does not provide very low-flush option, i.e. 2 litres flush</td>
</tr>
<tr>
<td></td>
<td>Dual-flush</td>
<td>Higher maintenance option than single flush</td>
</tr>
<tr>
<td></td>
<td></td>
<td>User instruction required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tests indicate that actual flush volumes are regularly higher than theoretical</td>
</tr>
</tbody>
</table>

**Table 11 - Summary of water consumption and frequency of use for toilet flushing**

<table>
<thead>
<tr>
<th>Country</th>
<th>Average water consumption per flush (litres)</th>
<th>Frequency of toilet flushing (per day)</th>
<th>Average total water consumption per day (litres)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>9.4</td>
<td>11.62</td>
<td>109.2</td>
<td>WRc, 2005</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>9.5</td>
<td>12.5</td>
<td>118.8</td>
<td>Dimitrov, 2004</td>
</tr>
<tr>
<td>Portugal</td>
<td>9.1</td>
<td>9.3</td>
<td>84.8</td>
<td>Viera et al., 2007</td>
</tr>
<tr>
<td>Finland</td>
<td>6.0</td>
<td>-</td>
<td>-</td>
<td>Etelmaki, 1999</td>
</tr>
<tr>
<td>Range (Europe)</td>
<td>6.0 – 9.5</td>
<td>7 - 11.62</td>
<td>84.8 – 118.8</td>
<td>Mayer et al., 2000</td>
</tr>
<tr>
<td>USA</td>
<td>13.7</td>
<td>12.97</td>
<td>177.7</td>
<td></td>
</tr>
</tbody>
</table>

Based on a review of the current state of the art in WC technology, a summary of water use efficiency rating for WCs used in residential buildings is presented in Table 12.
Table 12 – Water use efficiency rating for WCs in residential buildings

<table>
<thead>
<tr>
<th>Proposed efficiency rating</th>
<th>Flush volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor (-)</td>
<td>&gt;6 litres</td>
</tr>
<tr>
<td>Good (*)</td>
<td>&gt;4.5 and &lt;6 litres dual-flush/siphon single flush</td>
</tr>
<tr>
<td>Excellent (**)</td>
<td>&gt;3.5 and &lt;4.5 litres combined dual-flush/siphon single flush</td>
</tr>
<tr>
<td>Outstanding (***</td>
<td>&lt;3.5 litres dual-flush</td>
</tr>
</tbody>
</table>

**Showers**

Water consumption of showers in residential buildings depends on the type of shower, flow rate, frequency of use, and average time per use. There are three means of supplying water to showers: gravity-fed, electric, and pumped. Customer satisfaction is a major concern for showers, as inefficient performance may lead to longer duration of showering, hence water savings may not be achieved, and even lead to its replacement.

It is possible to reduce the flow rate of gravity-fed showers by using a flow restricting device or by using a low flow showerhead – these restrict the flow by altering the spray pattern or by introducing air into the showerhead. An aerated showerhead seems to provide the best solution as it appears to deliver a higher flow (than what it actually delivers and provides the user with the experience of a power shower, but with significantly less water. However, aerated showerheads do not necessarily work on gravity fed systems and need a pressure of at least one bar to function correctly.

About 45% of households in the UK have an instantaneous electric shower ([Water wise](#), 2008) and because the volume of water that needs heating limits flow rates, the water efficiency of these devices cannot be improved. Most countries do not have electric showers or low pressure systems so shower water use is usually higher compared to the UK.

To help people limit their showering durations, a shower timer can be used. These are of two types, either a sand timer set for a fixed duration or a digital alarm that the user can pre-set. As for limiting the frequency of showering it is not considered appropriate (unless switching from baths to showers) as this may be seen to be dictating lifestyles ([Water wise](#), 2008).

Results of empirical studies in EU Member States compared with a representative study from the USA are presented in Table 13.

Table 13 – Summary of water consumption and frequency of use showerheads

<table>
<thead>
<tr>
<th>Country</th>
<th>Flow rate (litres/minute)</th>
<th>Average shower duration (minutes)</th>
<th>Average frequency of use (use/household/day)</th>
<th>Average water consumption per use (l/shower)</th>
<th>Average total water consumption per day (l/household)</th>
<th>Data source</th>
</tr>
</thead>
</table>

---

[Water wise](#), 2008
Excessive flows and/or leaks from taps in bathrooms and kitchens can be a significant source of water wastage. A single dripping tap can waste more than 24 000 litres per year (Department of the Environment and Heritage, AU, 2006). Unregulated flows can reach 15-20 litres/minute when 6 litres/minute or even less is enough for hand washing. Reducing wastage from hot water taps has the added benefit of saving energy, the cost savings of which can typically be double or triple the water cost savings.

Some very simple and inexpensive retrofit measures are available that save water as well as energy whilst improving user amenity and safety. Savings of 20-30% are common with paybacks of less than 2 years. A list of measures is summarised below:

- Fit new water efficient tap-ware. Typical taps discharge 15 to 20 litres per minute but new low-flow and aerating models may use as little as 2 litres per minute.

- Fit low flow aerators to basin spouts which may reduce the flow by one-third or less (6 litres/minute or less). This is an inexpensive option but devices are subject to clogging and tampering.

- Fit durable tap washers (usually with a rubber O-ring and mechanical protection against over tightening) as insurance against future unreported leaks and to reduce maintenance costs. This could be done in conjunction with almost all the above measures.

A review of existing initiatives suggests that there are very few faucet monitoring studies for households in EU Member States. The results in Table 15 are from empirical studies. Anecdotal evidence (Alitchkov et al., 1996), however, claims that consumption for faucets in some countries may be up to 50% higher than the figures quoted below.
Table 14 - Summary of faucet usage in EU Member States

<table>
<thead>
<tr>
<th>MS</th>
<th>Average water consumption per use (litres)</th>
<th>Frequency of use (use/household/day)</th>
<th>Average total water use (litres/household/day)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>2.3</td>
<td>37.9</td>
<td>87.2</td>
<td>WRc, 2006</td>
</tr>
<tr>
<td>Portugal</td>
<td>5.84</td>
<td>10.6</td>
<td>61.9</td>
<td>Viera et al., 2007</td>
</tr>
</tbody>
</table>

- **Washing machines**

Efficiency of washing machines is measured either by the water volume used per cycle (l/cycle), or the volume used per kg or dry load (l/kg of dry load). Washing machines have become much more water efficient over the past twenty years. AEG provided figures of average water usage of their machines, which twenty years ago used about 150 litres per cycle, whereas today these machines use about 50 litres per cycle, on average, with the most efficient machines using about 35 litres per cycle. The water consumption of front-loading washing machines has been reduced by 76 percent during last 30 years, from 30 l/kg in 1970 to 13.6 l/kg in 1990 to 7.2 l/kg in 1997 (Grant, 2002).

- **Dishwashers**

The penetration of dishwashers in European households varies, and is lower compared to washing machines. For example, 60 percent of households in Germany own a dishwasher, whereas only 28 percent of households in England own a dishwasher. Reasons often cited for low penetration in the UK include the lack of space in homes, perceptions of high purchase and running costs, and the view amongst householders that they do not have enough dishes to wash to justify the investment (Market Transformation Programme (1), 2008).

In general, the use of a dishwasher may be more water efficient than washing up by hand (Market Transformation Programme (2), 2008). In practice, however, the water and energy impacts of washing up are heavily dependent on the user behaviour. Typical per cycle water usage for dishwashers is shown in Table 15.

Table 15 - Typical per cycle water usage for dishwashers

<table>
<thead>
<tr>
<th>Dishwasher Model</th>
<th>Typical consumption (litres per load)</th>
<th>Range of consumption (litres per load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured before 2000</td>
<td>25</td>
<td>15-50</td>
</tr>
<tr>
<td>Manufactured post-2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal setting</td>
<td>14</td>
<td>7-19</td>
</tr>
<tr>
<td>Eco-setting</td>
<td>10</td>
<td>8-12</td>
</tr>
</tbody>
</table>
Garden irrigation

Very few studies were found estimating water consumptions in residential buildings for outdoor use. A recent study (WRc, 2005) showed average water consumption of 48.9 litres per use, with an average frequency of 0.89 times per day. Another study by UKWIR (UKWIR, 1998) measured consumption for car washing and lawn watering. The car washing methods analysed were hose-pipe and bucket and the ranges were 80-170 litres per use with a hose-pipe and 30-50 litres per use with a bucket. For lawn watering, the methods analysed were sprinkler, hose-pipe, and watering-can and the ranges were 450-1200 (with a frequency of 0.06 times per day), 65-200, and 15-30 litres per use respectively.

Flow rates for standard technology for reticulated and manual garden irrigation are summarised in Table 16.

<table>
<thead>
<tr>
<th>Product</th>
<th>Typical water consumption (litres per hour)</th>
<th>Range of water consumption (litres per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosepipe with trigger gun/nozzle</td>
<td>600</td>
<td>400-800</td>
</tr>
<tr>
<td>Hosepipe without trigger gun/nozzle</td>
<td>1000</td>
<td>600-1200</td>
</tr>
<tr>
<td>Sprinkler</td>
<td>1000</td>
<td>600-1200</td>
</tr>
</tbody>
</table>

For houses with gardens, water saving devices can be offered together with guidance advising customers on how to be water efficient in gardens. Examples of good devices to offer customers include water butts and trigger hose guns (if no hosepipe ban exists in the customers’ area).

---

9 A network of pipes
1.5.2. **COMMERCIAL AND PUBLIC BUILDINGS**

This section describes WuPs used in commercial and public buildings. Opportunities for improving water use efficiency are highlighted and, where available, examples are provided of volume per use or frequency of use for specific WuPs.

**WCs**

WCs in commercial buildings are generally used more frequently than those in residential buildings, meaning higher potential for water savings, and also different design requirements, e.g. faster cistern refilling times.

For commercial and public buildings, by replacing an 11 litres single flush with a 4 litres single flush or 4.5/3 litres dual flush unit could provide total water savings of about 170 litres/day (more than 60 m³ per year) assuming a relatively high utilisation rate of 50 flushes per day. Water savings and costs of implementation vary greatly depending on the level of use, specific water savings measures, type of pan, and other factors such as plumbing system and WC design. It is usually expensive for consumers to replace old WCs, except when part of a major building or floor upgrade, as the low cost of water does not allow consumers to rapidly recover the costs of WC replacement through reduced water consumption.

As mentioned earlier, there are three basic types of WCs: Gravity tank, Flush-valve operated, and pressurised tank. Gravity tank WCs are most widely used in residential buildings. Although gravity tank WCs are sometimes used in commercial buildings, flush-valve and pressurised tank operated models are being increasingly used, mainly because they do not require long periods to refill the cistern. A description of different type of WCs used in commercial and public buildings is provided below.

- **Flush valve operated** type of WC is considered to be heavy duty compared to the gravity tank type. It is found in quality office buildings, high use public areas, and hospitals. Instead of a storage tank, this toilet uses a ‘flush-o-meter’ valve directly connected to the water supply plumbing. This valve controls the quantity of water released over time by each flush. It is very important that there is a proper match between the valve and the bowl or pan. Unlike tank-type toilets, flush-o-meter valve toilets accommodate different water pressures at different points in a building. Flush-o-meter toilets usually require a minimum water pressure of 175-275 kPa to operate properly. They are very susceptible to clogging due to unclean water and rely on an adjustable valve for flush timing. Given that there is no tank to fill, there is no cycle time limit so they are ideal for heavy use public facilities.

- **Pressurised tank** has a relatively new design which uses water line pressure to achieve a higher flush velocity. Water is not stored inside a cistern, but in a vessel that compresses a pocket of air and releases pressurised water into the bowl and out the trap-way. They require a minimum water pressure of 175 kPa to operate properly and they may not be suitable for a retrofit installation.
depending on the existing plumbing system. They provide an excellent and consistent cleaning action, require low maintenance, and are very water efficient. However, like the gravity tank type, they have a finite cycle time which makes them unsuitable for very busy public facilities.

As mentioned earlier, flush volumes for WCs in commercial buildings can be as high as 11 litres. Because of a growing interest in sustainability, especially in new buildings, water efficient WCs are increasingly becoming popular. For example, to achieve BREEAM sustainable building standard credits for WCs in offices, all WCs must have an effective flush volume of 4.5 litres or less. A second credit can be awarded when either all WCs have an effective flush volume of 3 litres or less or all WCs comply with the requirements for the first credit and fitted with a delayed action inlet valve.

➢ Taps

Some very simple and inexpensive retrofit measures are available for existing taps in commercial buildings that can save water as well as energy whilst improving user amenity and safety. With such retrofits, water savings of 20-30% are common with a payback period of less than 2 years. A list of measures, required to attain BREEAM (BREEAM Offices, 2008) sustainability credits for taps in commercial buildings, are summarised in Box 1 below:

Box 1 - Measures for taps, required to attain BREEAM sustainability credits for commercial buildings,

1. All taps except kitchen taps, cleaners’ sinks and external taps should have a maximum flow rate of less than 6 litres/min for a water pressure of 0.3MPa and can be one of, or a combination of, the following types:
   a. Timed automatic shut-off taps e.g. push taps
   b. Electronic sensor taps
   c. Low flow screw-down/lever taps
   d. Spray taps

2. Kitchen sink taps should be click taps or two stage mixer taps which provide a break point at the mid range of the flow allowing a low flow rate for rinsing, and a higher flow rate beyond the break point for filling objects.

A wider range of options exist for reducing water use through taps in commercial buildings, as listed below (Sydney Water Corporation, 2007 and Amy Vickers, 2001).

• Fit new water efficient tap-ware typical taps with discharge of 15 to 20 litres/minute but new low-flow and aerating models may use as little as 2 litres/minute.
• Fit low flow aerators to basin spouts which may reduce the flow by less than one-third (6 litres/minute or less). This is an inexpensive option but devices are subject to clogging and tampering.

• Throttling back under-basin control valves (where fitted) to 6 litres/minute or less and removing handles to avoid tampering are cost effective measures. Over throttling can lead to jumper valve noise and/or tap seat wear problems. In situations of higher frequency use it may be preferable to fit in-tap flow regulators and long life jumper valves to achieve a more robust and tamper proof solution.

• Fit movement-sensor operated basin spouts that automatically turn on but only when the hands are placed under the spout. Whilst this is arguably the most hygienic and efficient solution to water control, these systems are somewhat expensive and introduce another level of maintenance complexity. They might be feasible only in very high usage areas and in buildings benefitting from high levels of maintenance.

• Fit lever or button operated timer taps that allow water to flow for 10-15 seconds after operation. Some of them have built-in, adjustable flow regulators. Whilst not as hygienic or efficient as movement-sensor controlled spouts, they are not complex and are less costly.

• For showers, fit low-flow heads or in-tap regulators to reduce flows from 15-25 litres/minute to less than 10 litres/minute. Care needs to be taken in choosing shower heads so as to achieve an acceptable spray pattern. The back pressure produced can exacerbate leaks from worn tap spindles (such leaks are often hidden as they occur behind the wall tiles). Taps should be refurbished at the same time as fitting the shower head or consider fitting in-tap flow regulators provided an acceptable spray pattern can be achieved with the existing shower head.

• Fit long-life tap washers (usually with a rubber O-ring and mechanical protection against over tightening) as insurance against future unreported leaks and to reduce maintenance costs. This could be done in conjunction with almost all the above measures.

If infrared technology is installed, care needs to be taken to ensure when installing and setting-up the equipment. In one study – the Millennium Dome WaterCycle experiment (Hills et al., 2002) – three types of tap were evaluated, infra-red activated (48 in total), push-top (96 in total) and conventional swivel top (96 in total). Surprisingly, over the year the conventional swivel top taps used significantly less water than the purported more efficient types with each user of the swivel top taps using, on average, just less than 1 litre of water compared to 1.8-1.9 litres with infra-red and push-top taps.
Urinals

Urinals can be either a multi-user trough or individual wall hung pods. Water volume per urinal use is commonly as high as 3-4 litres per flush and recently developed commercial building codes stipulate flush volumes of 1.5 litres per flush to achieve certification (BREEAM Offices, 2008). Urinal flushing mechanisms can be cyclic ‘fill and dump’ units, which as mentioned above are highly inefficient, manually operated cistern (concealed push button or exposed overhead chain-pull), lever operated flush-o-meter, or a movement sensor controlled solenoid valve. UK Water Supply (water fittings) Regulations stipulate that an automatically operated flushing cistern serving urinals should be filled with water at a rate not exceeding:

1. 10 litres per hour per urinal bowl for a cistern serving a single urinal; or,
2. 7.5 litres per hour per urinal bowl or position, or, as the case may be, for each 700 mm width of urinal slab for a cistern serving two or more urinals. Where manually or automatically operated pressure flushing valves are used for flushing urinals, the flushing valve should deliver a flush volume not exceeding 1.5 litres per bowl or position each time the device is operated.

Consumption also depends on usage levels, equipment type and settings, and can vary from 50-100 m$^3$ per year (30-70 flushes per day of 4 litres each). However, there are still some cyclic units installed that operate on a 24x7 basis and these can waste over 500 m$^3$ of water per year, and replacing these with more efficient models can result in water savings of up to 90%.

As Table 17 (below) shows, from an example of using different types of urinals in commercial buildings in Sofia, Bulgaria, a key design criteria that affects water consumption for urinals is the mechanism that controls the flush frequency (Dimitrov, 1998).

**Table 17 - Potential water savings from replacement of urinals in commercial buildings in Sofia (Bulgaria)**

<table>
<thead>
<tr>
<th>Kind of building</th>
<th>Occupancy</th>
<th>Urinals (no. of flushes per month)</th>
<th>Urinals (volume used per month)</th>
<th>Potential saving %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>12</td>
<td>5400</td>
<td>148.5</td>
<td>6534</td>
</tr>
<tr>
<td>Restaurant</td>
<td>250</td>
<td>8640</td>
<td>3000</td>
<td>15000</td>
</tr>
<tr>
<td>School</td>
<td>100</td>
<td>4320</td>
<td>650</td>
<td>3750</td>
</tr>
<tr>
<td>Public WC</td>
<td>1200</td>
<td>14400</td>
<td>9360</td>
<td>36000</td>
</tr>
</tbody>
</table>

A number of case studies where urinals have been replaced in commercial buildings in Europe, Australia and the USA are presented in the Box 2 below.
Box 2 - Water savings from urinal replacement programmes

**UK**

- The Arenson group, which is involved in office furniture manufacturing, implemented a number of simple water saving measures in the non-manufacturing processes (e.g. installing passive infrared detectors in the urinals to prevent unnecessary flushes, on-going maintenance to maintain spring-loaded taps, check water meters to ensure no water being wasted from leaks). As a result, water use in factory/office washroom environments was reduced by 45%, i.e. from 3 800 m$^3$/year to 2 100 m$^3$/year, equivalent to cost savings of £3 000/year.

- The Wilton Park Conference Centre employs 51 to 60 persons. It has installed new urinals set to save 511 m$^3$ of water each year. The urinals cost £1000 to install and the payback period was approximately two and a half years.

- The Environment Agency offices in North West England were found to consume more than 300 litres of water per hour when the office was unoccupied. When urinal controls were changed, this reduced to 10 litres per night.

- The Gwesty’r Llew Coch Hotel at Dinas Mawddwy in North Wales is a rural hotel with only six rooms and is not connected to sewerage mains. Despite this, the hotel used more than 15 000 litres of water per guest, per day. On investigation, more than one third of this was found to be consumed by a single uncontrolled urinal. Replacing this urinal immediately saved more than £100 per year.

**Australia**

- The city of Borondara decided to replace full flush toilets with dual flush toilets and 7 water flushing urinals with waterless urinals at four public facilities. Potential savings have been assessed at 789 m$^3$ per year with a cost of $38 315.

- The Newmarket State School expects to save more than 150 000 litres per year by installing 18 dual flush toilets, 2 waterless urinals, using rainwater collected in tanks to supplement toilet water supply and installing irrigation controllers for the garden with rainfall and soil moisture sensors. The cost of the total project is estimated at $45 454.

**USA**

- Replacing the flush valves on toilets and urinals, and installing low-consumption aerators on all lavatory faucets resulted in a savings of 11.3 million litres per year.
Air conditioning

The water used for air conditioning units (based on a 3.5 kW per unit capacity) is illustrated in Table 18 below.

Table 18 - Lifetime water use for 3.5 kW air-conditioning unit (reversible and cooling only) (EcoDesign Lot 10, 2007)

<table>
<thead>
<tr>
<th>Type</th>
<th>Lifetime water use for cooling (litres)</th>
<th>Expected lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moveable Room Air-Conditioners (RAC)</td>
<td>165 098</td>
<td>12</td>
</tr>
<tr>
<td>Split cooling only</td>
<td>170 230</td>
<td>12</td>
</tr>
<tr>
<td>Reversible split</td>
<td>353 016</td>
<td>12</td>
</tr>
</tbody>
</table>

Available information suggests that the environmental impact of larger units does not differ much from 3.5 kW units. However, no data were available to verify whether this means that water use is the same for higher powered units. According to manufacturers, there are important differences between fixed air conditioners depending on whether capacity is less than 6 kW or between 6-12 kW.

A US report on evaporative air-coolers (Alliance for water efficiency, 2009) states that “field studies have not yet verified the amount of energy saved per gallon of water consumed” and that “there is not enough experience with the systems to verify long-term water use”. The report also suggests that 30 gallons (or 114 litres) per day (GPD) of water use is likely, and that the technical information suggests peak day use would probably be approximately 50 to 60 GPD in a perfect installation. In some areas, the water use might be as high as 100 GPD on peak use days. In most climates, the peak use day for air conditioning would coincide with the peak water use days (July and August) when water suppliers are often operating at full capacity and often pleading for customers to curtail usage. This 50 to 100 GPD usage represents an increased demand of approximately 25% for a typical home. If the equipment is not properly installed and maintained, the water use can easily exceed 500 GPD.

The pie-chart in Figure 9 based on Australian data, shows the typical breakdown of evaporation, bleed/blow-down, drift and splash (these terms are explained below) in a well-designed tower. In Australia, AC units can account for 30-40% of total water consumption in buildings with cooling towers. This percentage can be higher if the system has leakage, water treatment, or overfilling problems. These losses are compensated by makeup water (usually from the potable water supply) which is added to the basin and regulated via a float valve. The percentages shown are of the circulating cooling water. For a 1050 kW tower this could be 25 l/minute. The bleed shown is for cycles of concentration ratio of 2. Improving this ratio from 2 to 12 will save 45% of water used (10-11 litres/minute).
Figure 9 - Water consumption for a well-maintained cooling tower (Sydney water, 2008)

A benchmarking study by Sydney Water (Sydney water, 2008) has developed a water consumption guide for commercial buildings with water-cooled air conditioning systems, as shown in Figure 10.

Figure 10 - Best Practice Guideline for offices with cooling towers (Sydney Water, 2008)

1.5.3. RAINWATER HARVESTING

Rainwater harvesting involves diverting rainfall water into a storage tank. It has been used for centuries as a way of storing water to face droughts and overcome the seasonality of rainfall. For buildings, rainwater harvesting can be applied to roofs and other impervious surfaces (car parks, pathways, etc.). Collected water can directly be used for non-potable demand such as toilet flushing, washing machines, garden irrigation, and general cleaning. The use of roof runoff is preferred as it is generally less contaminated.

Regarding the growing pressure on water resources, this technique meets a renewed success in some Member States. In Germany, a study into rainwater harvesting showed
that 35% of new buildings built in 2005 were equipped with a rainwater collection system (Umwelt, 2006). However, several barriers to a wider adoption of rainwater harvesting systems have been identified in a UK study; such as cost of equipment and the lack of regulation for safe use of water (Ward, 2007). The latter also appears to be the main obstacle for rainwater harvesting in France (Perraud, 2005).

Table 19 below presents some UK case studies of rainwater harvesting systems.

<table>
<thead>
<tr>
<th>Name</th>
<th>Size of Development</th>
<th>RWH/ Annum</th>
<th>Pay-back period (yrs)</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great BowYard</td>
<td>12 houses</td>
<td>28m3</td>
<td>24</td>
<td>WC; GT</td>
</tr>
<tr>
<td>Millennium Green</td>
<td>24 houses, 1 office building</td>
<td>84m3</td>
<td>unknown</td>
<td>WC; WM; GT</td>
</tr>
<tr>
<td>Barn Park</td>
<td>37 houses, 11 systems</td>
<td>194m3</td>
<td>4.6</td>
<td>WC; WM; GT</td>
</tr>
</tbody>
</table>

WC = toilet flushing; WM = Washing Machine; GT = Garden Taps

1.5.4. **GREY WATER REUSE**

Grey water is wastewater generated from domestic activities such as laundry, dish washing, bathing or showering. Grey water is different from black water (wastewater from toilets) in its level of contamination. Usually black and grey water in buildings are mixed and removed together through the sewage system. But grey water can also be reused within the buildings for toilet flushing, garden irrigation, or washing machines.

Health issues and water quality legislation are the main obstacles to grey water reuse. In fact, grey water may contain bacteria and other potentially dangerous pollutants and its reuse is a public health issue.

1.6. **SYNTHESIS OF LITERATURE AND DATA REVIEW**

This section presents key elements to understanding water performance of buildings. The following sub-section discusses five main elements:

- Estimation of water consumption within buildings
- Scope definition
- Metrics
- Water saving potential

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10 A daily monitoring of water use in one of the house of the Millennium Green project showed than almost 50% of water demand can be served by the rainwater supply. ([http://www.freerain.co.uk/domestic-case-study.html](http://www.freerain.co.uk/domestic-case-study.html))
• Issues for policy makers

1.6.1. Estimation of water consumption within buildings

Very little published information exists on water performance of buildings. Only local and ‘bottom–up’ approaches are possible to establish or assess a scheme dealing with water performance of buildings. The following table presents a rough estimation of water consumption in buildings. The last column gives an approximation of the share of total water consumption from EU water supply system abstraction. All the other figures should be interpreted with care as they are a first estimate, which needs to be confirmed with robust statistical analysis.

Table 20 - Estimates of global annual uses from the public water supply in the EU11

<table>
<thead>
<tr>
<th>RESIDENTIAL</th>
<th>Number of inhabitants</th>
<th>Average consumption per capita</th>
<th>Total amount of water</th>
<th>Share of total water supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>millions</td>
<td>m$^3$/annum/per capita</td>
<td>million m$^3$/annum</td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>500</td>
<td>50</td>
<td>25 000</td>
<td>60 to 70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOMESTIC NEEDS WITHIN COMMERCIAL AND INDUSTRIAL BUILDINGS</th>
<th>Number of positions</th>
<th>Average on-site consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale and retail trade, repair of motor vehicles,</td>
<td>56</td>
<td>9</td>
</tr>
<tr>
<td>motorcycles and personal and household goods; hotels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and restaurants; transport, storage and communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial intermediation; real estate, renting and</td>
<td>33</td>
<td>9</td>
</tr>
<tr>
<td>business activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public administration and defence, compulsory social</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>security; education; health and social work; other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>community, social and personal service activities;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>private households with employed persons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industries</td>
<td>38.5</td>
<td>9</td>
</tr>
<tr>
<td>ASSESSMENT OF OTHER DOMESTIC USES (hospitals,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hotels, etc.)</td>
<td>2 000</td>
<td></td>
</tr>
<tr>
<td>TOTAL WORKING PLACE CONSUMPTION</td>
<td>192</td>
<td>13</td>
</tr>
<tr>
<td>OTHER (leakages, companies productive uses)</td>
<td>8 000</td>
<td>15 to 30%</td>
</tr>
<tr>
<td>AGRICULTURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total water used</td>
<td>41 278</td>
<td>100%</td>
</tr>
<tr>
<td>Share from the water supply system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysed local case studies describe consumption patterns and water savings potential among buildings. A major feature to be taken from these cases is the variability of consumption between the case studies and across Member States. Consumer behaviour, local particularities and fixtures performance all appear to have

---

11 Data source: Eurostat, 2007
BIO calculation, under the following assumptions:
- average daily consumption coming from average of literature review
- data from small commercial buildings was used as reference value
- for public buildings with visitor, average value of 100 l/day/employee used
Please note that it is a rough estimate and not to be used for other calculations.
an important effect on the final consumption. However, it was not possible to quantify the individual effects of each factor.

1.6.2. **Scope Definition**

The activities taking place within buildings can be divided into domestic uses and productive functions. These two kinds of uses are very different, do not use same fixtures and devices, and do not have the same drivers of water consumption.

The objective for this study is to include the domestic uses of non-residential buildings as well as all residential buildings. The scope for improving regulations for water efficiency in buildings should not include specific requirements arising from production needs. These needs rely too much on the nature of the work being undertaken, and are a consequence of the production process management, in other words, they are part of the process or activity being undertaken rather than elective use (Defra, 2006). Thus, they fulfil diverse and complex functions that have little to do with the function of the building itself.

Furthermore, regulations for governing the process uses of water for productive purposes (such as use during manufacturing, construction, and industrial processes such as cooling, washing and cleaning) are in general dedicated or multi-targeted, such as the IPPC, which provides regulation on water abstraction.

Finally, the estimation to assess consumption pattern of the different types of buildings shows that domestic needs are the dominating uses of water coming from water supply systems. These needs are fulfilled mainly within buildings. On productive consumption of water within buildings, no data were available to enable an assessment of saving potential, impacts, etc.

In summary, the WPB approach is argued as being not relevant to productive water uses. Such uses should be covered by research focusing on specific industries to assess the impacts of building design in water consumption.
1.6.3. **Metrics**

To measure water performance of buildings, existing studies build performance measures on selected metrics, as described in the following table. These metrics indirectly define the function that is ascribed to the building (*deliver water to fulfil the needs of one person during one day*, when litre/capita/day metric; *deliver water to fulfil the needs of one patient during one day*, when litre/patient/day metric).

**Table 21 – Summary of metrics used to assess water performance of buildings**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Building category</th>
<th>Category sub-set</th>
<th>Metrics</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>Private housing</td>
<td>Single-family units</td>
<td>litres / capita / day</td>
<td>Per capita disposable income</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multi-family units</td>
<td>litres / capita / day</td>
<td>Changes in Lifestyles</td>
</tr>
<tr>
<td>Government / co-operative</td>
<td></td>
<td>Single-family units</td>
<td>litres / capita / day</td>
<td>Per capita disposable income</td>
</tr>
<tr>
<td>housing</td>
<td></td>
<td>Multi-family units</td>
<td>litres / capita / day</td>
<td>Changes in Lifestyles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Price (fees, taxes, metering)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Environmental information and awareness</td>
</tr>
<tr>
<td>Public buildings</td>
<td></td>
<td>Public cultural buildings</td>
<td>litres / capita / day</td>
<td>Function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital</td>
<td>litres / patient or bed</td>
<td>Floor area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clinics</td>
<td>litres / patient or bed</td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>/ day</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Offices</td>
<td>litres / employee / day</td>
<td>Price (fees, taxes, metering)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or m3/m2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Educational buildings</td>
<td>litres / student / day</td>
<td>Environmental information and awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial buildings</td>
<td></td>
<td>Leisure facilities</td>
<td>no examples available</td>
<td>Function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hotels</td>
<td>litres / bed / day</td>
<td>Floor area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restaurants</td>
<td>litres / dish /day</td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shops</td>
<td>m³/m²</td>
<td>Price (fees, taxes, metering)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Offices</td>
<td>litres / employee / day</td>
<td>Environmental information and awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or m³/m²</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garages (car wash)</td>
<td>litres / use</td>
<td></td>
</tr>
</tbody>
</table>

1.6.4. **Water saving potential**

Water saving potential in buildings can be quantified, for example, on the basis of available best technologies for water-using fixtures.
Performance assessment calculations are in general based on theoretical water savings and are opaque with respect to underlying assumptions (reference case, fixture used, and water consumption patterns, etc.). For example, number of baths, number of toilet flushes, time under shower and outdoors uses, are highly sensitive parameters to establish water consumption patterns, and thus in estimating the water reduction potential.

Table 22 – Potential water saving within buildings

<table>
<thead>
<tr>
<th>Water consumption within household</th>
<th>No behavioural changes</th>
<th>With assumed moderated behavioural changes</th>
<th>With assumed higher behavioural changes</th>
<th>Estimated cost per capita (assumption: 2.7 inhabitants)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>l/capita/day</td>
<td>% changes</td>
<td>% changes</td>
<td>% changes</td>
</tr>
<tr>
<td>No fixture changes (base case)</td>
<td>150</td>
<td>0</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>First level retrofitting</td>
<td>120</td>
<td>20%</td>
<td>33%</td>
<td>40%</td>
</tr>
<tr>
<td>Best efficiency fittings of key fixtures</td>
<td>90</td>
<td>40%</td>
<td>50%</td>
<td>55%</td>
</tr>
<tr>
<td>Best fittings, plus water reuse</td>
<td>75</td>
<td>50%</td>
<td>55%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table 22 summarises potential water savings in a 2.7 person household, for an average use pattern, 6 l per toilet flush, shower and tap consumption of 12 l/min, bath taken once a week, and outdoor uses of 8 m³/year (see Table 23 for calculation details). Even if it is difficult to estimate precise values and they will not be valid for all MS, the objective was to establish an order of magnitude. The second idea was to illustrate the costs implied by changing to more efficient fixtures. Finally, a third parameter was simulated, assessing the sensitivity of behavioural choices and the role they could play in water saving. Assumptions for these calculations are given in the next table (Table 23).

Three levels of passive actions were simulated:

- Cheap retrofitting as water bags (1 litre / flush save), more efficient showerhead (12 to 8 litres/min), and more efficient taps (from 12 to 10 litres). These actions lead to a rough 20-25% savings, for a reduced cost.

- A second level can be reached with fixture changes as toilets (3-6 dual flush), reduction of bath size, and investment in more efficient white goods (marginal part of the saving actually, for a high cost, which explain the high variability of cost mention on this line). With such changes, one could save around 35 – 45 % of water as compared to the base case.

- Achieving further water savings implies significant modifications in water systems through water reuse installation, or rainwater harvesting, used to replace water in toilets and gardening mainly, the two easiest uses to fit as regard sanitary
requirements. These modifications help save 10% more water (after the first two options have been applied), but at much higher cost.

Making the comparison with moderate changes in consumer behaviour is very instructive: with few changes in the calculation (mainly one bath every 10 days, 4 minutes shower instead of 5 for the base case, 25% reduction on tap water), 20% saving from base case can be obtained without any cost and without significantly modifying personal comfort. Such savings can go further, if baths become even more seldom, showers shortened to 3 minutes, and tap water use further reduced (these changes could be expressed as “significant behavioural changes”).

This demonstrates that user behaviour plays a key role on water consumption. With these preliminary calculations, it can be observed that water savings in buildings can be realised without significant costs. These drop off are relevant as reduction options. When combining passive savings and behavioural changes, the joint impact of the two options is slightly reduced. But still, efficient fixtures with some behavioural changes can have the same effects as a more efficient (and expensive) installation.

This point is important, as all presented simulations are based on theoretical values, with a strong assumption underpinning the no behavioural changes. Indeed, efficient water using fixtures may sometime not reach assumed savings, because the water is used for its quantity or for its pressure (to fill recipients, clean things, etc.). They can also be more fragile or less effective, as it has been reported once for some 3-6 toilets. Thus, all these passive saving rates are probably optimistic, unlike behavioural change ones. They can be partly offset rather easily by user behaviour changes.

Table 23 – Examples of water saving calculations in buildings

<table>
<thead>
<tr>
<th>Base case</th>
<th>kitchen tap</th>
<th>basin tap</th>
<th>shower</th>
<th>bath</th>
<th>WC full</th>
<th>WC short</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol/flow</td>
<td>12.00</td>
<td>12.00</td>
<td>12.00</td>
<td>225.00</td>
<td>6.00</td>
<td>6.00</td>
</tr>
<tr>
<td>use factor</td>
<td>0.67</td>
<td>0.40</td>
<td>5.00</td>
<td>0.14</td>
<td>0.33</td>
<td>0.67</td>
</tr>
<tr>
<td>uses/person/day</td>
<td>4.00</td>
<td>3.00</td>
<td>0.60</td>
<td>0.40</td>
<td>1.58</td>
<td>3.21</td>
</tr>
<tr>
<td>CHS factor</td>
<td>2.68</td>
<td>1.20</td>
<td>3.00</td>
<td>0.06</td>
<td>1.58</td>
<td>3.21</td>
</tr>
<tr>
<td>fudge factor</td>
<td>0.67</td>
<td>0.67</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>TOTAL /person/day</td>
<td>21.55</td>
<td>9.65</td>
<td>36.00</td>
<td>12.86</td>
<td>9.50</td>
<td>19.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>washing machine</th>
<th>dishwasher</th>
<th>bidet</th>
<th>water softener</th>
<th>outside</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol/flow</td>
<td>49.00</td>
<td>13.00</td>
<td>1.00</td>
<td>1.00</td>
<td>8.12</td>
<td>8.12</td>
</tr>
<tr>
<td>use factor</td>
<td>1.00</td>
<td>1.00</td>
<td>2.64</td>
<td></td>
<td></td>
<td>2.64</td>
</tr>
<tr>
<td>uses/person/day</td>
<td>0.20</td>
<td>0.20</td>
<td>2.00</td>
<td></td>
<td></td>
<td>2.00</td>
</tr>
<tr>
<td>CHS factor</td>
<td>0.20</td>
<td>0.20</td>
<td>5.28</td>
<td>12.50</td>
<td></td>
<td>12.50</td>
</tr>
<tr>
<td>fudge factor</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>TOTAL /person/day</td>
<td>9.80</td>
<td>2.60</td>
<td>5.28</td>
<td>12.50</td>
<td>8.12</td>
<td>147.13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficient fixtures</th>
<th>kitchen tap</th>
<th>basin tap</th>
<th>shower</th>
<th>bath</th>
<th>WC full</th>
<th>WC short</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol/flow</td>
<td>8.00</td>
<td>6.00</td>
<td>8.00</td>
<td>160.00</td>
<td>6.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

---

European Commission (DG ENV)
Study on water performance of buildings

May 2009
When discussing fixture efficiency, the question of their effectiveness is crucial. The lack of standardisation is a critical issue such as for the measurement of fittings performance and bath volumes. For example, a shower or tap must provide an effective “wash” performance in order to be useful. With a decrease in flow rates for the purpose of reducing water consumption in buildings, there is a danger that the effectiveness of low-flow fittings could be reduced. A unit of performance needs to be considered when testing these types of fittings to ensure that they are not used for a longer period of time (under identical conditions) than regular flow fittings, otherwise savings in water use will not be achieved and attempts to reduce consumption will fail.

1.6.5. IDENTIFICATION OF KEY ISSUES FOR POLICY MAKERS

Three key major issues were identified for improving water efficiency in buildings. Firstly, routes to implement water efficiency including regulatory (top-down) and voluntary or market driven (bottom-up) are discussed. Secondly, the challenges faced in new-build and existing stock are presented. Thirdly, existing studies have provided insights into how regional differences (e.g. water resources, socio-economic and technological) should be addressed in policies.

1.6.5.1 Implementation options

- A review of existing legislation and consultations on water efficiency in buildings identifies three proposed options for implementing water efficiency in buildings. The three approaches are summarised in the Box 3.

- All approaches are not equivalent and will not fit in the same way with each set of MS regulations, water industry, and infrastructure context.
Box 3 - Three routes to implement water efficiency in buildings

1. Amending Building Regulations

• There are two main advantages in using the Building Regulations route. First, to bring the regulatory requirements for construction, design or refurbishment of a new building into one place, in order to make the regulations as simple and light as possible. Second, to aid compliance – as building control bodies already help confirm compliance with building regulations, this additional requirement would fit well with their remit.

• Building regulations can provide a single set of regulations that deal with the most important sustainability requirements within buildings.

• There may be a requirement to accommodate regional differences, and also to allow exemption for special cases where water conservation may be impractical or unfeasible.

2. Amendments to Water Fittings regulations

• The Water Fittings Regulations make provision for preventing contamination, waste and undue consumption of water supplies. The health and sanitation aspects of this legislation are very important, and provisions to prevent incidents of cross-contamination and backflow are there to protect public health.

• As with Building regulations, there may be a requirement to accommodate regional differences, and also to allow exemption for special cases where efficient water fittings may be impractical or unfeasible.

3. Transforming the market

• Transforming the market implies using market forces to drive efficiency. Many existing programmes, e.g. the Code for Sustainable Homes in England, the Water Efficiency Labelling Scheme (WELS) in Australia, and the Smartcodes programme in the USA, have adopted different approaches, e.g. product labelling, sustainable building codes, benchmarking, working with manufacturers, and point of sale information in the retail market, to promote water efficiency using market forces. Problems with evaluating the effectiveness of such approaches is related to the fact that there is little empirical information on whether, and to what extent, these programmes are effective. It is perhaps more accurate to consider market transformation activities as a vital part of engaging with the public, i.e. manufacturers, building contractors etc, to raise awareness about the advantages of water efficiency, and to provide mechanisms that will facilitate implementation.
1.6.5.2 Challenges to achieve water efficiency in buildings

Statistics from some Member States suggest that new dwellings are created faster than old stock is demolished. This means that improving the water efficiency only in new buildings is unlikely to reduce water demand. This highlights the importance of addressing the existing building stock, but it does not mean that improving the standards of new buildings is not important. By 2060, the proportion of buildings built since 2006 will be substantial, e.g. in the UK this could be as much as one-third of the total building stock.

Experiences in Australia, USA and Europe have shown that achieving uptake of water efficient products in existing homes and commercial buildings is more challenging than new build because of difficulties of ensuring compliance (controlling any requirement that would be set up at building level is more difficult than controlling that products sold are efficient for example), high cost, and the difficulty of imposing regulatory requirements on people’s water use behaviour and the type of water appliances they have. However, there are specific points in a building’s lifetime (such as major refurbishment, especially for offices, or sale of the building) that can be used overcome these limitations and increase the number of buildings encompassed under such requirements.

The different challenges in new-build and existing stock point to a requirement for different approaches to achieve water efficiency in these contexts, and this would indicate that consultation for regulation needs to be carried out separately.

1.6.5.3 Regional differences

A case can be made for regional water efficiency standards; with higher performance levels required in those areas where there are particular supply-demand problems or in the water scarce regions of the EU such as those in the Southern MS and the Mediterranean islands. Such an approach could be justified in terms of its acceptability to the public. It would, however, be more difficult to explain to prospective homebuyers and existing homeowners in the water abundant regions why water efficient fixtures and fittings are required in their homes.

The above argument for regional water efficiency standards needs to be balanced against the following important practical and ethical issues that weigh against a regional approach.

A sufficiently high degree of market transformation needs to be achieved if standards of water efficiency are to be raised and maintained for the future. Manufacturers do not design or supply bathroom and water fittings on a regional basis; their market is national, European or even international. Water is a scarce resource and both its treatment and transport require energy, which results in significant carbon emissions and contributes to climate change. This means we should aim to reduce our use of water in all regions. Finally, it is important for future sustainability that all members of the public and civil society in general value water as a precious resource to be used
wisely, and not just a commodity. Regional standards would not help to promote this message to the wider community.

Taking above arguments into consideration, consultations with stakeholders at the national level (Defra, 2006) have “not been persuaded that a regional approach for water efficiency regulation is viable”. They do, however, point out that opportunity for regional targets exist in the planning process, and could be used to require higher levels of water efficiency in developments. Their main reason, is the need to drive the markets. This is in contrast to the regional approach to metering adopted by the Government-led Water Saving Group in England, which, they say, can be justified because building water efficiency standards depend on market transformation, and as explained above the market for water fixtures and fittings is not regional.
2. WPB POLICY TOOLS AND INITIATIVES

Before analysing possible future policy instruments targeting water performant buildings approach to target water savings, this chapter provides generic descriptions of policy measures encountered.

2.1. EXISTING POLICY MEASURES

The existing policy measures can be structured as shown in Figure 11 on the basis of their legal status and main characteristics.

Figure 11 - Classification of WPB policy measures

- **Regulatory instruments** refer to legislation that require certain devices, practices, or systems design to improve water efficiency. They are established by public authorities and are subsequently enforced by compliance procedures. This group of policy instruments can include laws, directives, and technical guidance documents of a legally binding nature. The two main subcategories of regulatory policy instruments targeting the water performance of buildings are building codes and strategic plans or planning guidelines.

- **Information instruments** are designed to increase the awareness and understanding of water efficient products, services, and provide benefits to a
variety of actors. These instruments aim to persuade actors to adopt more water efficient practices and products. For the building sector, the two most commonly found instruments in this category are building rating tools (certification programs) and eco-labels.

- **Incentive instruments** refer to financial or technical tools set up to incentivise specific stakeholders to change their behaviours. Subsidies and taxes are the most widely used by public bodies when changes are costly and/or can not be made within short-term future. Such instruments are in general rather complex and spread between different actors. Structuring and financing R&D and technical institutes is also a way to create knowledge and to drive changes. Funded institutes investigating water issue are numerous and routinely work at improving water uses. Assessment framework

In order to improve resource efficiency and promote sustainable consumption, governments are required to establish adequate policy frameworks. Local, regional and national governments can apply a wide range of instruments including regulatory, economic, information, education, research, and development instruments as well as voluntary agreements and cross-sectional measures (Vreuls 2005; GTZ et al. 2006). Each of these basic instrument groups can have different sub-categories which can be combined in order to enhance the desired effect. Different instruments are suitable for different objectives and address very specific “target audiences”. Policies can range from “hard” strategies which reward or penalise consumers and producers to “soft” strategies which support and motivate the change of consumption or production patterns. The challenge for policy-makers is to select the appropriate instrument or mix of instruments to meet specific environmental objectives without compromising the functioning of the market or creating unfair economic or social impacts (GTZ et al. 2006). Environmental policy research highlights that innovation and the promotion of technological and social change can best be promoted by a policy mix approach that combines several different environmental policy tools (e.g. Jänicke and Weidner 1995), therefore necessitating a careful evaluation of the potential and limits of different environmental policy measures. In this analysis, we particularly focus on informational and regulatory instruments or combinations thereof with the aim of developing a better understanding of the strengths, weaknesses and relevance of current policy instruments to inform the formulation of future performance initiative linked to buildings. To support this aim, the analysis pursues the following three objectives:

- To characterise key features and identify gaps and inconsistencies of current policy instruments aimed at increasing the water performance of buildings,
- To investigate the outcomes, impacts, and fail/success factors of existing policy instruments, and
To explore and discuss on the basis of the previous analyze, benefits and limitations of the investigated instruments for increasing the water performance of buildings.

Before presenting the results of this investigation and drawing conclusions for both policy-makers and analysts, we provide a general introduction to the investigated types of water efficiency policy measures and briefly outline the methods adopted throughout this analysis. It should be noted that the terms policy measures, instruments, are used interchangeably throughout this report and generally refer to “a specific type of political action or market intervention designed to persuade water consumers to reduce water use and encourage market parties to promote water efficient products and services” (Vreuls 2005, p.14, adapted).

2.1.1. Classification of water Performance policy measures

The majority of contemporary water efficiency efforts adopt informational and regulatory instruments or combinations thereof. To facilitate the comparative assessment of the characteristics, benefits and limitations of different instruments at an aggregate level, instrument sub-categories were identified and grouped according to their legal status.

Table 24 contains an overview of existing (local, regional, and national) policy measures targeting water efficiency either exclusively or in connection with a broader set of environmental objectives, differentiated by their legal statues. The background and operational detail of these measures are discussed in chapter 3.

<table>
<thead>
<tr>
<th>Investigated policy measures</th>
<th>Voluntary measures</th>
<th>Rating tools</th>
<th>Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td></td>
<td>BREAM (UK)</td>
<td>European Eco-Label</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AECB (UK)</td>
<td>Nordic Swan (DK, S, FIN, NOR, ICE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HQE (FR)</td>
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<td></td>
<td></td>
<td>H&amp;E (FR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GSBC (DE)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Green Star (AUS)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>NABERS (AUS)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>LEED (USA)</td>
<td></td>
</tr>
</tbody>
</table>
It is however important to note that this overview is by no means exhaustive, given the difficulty of obtaining information. We also need to highlight that such policy measures are usually not implemented in isolation but as part of a mix of instruments in order to increase the intended effects. Information measures, for instance, are frequently combined with other instruments because people need to gain an awareness and knowledge of a certain problem area in order to stimulate a change in behaviours and practices. For example, product labelling schemes (information) are frequently based on minimum performance standards (regulation). Therefore, it is somewhat difficult to clearly put an instrument in a specific category. The assessment of measures focuses on the characteristics, outcomes and impacts of single instruments, but also takes into account the interaction with other measures. It should be noted that not all of the identified measures were assessed with the same level of detail, either due to limited data availability or because they have been established recently, thus little insight is available regarding their effects.

2.1.2. ASSESSMENT APPROACH, FOCUS AND LIMITATIONS

It is widely agreed that that the evaluation of policy effects is a challenging task (e.g. UNEP 2005). The ‘effectiveness’ of (environmental) policy instruments must ultimately be judged in terms of environmental improvements. In the context of this study, this would mean estimating the amount of water saved by introducing a specific policy measure. However, several challenges exist in assessing a policy related to water efficiency:

- Theoretically, it is possible to quantify improvements associated with compliance with different types of water efficiency measures, but in practice such quantitative information is not easily available. Most policy instruments lack accompanying monitoring programmes and baseline data which could be used to estimate the impacts of the instrument. As a result, evaluations often rely on proxy indicators and anecdotal evidence (see also UNEP 2005). Where evaluation studies are available, applied methodologies frequently vary, making it difficult to compare policy impacts in a consistent manner.
Many policy instruments addressed in this study were recently adapted. Therefore, only short-term effects are noticeable at this point of time as certain amount of time is needed for policy measures to achieve their intended targets. Evaluations therefore need to take into consideration the length of time a scheme has been in operation as well as the time it might require to develop its full impacts.

Furthermore, the instruments investigated in this study address specific target audiences and pursue different ‘avenues of change’. Building codes, for example, are specifically aimed at architects, developers and equipment manufacturers and directly prevent them from constructing less efficient buildings. Labels on the other hand focus both on the developers as well as potential homeowners, in an attempt to encourage a change in construction and purchasing behaviour. Subsequently, effectiveness needs to be approached differently for different categories of instruments and target audiences.

Finally, it is difficult to establish the influence of a certain policy measure on the behaviours and action of the target group. For example, developers are affected by a multitude of market and regulatory pressures, technology changes, etc. It can be difficult to discern whether they change their design and construction practices in reaction to the introduction of a label or simply use it as a marketing instrument for actions taken in response to other causes.

A comprehensive assessment strategy was adopted, drawing strongly from recent developments in theory-based policy evaluation methodologies rather than simply focusing on impacts only, i.e. on energy or water savings, emission reductions and costs. Such an evaluation focuses on the whole policy process and considers both quantitative and qualitative aspects. In doing so, it provides insight in the success or failure of policy instruments and could be used to improve the policy process and optimise final effects. Theory-based policy evaluation establishes a plausible theory on how a policy instrument (or a package of instruments) is expected to lead to efficiency improvements. Application of the theory-based approach in ex-post policy evaluation means that the whole policy implementation process is unravelled to evaluate the effectiveness and efficiency of the different steps of the implementation process (Blumstein et al. 2000; Vreuls 2005; Khan et al. 2006). Adopting a theory-based approach allows us

- To develop instrument-specific indicators which take into the mechanisms by which they are intended to bring about change,
- To develop insights into the implementation process and identify barriers and facilitators of success, and
- To evaluate instruments in all implementation stages by developing cause-impact chains and proximate objectives for each link in the chain.
Whilst theory-based evaluations are increasingly popular in the field of energy policy\textsuperscript{12}, they have, to our knowledge, not been applied to water efficiency policy instruments. Drawing from these recent experiences (Vreuls 2005; Khan \textit{et al} 2006), the evaluation process was carried out in three steps:

1. Initial characterisation of policy measures: In order to specify the assessment focus and select indicators, objectives and target groups were identified and cause-effect relationships were mapped for each instrument (see below).

2. Specification of assessment focus, indicators, and success and failure factors: The characterisation provided the basis for specifying the assessment focus, selecting responding indicators and identifying fail and success factors for each instrument. Based on existing literature (Vreuls 2005; Khan \textit{et al}. 2006; Gupta \textit{et al}. 2007), data availability, and taking into account the timeframe for which most of the schemes have been in operation, the research team decided to cover, outcomes, impacts as well as facilitators and barriers of policy success. Outcomes are the changes or improvements for individuals, groups or organisations which directly result from a policy instrument. They include short-term effects such as a change in knowledge or attitudes as well as intermediate outcomes such as a change in behaviours, decisions and actions. For example, the introduction of a water efficiency rating scheme might create an increased awareness among architects and developers and might motivate them to design and construct more water efficient buildings (short-term outcome). Eventually, the market share of water efficient buildings will increase (long-term outcome) resulting in water savings (impact). For the assessment of the effectiveness or impacts of environmental policy instruments, the literature distinguishes between environmental effectiveness, socio-economic impacts (distributional consequences) and institutional feasibility (Gupta \textit{et al}. 2007). This analysis will focus on assessing the actual or potential water savings (depending on data availability) resulting from each instrument. Socio-economic and institutional aspects will be discussed when examining the facilitators of and barriers for policy success. These can be broadly grouped into the following categories (Khan \textit{et al}. 2006; GTZ \textit{et al}. 2006; Gupta \textit{et al}. 2007):

- Technical barriers: Options may not yet be available, or actors may consider options not sufficiently proven to adopt them.

- Knowledge / information barriers: Actors may not be informed about possibilities for water efficiency improvement. Or they know certain technologies, but they are not aware to what extent the technology might be applicable to them.

\textsuperscript{12} The AID-EE project (Active Implementation of the European Directive on Energy Efficiency) sponsored by the European Union as well as the International Energy Agency’s IEADSM programme (Demand-Side Management Technologies and Programmes) have recently applied theory-based evaluation frameworks to energy efficiency policy measures.
• Economic barriers: The standard economic barrier is that a certain technology does not satisfy the profitability criteria set by firms. Another barrier can be the lack of capital for investment. Also, an unbalanced or unfair distribution of benefits and costs can be a major hindrance for achieving policy objectives.

• Institutional barriers: Institutional realities inevitably constrain policy implementation and enforcement. Important factors include human capital, infrastructure and knowledge. Moreover, certain policy instruments work well in one situation due to institutional familiarity or organisational structures, whereas in another context, authorities struggle with the practical implications of particular instruments.

• Lack of interest in water efficiency improvement: Companies, organisations and households tend to focus on their core activities only, and neglect other matters which do not directly affect their everyday life or core business. This couples with (comparatively) low costs for water supply and consumption in many MS, where they will not spend much effort on improving the knowledge on options for reducing their water consumption.

• Policy context: Information on the policy context of the instrument can help to explain the success of failure of its implementation. The main characteristics of the general environmental or water policy, the general status of environmental concerns on the political agenda and the political support for water efficiency initiatives can be crucial determinants of an instruments success.

3. Collect information and analyse all aspects of the policy measure: As pointed out earlier, information on different water efficiency measures, particularly their impacts, is currently not widely available. Subsequently, the analysis largely relies on anecdotal evidence which was collected through a review of reports, journal articles and official websites. To obtain a more in-depth understanding of their implementation and impacts, national and international government bodies and stakeholders were surveyed using a self-complete questionnaire. In order to ensure a high response rate, the questionnaire was disseminated by email and through a dedicated website (www.waterefficiency.eu).

Finally, it should be noted that data availability varies largely between investigated instruments, implying that not all initiatives can be analysed to the same level of detail. Moreover, considering the relatively recent establishment of the majority of water efficiency policies, the assessment focuses in many cases on outcomes rather than impacts as well as the early experiences of implementing and operating these measures. Thus, they are best described as ‘review evaluations’ rather than ‘comprehensive evaluations’. Comprehensive evaluations, which target major, longer timeframe policies, require the collection of baseline data and ex-ante estimates, whilst smaller measures often only qualify for review evaluations which include neither extensive primary data collection nor rigorous estimation of baselines or net savings (Vreuls 2005).
2.1.3. CHARACTERISATION OF POLICY MEASURES AND INDICATOR SELECTION

Having established the general assessment strategy, this section characterises the investigated policy measures and formulate instrument-specific indicators. It should be noted that, whilst the analysis differentiates between mandatory and voluntary measures, this initial characterisation is organised along the two types of policy measures: information and regulatory instruments.

2.1.3.1 Information measures

The majority of existing water efficiency measures fall into the information category. In general, the objectives of information policy measures and programmes are to:

- Increase the awareness of equipment manufacturers, architects, developers and home owners about water-efficient products and services, as well as their economic and environmental benefits.
- Provide equipment manufacturers, architects, developers and home owners with the technical information they need to identify and adopt energy efficient products and practices.
- Persuade equipment manufacturers, architects, developers and home owners to adopt water efficient products and practices.

Information measures cover a spectrum of very diverse instruments, including information centres and campaigns, environmental auditing and reporting systems, and product markings. In this analysis, we will specifically focus on the following two sub-categories: building rating tools or certificates and eco-labels. One of the key strengths of these information instruments is their potential of increasing the awareness on water efficiency issues, thus contributing to changes in both construction practices as well as purchasing behaviours. Factors which affects the success of rating or labelling schemes include the consultation of stakeholder consultation and credibility of the sponsoring or certifying agency. Furthermore, the intensity of information provided play an important role in fostering the public’s trust in information schemes (Vreuls 2005; GTZ et al. 2006). It should be noted that whilst the marketing opportunities of information schemes (positive image of developers as well as participating or sponsoring public authorities) encourage ambitious developers to commit to constructing more water efficient products, it might hinder the innovation process. If efficiency criteria are not continuously evaluated and updated, there is little incentive for manufacturers to improve performance beyond current standards (GTZ et al. 2006). Furthermore, public authorities need to be aware of the resources involved in establishing rating or labelling schemes, for equipment manufacturers, developers and architects as well as the responsible authority: companies may have to collect and disseminate information they would not otherwise have gathered, and government agencies will have to verify the information. Since companies may view information policies as overly burdensome and argue that voluntarily provided information is sufficient (Sterner, 2003), it is crucial to consult the
affected target group prior to establishing any information scheme, in order to define appropriate and feasible measures.

Ratings tools or eco-labels indicate water efficiency of products, service, or building in order to provide information to the public. They aim at stimulating both the construction of and demand for buildings with improved resource efficiency (GTZ et al. 2006). This study distinguishes between building-specific rating tools and eco labels targeting not only buildings but also products and/or services. These instruments can further differ in terms of the environmental aspects they cover; some exclusively address the water performance of buildings whilst others target multiple environmental issues. Moreover, these tools can either rate buildings efficiency using a ranking system or indicate through a quality mark, whether a building meets an efficiency level. For architects, developers and equipment manufacturers, a rating or labelling scheme has the objective of encouraging the construction of more efficient buildings and the production environmentally friendly fixtures and fittings products. By raising questions of water performance of buildings, home buyers and owners become more aware of the issue and might consider water efficiency when buying houses, fixtures and appliances. Thus, information schemes might develop into marketing tools encouraging developers and manufacturers to design, construct and produce more efficient buildings and products. As less water efficient houses are slowly being replaced, the water consumption is expected to decrease (IEA 2000; GTZ et al. 2006).

Indicators of impacts of building rating schemes and eco labels can focus on:

- Changes in customer awareness levels and attitudes towards energy efficiency
- Changes in purchasing behaviour
- Adoption (change of behaviour) of the targeted practices and products
- Changes in water consumption at the consumer level

The following table summarises cause – impact relationships underpinning such requirements. In parallel, indications on needed inputs, underlying assumptions and possible indicators, are also suggested for all the different stages. Definition stages and achieving wide use of the scheme are the assessed “hotspots” of these instruments.
Figure 12: labels and rating system: cause – impact relationship, external needs and assumptions

**Cause-Impact relationship**
- Define and agree on a reference
- Define and agree on the labelling scheme
- Training of users
- Information and promotion
- Feedback and up-date
- Use of the scheme by final consumer
  - Architects
  - Building industry
  - Owners
- Controls, feedback
- Water savings

**External needs**
- Expertise and data
- Existing references

**Assumptions**
- Reality can be represented with such data
- A comprehensive approach can be set up

**Indicators**
- Position of the defined targets as regard other programs, potential savings
- Number of people trained
- Number of citation
- Update interval
- Number of buildings certified
- Market changes
- Level of awareness
- Number of controls
- Water saving estimation

**Need for awareness**

**Need for technical solutions**
- Voluntary approach will lead the market toward changes
- Verification will avoid false reporting
- People won’t change their behavior
- The technical solution will be durable

European Commission (DG ENV)
Study on water performance of buildings

May 2009
2.1.3.2 Regulatory measures

The term ‘Regulation’ refers to legislations that require certain devices, practices, or system design to meet defined water efficiency objectives. Regulatory instruments in general are quite effective in achieving their objectives. However, this success relies heavily on an effective enforcement and control system with sufficient capacities to implement and ensure compliance with any legal requirements, possibly by using penalties (GTZ et al. 2006; Khan et al. 2006). Performance or technical standards are relatively easy to formulate and enact. However, they need to address complex problems, and pressure from stakeholders may hinder the process (Harrington and Morgenstern, 2004). Therefore, it is crucial to ensure that standards are based on an extensive knowledge base and to consult involve stakeholders throughout the development process.

Whilst mandatory standards have the advantage of creating a level playing field, they incur comparatively higher costs than, for example, economic instruments. Ensuring a balanced distribution of costs and benefits of a measure is thus a key to achieve success. One of the drawbacks of mandatory standards is that they offer little incentive for innovation. They have to be constantly revised and updated, to ensure that companies move beyond existing standards which, again, relies on sufficient human and organisational resources of the responsible authority. Finally, regulations need to be coherent with other policy measures in order to achieve the intended impacts. The two main subcategories of regulatory policy measures for water efficiency include building codes/regulations and strategic plans or guidelines. Building codes/regulations specify how buildings (or subsystems of buildings) must be constructed or perform. Most codes apply to both residential and non-residential (commercial) buildings, although the exact requirements usually differ for various categories of buildings. Building codes can vary in the methodology they adopt to increase the water performance of buildings, either by setting a performance benchmark for the whole building or by specifying efficiency levels for key fittings. The theory underlying the building codes assumes that architects, builders, producers of building equipment, and contractors will apply water saving measures in their designs and constructions. In turn, the local authorities will check whether the designs and actual constructions comply with the code. The code must ensure that the buildings with the worst water performance can no longer be constructed, but these measures usually apply to new buildings, not the existing stock (which are likely to be poor performers). Building codes usually contain either technology standards or performance standards. Technology standards require that a particular feature or device is installed in all new products (e.g. the Irish Building Regulations prescribe the installation of dual flush toilets). Based on these identified effects, outcome and impact indicators can be divided into the following categories (Vreuls 2005):

- Changes in the level of awareness and knowledge.
- Changes in level of adoption of new designs and practices.
- Level of enforcement and compliance.
- Changes in water consumption of buildings.
Figure 13: Building codes: cause-impact relationship, external needs and assumptions

<table>
<thead>
<tr>
<th>Cause-Impact relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define a policy, set up objectives</td>
</tr>
<tr>
<td>Approbation of the policy</td>
</tr>
<tr>
<td>Implementation</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>(re) action of targeted stakeholders: Manufacturers, building industry, citizen</td>
</tr>
<tr>
<td>Monitoring, feedback, policy evaluation</td>
</tr>
<tr>
<td>Water savings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion with stakeholders, expertise and data</td>
</tr>
<tr>
<td>Achieve consensus for policy makers’ validation</td>
</tr>
<tr>
<td>Need for technical solutions reference</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enough means are in place to have a real and fair enforcement</td>
</tr>
<tr>
<td>Mandatory approach will impose planned changes of the market, of owners, etc</td>
</tr>
<tr>
<td>Controls will avoid false reporting</td>
</tr>
<tr>
<td>People won’t change their behavior</td>
</tr>
<tr>
<td>The technical solution will be durable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indicators</th>
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</thead>
<tbody>
<tr>
<td>Position of the defined targets as regard other programs or potential savings</td>
</tr>
<tr>
<td>Number of people involved in enforcement</td>
</tr>
<tr>
<td>Update interval</td>
</tr>
<tr>
<td>Number of buildings concerned</td>
</tr>
<tr>
<td>Rate of applications</td>
</tr>
<tr>
<td>Number of controls</td>
</tr>
<tr>
<td>Water saving estimation</td>
</tr>
</tbody>
</table>
Strategic plans or planning guidelines are another form of regulatory measure that influences the water performance of buildings. The target groups and mechanisms are quite similar to those of building regulations, the difference that strategic plans or planning guidelines usually outline a comprehensive water conservation strategy rather than simply target buildings. Like building codes, they can use prescriptive technical or performance standards (e.g. the Ordenanza de Gestion y Uso Eficiente del Agua uses a mixed approach). Other planning guidelines only outline the need to develop measures to reduce the water consumption in buildings but leave the type of measures open, therefore allowing flexibility for the architect or developer. Target groups, outcomes and impacts are similar to those illustrated for building codes.
### 3. ANALYSIS OF EXISTING WPB INITIATIVES

With the pros and cons of different policy instrument in mind, an exhaustive literature review was carried out to gather information on WPB initiatives, drawn from government reports, legislative texts, newspapers and online articles, and other published sources, including the official websites of the different water saving schemes and labelling initiatives. Additional information was also gathered through a questionnaire sent to MS and telephonic interviews. The analysis covers not only the 27 Member States (MS) (at the national, regional and local levels) but also third countries that have already developed and applied tools to improve water performance of buildings, such as Australia and the United States.

This chapter presents detailed information on the different standards, schemes, and other WPB initiatives. This review focuses on the following elements:

- Type of scheme (e.g. mandatory or voluntary)
- Operation of the scheme
- Type of building targeted
- Outcomes and impacts

Not all initiatives are analysed to the same level of detail, due to limited data availability and the relatively recent establishment of the majority of water efficiency measures. Also, for more detailed information on some of the WPB initiatives, please also refer to factsheets and tables provided in Appendix 2. However, other aspects have also been analysed in order to gain a better insight into the efficiency and potential limitations of existing approaches, including:

- Success and failure factors
- Methodologies
- Metrics

Mapping of existing regulation and other policy instruments enabled us to identify the implementation related issues in terms of the methodology, scope, and effectiveness. Based on this analysis, the benefits and limitations of different categories of policy measures that shape water efficiency at the building level are assessed. Finally, this feeds into the consideration of the need for a specific approach of water performance of buildings at the EU level discussed in Chapter 4.
3.1. EXISTING WPB MEASURES

3.1.1. VOLUNTARY MEASURES

These are voluntary certification programs aimed at reducing the overall environmental impact of buildings. They usually focus more on the energy performance of buildings but some of them have also developed criteria on water consumption13.

3.1.1.1 United Kingdom

➢ BREEAM: Building Research Establishment Environmental Assessment Method

A) Background and objectives

BREEAM, launched in 1990, is a green building assessment, covering individual buildings or developments. It was developed and is managed by BRE Global in the UK, and building assessments can be made internationally. BREEAM’s objectives are to assess the environmental impact of a building, across a range of indicators, and provide a single performance rating for that building. There are many variations of the scheme for different building types. Both new and existing buildings are also covered by different schemes.

B) Operation

Assessment can be at different stages - pre-design, post-construction, post-occupation – depending on the scheme. Assessments are carried out by members of BRE’s licensed assessor network, who receive training, and the network is accredited by the United Kingdom Accreditation Service. Assessors are also managed under ISO 9001 quality management systems.

For most schemes (Courts, Education, Prisons, Healthcare, Industry, Offices, Retail and Multi-residential dwellings), it uses a scoring system to rank buildings that pass its assessment into one of five levels: PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING. The BREEAM water standards are set out within Water Section (referred to as Wat 1, Wat 2, etc) of the various schemes. However, each scheme has its own set of these central standards (with occasional variations to these core standards) and assessor manuals are available on their website.

The number of credits available through water saving features varies, depending on the scheme, and the overall weighting percentage for water (amongst the 9 sections covered) is 6% for new buildings, extensions and major refurbishments, and 7% for building fit-outs only. One credit is required by all schemes in the Water Consumption category to achieve GOOD, VERY GOOD or EXCELLENT, and two credits in the category for OUTSTANDING.

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13 There is obviously a link between energy and water consumption within buildings but here are only presented schemes which have a specific part dealing with water.
### Table 25 - BREEAM water categories, minimum certification requirements and credit availability

<table>
<thead>
<tr>
<th>Standard title</th>
<th>Credit required to achieve levels</th>
<th>Schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>G</td>
</tr>
<tr>
<td>Wat 1 Water consumption</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Wat 2 Water meter</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Wat 3 Major leak detection</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wat 4 Sanitary supply shut-off</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Wat 5 Water recycling</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Wat 6 Irrigation system</td>
<td>-</td>
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</tr>
<tr>
<td>Wat 7 Vehicle wash</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

P = PASS, G = GOOD, VG = VERY GOOD, E = EXCELLENT, O = OUTSTANDING

BREEAM takes two approaches, depending on the building type, with key fixtures being addressed in most schemes and water consumption (in m$^3$ per person per year) calculated for offices, industrial and education buildings. The first credit in Water Consumption can therefore be achieved by overall water consumption between 4.5 and 5.5 m$^3$ per person per day (estimated using BRE’s Water Calculation Tool) or installation of low-flush volume toilets (less than 4.5 litres – a formula is provided for calculation of cistern volume for dual-flush toilets) and user guidance provided on dual-flush models. One credit is also required in the Water Meter category in order to achieve any rating above PASS, which effectively requires all houses above the PASS rating to have a water meter with a pulsed output installed on the mains supply to each building/unit. BREEAM OUTSTANDING requires a commitment to apply the BREEAM In-Use standard.

C) Outcomes and impacts

The focus of BREEAM water requirements is on reduced water consumption and metering, as is demonstrated by the categories outlined above. The associated requirements regarding key fixtures (toilets) or reduced total water consumption are clear and further credit is available for progressively more efficient toilets, efficient urinals, showers and taps, or further reduced water consumption.

However, the requirement that only some of these fixtures need to have reduced water consumption is an issue, particularly as the fixtures approach does not consider the whole building consumption – a building may be have efficient toilets, but other fixtures may be very inefficient. The requirement for metering is in all buildings rated above PASS is good, and would assist moves toward water management practices.

The control methodology ensures that features are in place, but does not currently measure performance when inhabited, unless signed up to the In-Use scheme.
The scheme has been operational for a significant time and has been involved in many assessments (110 808 projects in total (BRE Global, 2008); 26 606 registered assessments; 9137 certified). Its format has also been used as the basis for other green building schemes, such as the Code for Sustainable Homes. The recent drop in assessments could be attributed to the economic crisis and the transfer of domestic assessments to the mandatory Code for Sustainable Homes.

D) Success and failure factors

The scheme has a broad coverage, being able to assess a wide variety of buildings, and many buildings have already been assessed through BREEAM. BRE Global has therefore gained much experience and is respected in the green building assessment sector. BREEAM can, and is, used internationally, so the adaptability it has demonstrated is likely to maintain its durability.

The residential scheme, Ecohomes, has been adopted by the UK government to form the Code for Sustainable Homes. Therefore the BREEAM residential schemes in the UK may ultimately be sidelined.

Cost of certification and administration could be a failure factor. BREEAM has an approximate assessment fee of 2 400 to 12 000 €14, although information on the size of building that these fees cover is not available (BRE Global, 2008).

➢ AECB (The Association for Environment Conscious Building) Water Standards

A) Background and objectives

The AECB standards are based on performance requirements for individual water-using devices, requiring replacement of fittings with the greatest water consumption, rather than a whole building calculation method.

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14 Assuming 1 € = 0.847 GBP
The energy used to heat water in the home is around seven times greater than that used to treat and supply potable water and the AECB Water Standards prioritise hot water savings. The whole building calculation approach also allows cold-water savings to offset increased hot water use.

B) **Operation**

This scheme provides guidance only and follows the North American and Australian lead (requiring fittings of the lowest water use that have been shown to be acceptable to the majority of users). It does not prevent householders installing even lower flow fittings should they wish to, but this cannot be made a requirement for a building of unknown occupancy. Water pressure is also considered during fittings assessment.

The focus is on consumer behaviour to potentially achieve greater efficiencies than the highest levels of the Code for Sustainable Homes. There are also only two levels of specification provided in the guidance: Good Practice and Best Practice.

C) **Outcomes and impacts**

This scheme has only very recently been launched, and seeks to address some of the criticisms of the Code for Sustainable homes by providing freely available alternative water-efficient building design guidance. However, there is no certification involved and with the new UK Building Regulations coming into force, which follows the Code approach, this approach is increasingly distant from the approach taken by the UK government and is hence unlikely to be used widely.

D) **Success and failure factors**

No information.

3.1.1.2 **France**

- **Démarche HQE: Haute Qualité environnementale**

A) **Background and objectives**

HQE was launched in France in the 1990’s and today it is the corner-stone of French green building design. Its main ideas were develop by "Association HQE", as a voluntary approach, and later it was standardised by different standardisation bodies such as "NF Démarche HQE - bâtiments tertiaire". In 2004 the Certivea agency adopted it for a certification scheme for tertiary and publics buildings, and in 2003 Cerqual (Qualitel) created H&E for residential buildings, based on HQE.

“NF Démarche HQE - bâtiments tertiaire” has a progressive methodology. It uses post-occupancy feedback to improve a methodology that is based on the overall consumption level and implementation of key fixtures approach. Efficiency is perceived has the level of daily consumption in the building, and this figure is compared with “standard” fittings consumption in the same context (the difference between these figures giving a percentage of economy). It objectives are to reduce the environmental impact of a building through eco-design and eco-management engineering, and improve comfort and health, by mandatory
performance levels in 14 targets areas. HQE employs a global approach but more and more some targets like energy and water are becoming the main topics with greater demand for certification. Either a voluntary or certified approach can be used, but here we have studied the certified approach, because it uses tools to estimate and define a performance level.

B) Operation

A contracting owner can implement a green building design following HQE steps. Usually, building design in HQE is voluntary. For example, currently public buildings are “HQE”, but not to a required level. To implement HQE certification “NF Démarche HQE - bâtiments tertiaire”, the contracting owner is given clear information about the sustainability of the building. He could ask for a HQE building certification and provide this certificate that states the defined performances, by target rating, that the building has achieved.

A bottom-up methodology is used to evaluate the current performance of a building and a more efficient target level to reach, looking at current best practice for fittings and fixtures. PERFORMANCE levels have to be reach for different categories of water use: reduction of water consumption (as following), reduction of rain water flowing into the local water grid, increased site land permeability, recycling or treatment of waste water. Performance levels to reach on water consumption are following:

- BASE: Real consumption ≤ consumption reference (building consumption with standard fittings)
- PERFORMANT: Real consumption ≤ 0.90 consumption reference
- TRES PERFORMANT (5 POINTS): Real consumption ≤ 0.80 consumption reference
- TRES PERFORMANT (10 POINTS): Real consumption ≤ 0.70 consumption reference
- TRES PERFORMANT (15 POINTS): Real consumption ≤ 0.60 consumption reference

To be TRES PERFORMANT (High Performance), you need to obtain all the PERFORMANT conditions and to reach a minimum of points on global "Water efficiency" targets. Reduction of water consumption is one of the mandatory conditions to be PERFORMANT and you have to increase this performance further to be TRES PERFORMANT (as shown above).

Specially trained assessors certified by “NF Démarche HQE - bâtiments tertiaire” organisation (Certivéa) ensure technical control of the engineering design and during the build.

C) Outcomes and impacts

“NF Démarche HQE - bâtiments tertiaire” improves water consumption reduction, rain water harvesting, water recycling and water metering in building projects.

During the methodology of water consumption reduction, it is helpful for the contracting owner to define a return on investment, understand the share of water consumption by type of equipment in the building and control outflow. The control methodology ensures that features are in place, and performance is measured by metering during building life, to allow
verification of the actual building consumption in comparison to the estimation generated at design.

With this methodology one compares your building with standard fittings and water efficient ones. At the end one obtains a rate of water consumption reduction performance level to compare with other projects.

Reduction of water consumption could be 5 to 45%. Average water consumption in France is 162 l/capita/day, so 45% of consumption reduction could ensure a reduction of 72.9 l/capita/day. So, a potential of $4,743,856 \text{ m}^3$ of water saving could be achieved.

D) Success and failure factors

The methodology tries to estimate close to the real consumption with assumptions specific to the building under consideration, and could be in consultation with customers. So, we can compare two projects’ rate of consumption reduction (standard consumption compared to efficient consumption), but not two projects’ water consumption.

The main success of HQE is to provide water consumption reduction options, give feedback to the designers and increase use of efficient equipments.

More and more performances are controlled on working. It is an example of improving HQE methodology and feedback on its previous measures. Real consultation between the design team and certification body allows improvement of the methodology.

“NF Démarche HQE - bâtiments tertiaire” gives feedback and tries to evolve the French standard, which is now based on welfare, so will promote greater efficient fittings consumption.

- **H&E: Habitat & Environment**

While HQE is designed for the service sector (offices, hotels, schools hospitals, etc.), H&E is aimed at the household sector and has been adapted to be used for multi-residential buildings as well. It was launched in 2003 by the association QUALITEL. It defines seven environmental topics, and a minimum of six of them have to be completed to be certified (three topics are compulsory). Water is one of the 4 non mandatory topics; the requirements mainly deal with the water efficiency of fixtures within the buildings. It uses a single methodology to implement the certification process, due to the large variety of kinds of user. So, if certain solutions are not relevant, using key fixtures is a minimum for certification.

### 3.1.1.3 Germany

- **The German Sustainable Building Certification (GSBC)**

  A) **Background and objectives**

The German Sustainable Building Certificate was developed by the German Sustainable Building Council (DGNB) together with the Federal Ministry of Transport, Building, and Urban Affairs (BMVBS) to be used as a tool for the planning and evaluation of sustainable buildings. The certification system, which was first developed in 2008 for office and public
administration buildings, covers all relevant topics of sustainable construction, including ecology, economy, socio-cultural and functional topics, such as techniques, processes, and location. The first certificates were awarded early in 2009. Currently, the system is being expanded to include additional buildings types, such as retail, industry, residential and educational buildings. The German certificate evaluates the building’s performance and not single measures, thereby allowing owners and designers a maximum amount of flexibility to achieve the sustainability targets (DGNB, 2009).

B) Operation

The German Sustainable Building Certificate is operated by the DGNB. To start the certification process for a planned building, developers, architects or home owners need to appoint a DGNB accredited auditor who will then register the at the DGNB website. After registration at the website, the auditor submits the object specific specification sheet to the DGNB. It contains the data regarding all criteria of the German Sustainable Building Certification and is a binding declaration of intent by the owner to realize the planned performance goals. The DGNB checks the documents submitted by the auditor. If they comply with the requirements of the certificate, the owner receives a pre-certificate for his building. The pre-certification process allows owners to optimise their building during the planning phase and to market it at an early stage with verifiable statements about its sustainability. On this basis, the building design and construction can be started. The consulting auditor is to establish an accompanying planning and construction documentation in accordance with the specifications of the DGNB documentation guidelines. After completion of the building, the DGNB checks if the specifications of the pre-certificate have been realized. An assessor performs a conformity inspection based on the DGNB documentation guidelines, makes plausibility checks, and takes control-samples. Finally, the DGNB reviews if the entire certification process was executed properly. If all requirements are fulfilled, the owner receives, depending on the degree of compliance, the gold, silver, or bronze certificate from the DGNB and BMVBS, consisting of a certificate and a plaque for his building which may be use for marketing purposes.

The basis of the evaluation is a list of key topics with 49 corresponding criteria for sustainable construction which are weighted differently, depending on the building type to be evaluated. Water consumption and sewage generation is included as one evaluation criterion under the overall assessment of a building’s environmental performance. As part of the certification process, the “specific water-use value” needs to be estimated by adding the ascertained potable water consumption and the sewage production. This represents a simple value for the evaluation of the handling of water in the building. The basis for the evaluation is established with the aid of defined assumptions concerning consumer behaviour and specific values. Each criterion can be assigned a maximum of 10 points, depending on the documented or calculated quality. All criteria are weighted with a factor from 0 to 3, because individual criteria are treated as either more or less relevant. The degree of compliance with the requirements of the certification is calculated in accordance with the evaluation matrix. From a total degree of compliance of 50 %, the bronze certificate is awarded, 65 % for silver and 89 % for gold. Alternatively, the total degree of compliance is
indicated by a grade: a total degree of compliance of 95% corresponds to grade 1.0, 80 % corresponds to 1.5 and 65 % corresponds to 2.0 (DGNB, 2009)

C) Outcomes and impacts

Despite its fairly recent establishment, the scheme already has had considerable success (DGNB, 2009):

- Since the inception of this certification system, six buildings have been awarded gold, 7 silver and three bronze awards: one building is currently still being evaluated.
- Four buildings have been issued with gold, seven with silver and one with a bronze pre-certificate.

D) Success and failure factors

Given that the certificate was only launched in 2008, it is difficult to draw any lessons at this point. However, the DGNB identified the following key strengths of the scheme:

- The evaluation system is based on the involvement, from the beginning, of interested parties during the development of new variations. A supplementary consultation procedure ensures that the requirements of the construction and real estate sector are systematically queried and included into the system.
- The evaluation system allows a maximum degree of flexibility as criteria can be weighted differently, depending on the building type to be evaluated. Thus, each version of the system, hence each building type, has its own evaluation matrix. On this basis, the German Sustainable Building Certificate can be adapted to the individual requirements of different building types. Similarly, it can be adapted to regional requirements or social developments, for example to the increasing importance of individual criteria like indoor air quality or CO₂ emissions of a building.

3.1.1.4 Australia

A) Green Star

The Green Star Certification was initiated in 2002 by the Green Building Council Australia (GBCA). It is a formal process which involves a project using a Green Star rating tool to guide the design or construction process during which a documentation-based submission is collated as proof of this achievement. Water forms one of nine environmental performance indicators upon which the award of the Green Star is based.

B) Operation

Although Green Star tools are freely available for self-assessment, a design, project or building cannot publicly claim or promote a Green Star rating or use the Green Star rating logo unless the GBCA has validated the project’s achievement through formal assessment. There are two rounds of assessment available to a project in which to achieve validation of credits claimed. Few projects achieve their desired Green Star Certified Rating during the
Round 1 Assessment. Typically a project will be awarded one-third of the claimed points at the conclusion of the Round 1. Approximately 90% of projects achieve their desired Green Star Certified Rating during the Round 2 Assessment. Project teams are notified of their score based on the recommendation of the Assessment Panel and, where applicable, of any innovation credits that have been awarded by the GBCA. If a Certified Rating is awarded, the project will receive a framed certificate, award letter, marketing kit and relevant Green Star logos (GBCA, 2009). Water credits address reduction of potable water through efficient design of building services, water reuse and substitution with other water sources (specifically rainwater). The following certified rating can be obtained according to the number of points achieved: BEST PRACTICE, AUSTRALIAN EXCELLENCE, and WORLD LEADERSHIP.

C) Outcomes and impacts

152 certified Green Star projects (May 2009)

D) Success and failure factors

Cost of certification and administration could be a fail factor, as the cost of assessment starts at over approximately 3 000 € for buildings smaller than 2 000m$^2$ to approximately 18 000 € for buildings greater than 100 000 m$^2$\textsuperscript{15}.

NABERS: National Australian Built Environmental Rating System

A) Background and objectives

The National Australian Built Environment Rating System (NABERS) is a national voluntary program designed to rate an existing building’s operational performance against a number of benchmarks using a scale from 1-5 stars. NABERS currently measures the operational impacts on the environment in the areas of energy and water, and will soon expand to include waste and indoor environment quality. Currently, NABERS provides separate ratings for (Clark 2008; GBCA 2009a):

- Office building: This covers the environmental impacts of the activities and services traditionally supplied by, or within the control of, the landlords/operators of office buildings.
- Office tenancy: This covers the environmental impacts of the activities that are under the control of office occupants.
- Hotels: available for AAA-rated business hotels
- Homes: This is designed for occupants of homes, covering all situations where the home carries all of its own services and land as a single identifiable package.
- Ratings are in development for hospitals, hotels, schools and retail centres.

\textsuperscript{15} http://www.gbca.org.au/green-star/certification/assessment-fee/962.htm; assuming 1 € = 1.728 AUD
NABERS has been developed to (GBCA 2009a):

- Rate the environmental performance of operational buildings and homes.
- Provide separate ratings for the different stakeholders within a building (such as landlords and tenants) where appropriate.
- Provide an explicit and consistent rating system methodology, with a clear performance-based structure and methodologies and defaults where necessary.
- Provide a realistic rating scale that recognises and rewards current performance levels, and encourages and promotes best practice.
- Allow for voluntary self-assessment, with the option of seeking a certified rating from an accredited provider if desired.
- Contain appropriate adjustments for factors such as climate and occupancy patterns.

B) Operation

The NABERS tool was originally developed by the Australian Dept. of Environment and Heritage (DEH) and is now implemented by the NSW Department of Environment and Climate Change (DECC). The DECC manages the operation and development of accredited NABERS rating systems throughout Australia. This is overseen by the NABERS National Steering Committee, which is comprised of representatives of the Australian and State and Territory Governments, and the Australian Sustainable Built Environment Council as an observer. NABERS is available throughout Australia, with accredited assessors available to perform accredited ratings in every state and territory. It is important to note that ratings are only valid for 12 months from certification (Clark, 2008; GBCA, 2009). The water rating applies to the whole building and is based on the calculation of the annual water consumption in litres per square meter.

C) Outcomes and impacts

Since this scheme was launched (Clark 2008):

- 40% of national office market has been rated for Energy.
- Exact number of certified buildings is not available though.
- Average ½ star Energy improvement, 1 star Water: annual savings of 80,000 tonnes of CO2 and 220 ML of water

D) Success and failure factors

No information was found.

3.1.1.5 USA, Canada

LEED: Leadership in Energy and Environmental Design (LEED) Green Building Rating System
A) Background and objectives

LEED is a certification system that measures how well a building performs across nine metrics, including water efficiency and others such as stewardship of resources and site sustainability. LEED was developed by the U.S. Green Building Council (USGBC), in 1998, to provide building owners and operators with a framework for identifying and implementing green building design, construction, operations and maintenance. The Canada Green Building Council also has its own version of LEED.

LEED can be applied to commercial as well as residential buildings, at any time throughout the building lifecycle (design and construction, operations and maintenance, tenant fit-out and significant retrofit). Assessment can also be applied to a wider urban community.

B) Operation

LEED points are awarded on a 100-point scale, with credits weighted to reflect their potential environmental impacts. A project must satisfy all prerequisites and earn a minimum number of points to be certified.

Similarly to HQE, a reference consumption value is calculated for a specific new building, using standard fixture fittings, and a new building must save 20% compared to this standard consumption through the use of more efficient fixtures. Water pressure is also considered. Existing buildings must to a level equal to or below the LEED 2009 for “Existing Buildings: Operations & Maintenance baseline” (calculated assuming 100% of the building’s indoor plumbing fixtures and fittings meet the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code or International Plumbing Code). Fixtures and fittings included in the calculations for this credit are toilets, urinals, showerheads, taps, tap replacement aerators and metering taps. The LEED 2009 water use baseline is set depending on the year of substantial completion of the building’s indoor plumbing system.

The new buildings scheme does not discuss water metering, while the existing building scheme does include this feature as a credit-gaining option. Other technologies discussed include landscaping irrigation, water harvesting, cooling tower water management and further water use reduction technologies.

LEED is a third-party certification program and the scheme is developed through an open, consensus-based process led by LEED committees. Each volunteer committee is composed of a diverse group of practitioners and experts representing a cross-section of the building and construction industry. The key elements of USGBC’s consensus process include a balanced and transparent committee structure, technical advisory groups that ensure scientific consistency and rigor, opportunities for stakeholder comment and review, member ballot of new rating systems, and a fair and open appeals process. CERTIFICATION, SILVER, GOLD and PLATINUM are the achievable level depending on the total number of credits.

C) Outcomes and impacts

In the US, state and local governments adopting LEED for public-owned and public-funded buildings; there are LEED initiatives in federal agencies, including the Departments of Defence, Agriculture, Energy, and State.
35,000 projects are currently participating in the LEED system, comprising over 4.5 billion square feet of construction space in all 50 states and 91 countries.

D) Success and failure factors

Cost of certification and administration could be a fail factor, as the cost of certification for LEED, for a construction review only for a building of less than approximately 5,000 m², starts at approximately 4,000 € and rises to approximately 24,000 € for a combined design and construction review of buildings of more than approximately 50,000 m². Prices are scheduled to increase marginally from the beginning of 201016.

3.1.2. ECO-LABELS

Eco-labels are very similar to the previous category of instruments as they also provide certified information about environmental quality. They are presented in a separate subsection because eco-labels are not building specific. In fact, they cover a wide array of products and only the programs which have developed water performance criteria for buildings are presented here.

- The EU Eco-Label

Requirements for the labelling of tourist accommodation were established in 2003. Water requirements mainly focus on water efficiency of key fixtures, water metering and information to guest.

No information was available on the number of tourist accommodation certified.

- Nordic Swan (DK, SWE, FIN, NOR, ICE)

A) Background and objectives

The Nordic Council of Ministers decided to implement the Nordic Swan label (members include Denmark, Finland, Sweden, Norway, Iceland) in 1989 as an officially certified environmental label. The first licenses to use the Swan label were awarded at the end of 1991. It is the intention that only the most environmentally friendly brands within a given product category should be able to meet the gradually increasing requirements for obtaining the Swan label (without lowering the ‘use’ quality of the product).

Like the Blue Angel, it addresses general environmental, quality and health criteria for a wide range of products. The Nordic Eco-label deals with washing machines, dishwashers, car wash facilities, hotels, restaurants and laundries (Bjorner and al. 2002). In the guidelines developed in 1992 and revised in 1996 by the Nordic Council of Ministers, it is stated that the eco-labelling should aim to: (1) contribute to reduced environmental impact from consumption, (2) guide consumers and purchasers in their wish to practice environmentally conscious purchasing, and to stimulate the development of products and services that are associated with a lesser environmental burden compared to otherwise equivalent products (Reinhard et al 2001)

B) Operation

There are four limit values: Energy consumption (mandatory), Water consumption, Chemical products and Waste management. To acquire the Nordic Eco-label, at least one limit value, besides the energy consumption, must be fulfilled. It means that water consumption requirements (in litres per guest night) are not compulsory.

C) Outcomes and impacts

- In May 2009 approximately 150 hotels, 24 restaurants, ten car washes, and seven laundries had been awarded the Nordic Swan label.
- No further information on estimated water savings could be found.

D) Success and failure factors

- In a study carried out in 2001 by Reinhard et al, the authors report a general negative attitude towards eco-labelling in all of the Nordic countries.
- Other factors that have influenced the specification of label requirements for different products or services include the existing differences in the environmental, technological, market and cultural characteristics of the Nordic countries. These differences will sometimes create obstacles to setting strict criteria that are relevant to the situation in all the Nordic countries, thereby imposing further limitations on the potential of the Swan label.

3.1.3. MANDATORY INSTRUMENTS

3.1.3.1 Spain

Although Spain does not appear to have a national regulation specifically dedicated to WPB, some articles of the national building code influence it.

- Building codes

The national building regulation (Código Técnico de Edificación, CTE) was revised in 2006. Surprisingly, whereas there are numerous local initiatives dealing with WPB in Spain, this code doesn’t have a specific section dealing with it. It is understandable, given that the writing of CTE began in 2002 when energy aspects were receiving most focus (Conama, 2008). In fact, CTE only requires that taps in public buildings must be fitted with water saving devices.

On the other hand, the Government of Catalonia published an amendment in 2006 which goes further than CTE, since it makes the installation of water saving devices for taps and flushing boxes mandatory for every new or renovated building (Fundación Ecología y Desarrollo, 2006).
Ordenanza de Gestión y Uso Eficiente del Agua en la Ciudad de Madrid

A) Background and objectives

In 2006, the city of Madrid introduced a set of mandatory requirements regarding sustainable water management in the city. Within the framework of its Agenda 21, the Municipality of Madrid developed a water demand management plan in 2005 to set up a sustainable and integrated water use in the capital. One of its objectives is to reduce the water consumption of 12% by 2011. It resulted in a byelaw in 2006: the “Ordenanza de Gestión y uso eficiente del agua en la ciudad de Madrid” which deals with many facets of water management in the capital. Among them are systematic water metering and installation of water saving devices for taps, showers and toilets in new buildings, all public buildings and in case of major refurbishment of existing buildings. Outdoor water uses are also addressed, in particular through requirements for landscape irrigation.

B) Operation

The water requirements for buildings are supposed to be checked during the delivery process of building permits (new buildings) and refurbishment permits (existing buildings). A special service at the municipality is in charge of compliance control: the “Oficina azul”. The byelaw specifies a deadline for compliance of some of the requirements. In fact, existing public buildings have one year to put in place electronic or timed shut off taps that deliver a maximum volume of 1 litre between opening and closing. Existing dwellings have 3 years to install individual metering.

C) Outcomes and impacts

Given that the bylaw is rather recent, there is little general information about its progress and uptake, therefore no specific results concerning WPB are available.

In order to facilitate the implementation of its byelaw, the municipality of Madrid published a presentation guidebook for the public to understand and comply with the new legislation.

The set of requirements regarding WPB is rather comprehensive (see Appendix 3: Tables summarizing existing schemes and their water requirements). Systematisation of individual water metering is an essential step, not only to gather valuable information about water use but also to involve every household in the water conservation strategy. The associated requirements regarding key fixtures (toilets, taps, and showerheads) are clear. However, the fact that there is no differentiation according to the function of the tap may represent an obstacle. Indeed, while a low flow rate is not a problem for hand washing, it might be a hindrance when a large amount of water is needed rapidly (receptacle filling for instance). Finally, information about the water performance of the building has to be given at the point of rental or sale, which is likely to be a positive way to influence behaviour.

D) Success and failure factors

The fact that the byelaw is included in a wider strategic water management plan gives more strength and legitimacy to the regulation.
We choose to present the case of Madrid because it is one of the most comprehensive as regard WPB. Moreover this local regulatory initiative is also representative of many other comparable byelaws in Spain (Alcobendas, Asturias, Barberà del Vallès, Camargo, Castro Urdiales, Getafe, San Cristóbal de Segovia, Sant Cugat del Vallès). Most of them set similar requirements regarding toilets, taps and showerheads, but there is variation. For instance the byelaw in Castro Urdiales limits flow rate of taps to 5l/mn and flush volume of toilets to 7l (respectively 8l/mn and 6l in Madrid). The difficulty here is to determine whether local water contexts justify variations in requirements, or if uniform requirements at the national (or European) level would be more relevant.

Also it is important to highlight the fact that these byelaws are not building specific. Requirements dealing with WPB are in general a part of wider water management plans at the local scale.

3.1.3.2 Italy

- Local building codes

As in Spain, there appears to be no specific national legislation which sets water performance levels for buildings. However, certain areas carry their own legislation, often differing greatly from one to the other. Within the Building Regulations of the City of Avigliana (D.C.C, No. 91), it is stated that toilets in all new and renovated buildings must be equipped with dual flush systems with maximum flush total of 6 litres. However, this rule does not apply for systems that rely on harvested rain-water. It is also required for all taps of the bathrooms and showers, except those of bath tubs, to reduce the flow of water to 8-12 l/min. The General Regulatory Plan of the municipality of Urbino (D.C.C, No. 49) state that newly installed toilets must use dual flush systems, where the larger flush may be between 5 and 8 litres and the smaller between 3 and 5 litres. In the province of Sassari on the island of Sardinia, Energy Regulations (D.C.C No. 67) also state that toilets in all new and renovated buildings must be equipped with a dual flush system, with a maximum total of 6 litres. As in Avigliana, this does not apply to systems using harvested rainwater. Furthermore, it is required that all taps of the bathrooms and showers, except those of bath tubs, to reduce the flow of water to 8 l/min.

3.1.3.3 France

The national regulation related to water use in buildings is more focused on water quality rather than consumption. A local program setting mandatory requirements regarding water performance of buildings has been identified:

- SAGE Gironde: Schéma d’Aménagement et de Gestion des Eaux

A) Background and objectives

SAGE is a local regulation document on water (Integrated Water Management Plan) elaborated on the scale of a water basin. SAGE schemes exist widely in France, but very few have gone as far as the scheme in Gironde. Driven by specific water scarcity problems, publics bodies reacted in 2003 by passing tougher regulation aiming at reaching a global 10% saving in water abstraction in 10 years. Objectives are precisely defined and partitioned
between specific actions, and this is a major help in aiding the ongoing evaluation of this policy and its adaptation.

Buildings are targeted through two actions: the setting up of a water savings action plan for buildings under public responsibility, which encompass schools, universities, hospitals, the town hall and social housing (called “public buildings” hereafter). The second action is an obligation for social housing to take into account water efficiency one year after SAGE validation in order to rapidly reduce water prices for low income population.

One main limitation is that only public buildings have been targeted. Public bodies need to provide an example, but above all local competencies are limiting possible actions. Local bodies haven’t found a way to impose mandatory restrictions on privately-owned buildings. Their given objective of 20% savings in 5 years is ambitious, but estimated as achievable with only few changes of key fixtures and behaviours.

B) Operation

This legal text forces public buildings to set up water saving action plans within three years, which should be in place 2 years after drafting. This enters typically in what we called “Water management plan” approaches. It encompasses all the public buildings of a French department, which is assessed as being 20% of building water consumption in France.

It was outlined that this kind of methodology could lead to minor changes because of the potential lack of predefine objectives. Here, this regulation has not set up predefined water savings objectives that each building should reach. But a general saving objective (at a reasonable cost) has been assessed for each specific sector of buildings beforehand. With the obligation to transmit their plan and water savings achieved to the water management body, plans will be evaluated indirectly toward these predefined objectives. In short, controls on objectives are not imposed, but a general follow-up of the action plan is carried out to evaluate proposed savings and to react if ambition is too low.

On the other hand, this kind of initiative offers flexibility and a cost efficient approach, by leaving the possibility to building manager of defining their own objectives. But above all, this requirement impels the building owner to enter into a real water management strategy, based on real consumption value, and within which it is possible to act on behavioural aspects of users of the building.

As discussed, to be efficient, such an approach requires ambitious enough objectives and a control system. With local authorities and state bodies being the main actors of the board, and with existing secretarial and services since several years, it can be estimated that implementation means will be sufficient. It is reported that political moves will clearly push this policy, thus limiting local forces that are slowing down the process.

C) Outcomes and impacts

The awaited outcome is the finalisation within 3 years of the water management action plans, and of water saving actions within 5 years. Global awareness will rise among civil servants and public building visitors, which are numerous. All these actions form the basis of
strong communication campaigns, which aim at spreading to private companies and household water management practices.

By the end of the 5 year implementation period, the targeted impact is the reduction by 20% of the water consumption of public buildings, which count for 20% of all water abstraction from the French public supply system. Thus this action through public buildings accounts for almost a half of the total targeted reduction of 10%, but the remaining half being more difficult to assure through other measures, because of the non-mandatory instruments used (information and training mainly).

D) Success and failure factors

Several aspects favour reaching the given objectives:

- A comprehensive ex-ante impact assessment was made to assess water consumption patterns
- All saving actions can be chosen, even actions targeting consumer behaviour
- The strength of this scheme is that it is also to be built upon a mandatory instrument and on an existing and strong administrative area (water basins have in general their limitations, complicating administrative management for public bodies in general defined on other administrative boundaries)
- Quantitative objectives are defined
- Implementation and control means are present, as decision maker will to improve water efficiency

Failure factors could come from un-ambitious action plans, and difficulties to compel some building owners to go further. Actions other than public buildings will depend on the success of the communication scheme and on the effort of private water companies on leakage.

3.1.3.4 United Kingdom

The Code for Sustainable Homes

A) Background and objectives

The Code for Sustainable Homes in itself is not a regulatory instrument; in fact it is comparable to other green building rating tools. It replaced in 2007 the BRE Ecohomes tool for the assessment of new housing in England. In February 2008, the UK Government announced that mandatory rating against the Code for new homes will be implemented from May 2008. The overall objective is the reduction of the environmental impact of new homes.

B) Operation

The Code is managed by the UK Department for Communities and Local Government. Meeting minimum requirements is only mandatory for government funded housing. Water efficiency is one of the 7 key areas assessed (Energy efficiency, waste management, etc.). The Code awards new homes a star rating from 1 to 6, and all new domestic buildings
constructed with public funding must reach at least level 3 of the code. As for water, the Code fixes levels of consumption in litre per day per person. These objectives can be reached by installing water saving fixtures or rainwater harvesting.

C) Outcomes and impacts

Water targets in the Code are mandatory and cannot be trade against other environmental measures which makes water saving one of the priorities. Water criterion of the Code is based on overall consumption approach calculated through the Code Water Calculator. It projects water use within new homes, based on the water performance of key fixtures and devices and possible rainwater harvesting system. In fact the Code doesn’t set specific requirements regarding water fittings. In theory, it gives more licence to builders, as they can chose the performance of each water fitting according to the level they want to reach. The advantage of this water calculator is to provide a value of the WPB allowing occupants to benchmark the water efficiency of their homes. Giving information about the sustainability of new homes to buyers can influence behaviours in a positive way.

D) Success and failure factors

Given that it is a recent measure, there is no comprehensive feedback available yet. However some critiques have been recently put forward. They mostly claim that water requirements of the Code are too high and that meeting higher levels would require the installation of very low flow fixtures which wouldn’t be accept by users (Good Homes Alliance, 2008). In fact, it means that meeting higher levels of the Code is only possible with reuse systems such as rainwater harvesting or grey water reuse. After obvious actions for the improvement of fixtures, reuse systems are the most promising technology in terms of WPB. Their effectiveness is still questioned and might need further improvement before they can be used on a wide scale.

Cost could be a barrier to this instrument type, with the total cost of assessment per building was estimated at approximately 40 €\(^{17}\) per home. The annual projected cost for implementing the Code over a 15-year period was estimated at approximately 38 000 € (Department for Communities and Local Government, 2006)

- Water Supply (Water Fittings) Building Regulations 1999

This national building regulation sets minimum standards for the water consumption of WCs. In 2001, the Water Supply (Water Fittings) Regulations lowered the maximum flush volume of newly installed WCs from 7.5 litres to 6 litres and permitted the use of dual flushing mechanisms. However, due to the long lifespan of toilets, change takes times. For instance around 62% of existing housing in the United Kingdom is still equipped with high flush volume WC (flush volumes greater than 6 litres) (Defra, 2008).

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\(^{17}\) Assuming 1 € = 0.847 GBP
A) Background and objectives

Following a joint Communities and Local Government/Defra consultation in 2006/7 (Defra, 2007), the UK Government decided to introduce a regulatory standard of a maximum consumption of 125 l/person/day for all new dwellings. Implementation of the amendment is planned for October 2009. The appropriateness of the requirement and the calculation methodology to deliver this policy has been submitted to consultation in 2008 (Building Regulation Consultation, 2008). To our knowledge, the United Kingdom is one of the first countries where a minimum “whole building” water performance level is about to be established through an amendment to the UK Building Regulations.

B) Operation

The requirement will be implemented through an amendment to the UK building regulations. The calculation procedure will use a simplified version of the Water Calculator of the Code for Sustainable Homes. Control will be conducted by Building Control Services who will examine the declared schedule of appliances and undertake checks in the completed building.

C) Outcomes and impacts

To date the regulation is not in place; implementation is scheduled for October 2009.

D) Success and failure factors

We present here some results of the consultation conducted in 2008.

Though there is an overall consensus on the need for government action on the water efficiency of buildings, the amendment has been criticized. For instance manufacturers doubt that user will fully accept the very low flow taps which are needed to meet the requirements. But the main concern is about the low flows in drains and sewer resulting from the reduction in water use. In fact “a majority of respondents [to the consultation] believe a reduction in water use could lead to problems with blockages in drains and sewers” (Building Regulation Consultation, 2008).

3.1.3.5 Ireland

This amendment in 2008 to the Irish building regulation makes dual flush toilets mandatory in new buildings and in existing buildings where sanitary WCs are being replaced. This instrument has a national coverage. However, it does not define water consumption limits. This can be seen as a measure for WPB considering that dual-flush toilets consume less water than conventional single flush devices (see WES study).
3.1.4. **STANDARDS**

A standard is defined as a document, established by consensus and approved by a recognised body that provides (for common and repeated use) rules, guidelines or characteristics against which a product’s performance can be measured. Standards are based on consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits. In Europe, standards regarding building and construction activities are being developed by the Technical Committee 350 of CEN.

<table>
<thead>
<tr>
<th>SC/WG</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEN/TC 350/WG 1</td>
<td>Environmental performance of buildings</td>
</tr>
<tr>
<td>CEN/TC 350/WG 2</td>
<td>Building Life Cycle Description</td>
</tr>
<tr>
<td>CEN/TC 350/WG 3</td>
<td>Products Level</td>
</tr>
<tr>
<td>CEN/TC 350/WG 4</td>
<td>Economic performance assessment of buildings</td>
</tr>
<tr>
<td>CEN/TC 350/WG 5</td>
<td>Social performance assessment of building</td>
</tr>
</tbody>
</table>


“While energy costs are the utility cost that has historically been most subject to price increases disproportionate to inflation, other utilities (especially water) can be subject to similar pressures over the period of analysis.”

When considering the lifetime of a building, which may reach 100 years, the costs of utilities and hence the utilities consumption performance of the building will have a significant impact. Although full Life Cycle Costing is very complex and hence not calculated in this study, an indicative simplified payback period calculation for selected options is provided in section 3.4.

In general, existing or currently developed standards provide a general framework for the assessment and the improvement of overall environmental performance of buildings. Most of them focus on the environmental impact of construction products (Environmental Products Declaration), design and construction phases. No standards were found dealing directly with water performance of buildings. A telephonic interview with the secretary of TC 350 revealed the lack of methodology to assess the water performance of buildings in the building occupancy phase.

3.1.5. **OTHER INSTRUMENTS**

Other instruments and policy mixes are difficult to identify and assess. No instruments specifically dealing with WPB were found. Some tax rebates schemes exist but they are more focusing on water efficient products or water reuse systems. For instance in France, an amendment introducing tax rebates for the installation of rainwater harvesting systems was voted in 2006. A UK tax rebate scheme is described as an example in the following paragraph.
Enhanced Capital Allowances (ECA)

The scheme is managed by the UK's Department for Environment, Food and Rural Affairs and enables businesses to claim 100% first year capital allowances on investments in technologies and products that encourage sustainable water use. Businesses are able to write off the whole cost of their investment against their taxable profits of the period during which they make the investment. The objective is to encourage businesses to invest in water saving technologies.

A Water Technology List is provided to inform businesses which categories of technologies the Government currently supports within the ECA scheme (such as: efficient fixtures and washing machines, flow controllers, leakage detection equipment, meters and monitoring equipment, rainwater harvesting equipment, small scale slurry and sludge dewatering equipment, vehicle wash water reclaim units, water efficient industrial cleaning equipment and water management equipment for mechanical seals). There are product-dependent eligibility criteria for individual products within categories, to ensure that they are effective.

The categories and technologies are expected to be reviewed on an annual basis, on the basis of satisfactory methods of certification and identification, cost effectiveness and costs to the UK Government. Additional categories and technologies may also be added to the scheme, including those proposed by companies or associations.

No information is available on the outcomes and impacts of this scheme, such as water and money savings achieved, as the relevant data is spread across several government departments. Processes are currently being reviewed to allow collection and analysis of this data to assess progress and success.
3.2. ANALYSIS OF METHODOLOGIES

A global analysis of methodologies used by these instruments is presented in this section. Two key methodological issues discussed in the first chapter are considered:

- What is the global approach for the definition of a “high performance” building?
- Which metric should be used, and why?

3.2.1. MEASUREMENT OF THE WATER PERFORMANCE OF BUILDINGS

Water performance of a building can be defined as the overall water consumption within the building. In the initiatives described in the preceding section, different methodologies are used to measure water consumption in buildings. These different approaches are presented below.

3.2.1.1 Key fixtures approach

In this approach, a building is considered water efficient if its fixtures are water efficient. It sets water efficiency requirements for key fixtures used in buildings. Toilets are systematically addressed, as these are frequently the main source of water consumption in buildings and therefore provide a significant water saving opportunity, followed by taps and showers and sometimes cooling systems. Eco-labels, and most of the regulations discussed in the previous section (except the Code for Sustainable Homes and the SAGE Gironde) follow the key fixtures approach.

The key fixtures approach is quite straightforward, as it targets fixtures that have the highest water consumption. This approach can be applied to both new and existing buildings, and is a relatively simple process involving the selection of appropriate water efficient appliances. However, it does not consider the whole building, therefore may miss opportunities to make savings in ways other than the “standard” fixtures and at the system level.

3.2.1.2 Global water consumption approach

This approach assesses the overall water consumption of a building, taking into water consuming fixtures, and also other water consumption reduction options such as rainwater harvesting. Most of the green building tools, such as the UK’s Code for Sustainable Homes and HQE (France), use this approach and base their reduction requirements on an estimated “standard” water consumption reference value (using a “per person” or “per area” metric). The reference value can be a national average for a given building type, or can be calculated for a specific building during design. The water reduction goals are then fixed depending on the type of water saving fixtures in place. See Erreur ! Source du renvoi introuvable. for a description of the BREEAM water calculation tool.

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18 Although there is an example the German Sustainable Building Certification which includes sewage water in its calculation.
Box 4 - Estimation of potential water savings using the BREEAM water calculation tool

Assumptions:
The following assumptions are used for fixture use frequencies. If fittings water consumption data is not available, fixed assumptions are set for toilets, taps, urinals and showers. They are detailed in the following table.

<table>
<thead>
<tr>
<th>Fixtures</th>
<th>Uses/day/person</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>1.3</td>
<td>6 (l/flush)</td>
</tr>
<tr>
<td>Taps for hand wash basins</td>
<td>2.5</td>
<td>12 (l/mn)</td>
</tr>
<tr>
<td>Cistern serving single urinal</td>
<td>2</td>
<td>10 (l/use)</td>
</tr>
<tr>
<td>Cistern serving two or more urinals</td>
<td>2</td>
<td>7.5 (l/use)</td>
</tr>
<tr>
<td>Urinals with manual flush or automatic pressure flush valves</td>
<td>2</td>
<td>1.5 (l/use)</td>
</tr>
<tr>
<td>Shower-heads</td>
<td>0.1</td>
<td>14 (l/mn)</td>
</tr>
</tbody>
</table>

Specific data:
User has to enter the number and efficiency of the real fixtures of the building (dual toilet 3-6 flush, tap of 8 l/minutes, etc.). Use frequencies are pre-defined assumptions, thus keeping the possibility to directly compare consumption levels between buildings because of comparable consumption patterns and avoiding potential cheaters to drive uses too low, but also decreasing assessor freedom.

Calculation:
The calculation multiplies given fixture efficiency with use frequencies, and thus obtains total water use/day/person (no normalisation is needed here, as frequencies have already integrated this metric). The obtained level is then rated against a predefined credit threshold.

Other elements:
Calculations for the use of harvested rainwater and reuse of greywater are also included. These can then be set within the calculator to be used to supply the toilets and urinals. The rainwater harvesting is calculated by using the figure for annual rainfall and the catchable roof area, with a coefficient for resulting collection (dependant on selection of roof type) and filtration loss. Greywater volume is calculated by volume of water used by the fixtures that supply the greywater system – either showers or taps, or both.

Credit is awarded for calculated consumption below the following thresholds:

- 1 credit where consumption is 4.5 - 5.5 m³ per person per year
- 2 credits where consumption is 1.5 - 4.4 m³ per person per year
- 3 credits where consumption is <1.5 m³ per person per year

Using the reference figures for fixtures as described above as a baseline, assuming all urinals are served by one cistern, the calculator gives a water consumption figure of 8.34 m³ per person per year without water harvesting or reuse. Hence, it is possible to calculate that the award of the following credits will result in savings, compared to a “standard” building performance, of:

- 1 credit – at least 2.84 m³ per person per year
- 2 credits – at least 3.94 m³ per person per year
- 3 credits – at least 6.84 m³ per person per year
Schemes using this methodology frequently provide a calculation tool (as described in **Erreur ! Source du renvoi introuvable.** ) to facilitate assessment of the theoretical “standard” and “efficient” consumption of the specific building at the design stage (using average consumption figures for “standard” fixtures and average use frequencies), to provide a test platform for different fixture options. For existing buildings, the calculation is based on the fixtures already in place. If integrated as predefined standard value or possible default value, the use frequency of fixtures in the calculation tools are drawn from previous research, and hence may vary. As depicted in the literature review, the lack of harmonised data at aggregated levels such as local/regional or Member State, weaken these calculations. Sources and statistical representations of the data are important parameters to be kept in mind.

The methodology is more complex, involving calculations and assumptions, and the schemes using this type of methodology usually require trained assessors to evaluate and certify the building. These factors add cost, and many schemes have charges that users must pay for the assessment process and certification, adding up to thousands or even tens of thousands of Euros. Assessor networks are used, either independently accredited or not, and their training also adds to the schemes’ administrative burdens. However, a part of the cost of these schemes could also be attributed to the premium the market is willing to pay in order to have the promotional benefit of being certified. Therefore, the fees quoted for BREEAM, Green Star, and LEED in the scheme descriptions may not accurately reflect the actual cost of administering the scheme. The Code for Sustainable Homes cost-benefit impact assessment is likely to be a more accurate estimation of administrative costs of residential building schemes. All of these costs do not take into account the savings attained through reduced water consumption.

The **Erreur ! Source du renvoi introuvable.** and **Erreur ! Source du renvoi introuvable.** below demonstrate two possible routes to evaluate the overall consumption approach.

The BREEAM water tool is a comparative tool – the accuracy of the water usage is not as important as the relative consumption of different fixture specifications. If the building does not have water efficient measures installed, the water calculator will award less credits. Hence, the calculator tool is used to compare buildings, and not make a precise prediction of a building’s overall water consumption.

HQE has a more flexible approach, where most of the calculation details are controlled by the builder or owner. The main purpose of the calculations is to assess and judge what improvements an individual building can make – but these improvements are assessed by a factor of improvement (a percentage improvement). This is not as directly comparable to other buildings as in the case of BREEAM methodology.

Certain measures to reduce water wastage, such as shorter dead-legs and leak detection, also gain no credit in water calculation tools, as these features cannot be modelled.
**Consumption of efficient fittings** (user-defined):
- % Toilets type 1, % Toilets type 2, ...
  (l/use)
- % Taps type 1, % Taps type 2, ...
  (l/min)
- % Showers type 1, % Showers type 2, ...
  (l/min)
- % Urinals type 1, % Urinals type 2,
  ...
  (l/min)

**Fixed assumptions** (BREEAM defined):
- Frequency of use of fittings
- Consumption of fittings for which data is unavailable (minimum standards stated by UK Water Supply (Water Fittings) Regulations 1999)

**Figure 15 – Functional diagram of the BREEAM water calculation**

**Inputs**

- Rate of rainwater use
- Rate of greywater reuse

**Outcomes**

- Calculation of each fittings’ consumption per day
- Total water consumption with or without efficient fittings
Regarding rainwater harvesting and greywater re-use, the following issues have been raised, as the technology (Grant, 2002), in particular for rainwater harvesting, which:

- does not reduce water sewage volume
- has a high cost
- is not applicable to small roofs, which most residential buildings will have
- is not effective during dry periods, when it is needed
- requires repair and maintenance
- uses more energy to treat the harvested water than to treat and deliver water through the mains
- has no guarantee of user compliance
Greywater systems could re-use wastewater from fixtures such as hand basins and showers to use in toilets or urinals, but they are complex and costly to install. It has also been shown to be more cost effective to save water by lowering consumption than to re-use greywater (Crettaz et al., 1999).

3.2.1.3 The Water Management Plan (WMP) approach

This approach follows a performance management strategy for water and put in place the two previous tools to improve a system: metering and target definition. For example, the SAGE Gironde compels building managers to put in place a whole-building water management plan with reduction targets. Reduction targets are defined by the managers and are based on real consumption data. Thus water consumption monitoring is mandatory. Actions plans are validated by experts who are aware of water saving potentials, and hence this approach may involve some additional costs for the validation process.

The water management plan approach has two main advantages: building managers are the main actor of the change, thus better placed to motivate users of the buildings, and it focuses on real savings and real metering of the whole building, avoiding risk of mismatch between theoretical calculation and real water savings. On the other hand, by working without precise and predefined saving plans, such policy options are more risky on water savings really achieved. An action plan can bear low ambition, or not be dynamically enforced. For them to be efficient, they require policy designers to determine the level of ambition of the targeted water savings (explicitly or implicitly) and to set up rules that will enable a follow up and control of undergoing actions. Shorter interval data is better for problem analysis (such as monthly, daily, 5-minute intervals). All of the above issues suggest that an administrative framework for managing, following and controlling the scheme would be required.

One issue to bear in mind when setting water saving targets for this approach, is that any improvement obligation required by a water saving target is fulfilled against a building’s current water performance level, which may be initially poor, therefore the ensuing reductions in water consumption may not take the building to water performance level that would be considered “high-performance” in comparison to other similar buildings.
Conclusions

Overall, the global water consumption level approach allows some flexibility in the choice of areas where water savings can be gained. **Three main advantages of using a global water consumption approach over the key fixtures approach are listed below:**

- Rainwater harvesting and reuse systems can be considered in the calculations.
- This approach provides flexibility to builders by allowing them to choose the manner in which to address water efficiency. However, the approach cannot prevent fixtures with high levels of water consumption from being used, and in certain cases the tools can be used to trade off high water consuming fixtures for less proven water harvesting and reuse technologies.
- Above all, it gives more relevant information to help building owners to improve water management practices. Consumption levels are metered at building entrance and comparison of real consumption (provide in water bills) to calculated water consumption values is straightforward. The breakdown of a building’s water consumption into its component water consuming fixtures, through use of the global approach, provides an indication of the distribution of water consumption in the building.

On the second advantage of the global water consumption approach, there is a danger that extremely low-flow fittings, with ‘unacceptable’ performance for consumers, will be selected by unscrupulous developers to gain more credit with rating systems without improving the overall design, particularly as the functional ‘performance’ of fittings available on the open market is not always monitored (for example, the washing effectiveness of a low-flow...
shower head). This may lead to prolonged use (above the use figures used in the calculation tools) or replacement of the fitting by new occupants. Averaging of the performance figures for fittings with a similar function within the water consumption calculation tools may mean that the negative impact of one large fitting can be countered by installation of other smaller ones, which may end up not being used (for example, one high-flow shower is installed and used, while other low-flow showers are installed but not used in practice, in order to reduce the pre-occupancy water consumption figure for showers within a green building water calculation tool).

The following table summarises the benefits and problems associated with each methodology, drawn from the analysis above.

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key fixtures</td>
<td>• Simplicity</td>
<td>• Does not cover total water use and hence may miss potential savings</td>
</tr>
<tr>
<td></td>
<td>• Low cost</td>
<td>• Lacks the “overall” consumption view that enables understanding</td>
</tr>
<tr>
<td></td>
<td>• Directed at areas with greatest water saving potential</td>
<td>and trade-offs</td>
</tr>
<tr>
<td>Overall water consumption level</td>
<td>• Can be used to compare buildings performance and direct design</td>
<td>• More complex</td>
</tr>
<tr>
<td></td>
<td>• Comprehensive coverage</td>
<td>• Calculations are based on assumptions which may in reality</td>
</tr>
<tr>
<td></td>
<td>• Can be used to trade-off water uses</td>
<td>• not reflect use patterns</td>
</tr>
<tr>
<td></td>
<td>• Promotes understanding of the need to reduce overall consumption</td>
<td>• Attempts to reduce water consumption to gain credits may result in</td>
</tr>
<tr>
<td>Water management Plan</td>
<td>• Based on “real” consumption data</td>
<td>“ineffective” low-flow fixtures being used</td>
</tr>
<tr>
<td></td>
<td>• Encourages continuous improvement</td>
<td></td>
</tr>
</tbody>
</table>

3.2.2. METRICS

- Objective

The purpose of metrics is to enable understanding and comparison of buildings’ water consumption. They can be used internally as performance description, or used with a comparative and rating objective. Therefore, firstly, a metric can act as a baseline of facility information and data for temporal intra-building assessment. This metric should be adjusted to account for any abnormalities (such as water restrictions, major leak, significant vacancies) so as to give a realistic reference or baseline against which to measure the effectiveness of water savings measures.

Secondly, a metric can be used as a comparative standard for inter-building assessment. This is calculated once during initial building assessment to provide a figure for general performance assessment in comparison to a benchmark or other buildings.

In general WPB metrics follow the form of “water volume consumed” per “individual using building” (or floor area) per “unit time”. Table 28 lists commonly used metrics.
Table 28 – Summary of the metrics used in existing initiatives

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Metric</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM (UK)</td>
<td>m³ / capita / annum</td>
<td>Occupancy approximated at one person per 10 m²</td>
</tr>
<tr>
<td>AECB (UK)</td>
<td>No metric used</td>
<td></td>
</tr>
<tr>
<td>HQE (FR)</td>
<td>L / capita / annum</td>
<td>Performance rate used - percentage reduction in overall consumption</td>
</tr>
<tr>
<td>NABERS (Australia)</td>
<td>L / m²</td>
<td>Metric chosen after a statistical study</td>
</tr>
<tr>
<td>LEED (USA, Canada)</td>
<td>Gallons / capita / annum</td>
<td></td>
</tr>
<tr>
<td>The Nordic Eco-label</td>
<td>L / guest night</td>
<td></td>
</tr>
<tr>
<td>Code for Sustainable Homes (UK)</td>
<td>L / capita / annum</td>
<td></td>
</tr>
</tbody>
</table>

> What benefits and problems of using different metrics?

The issue with using “water consumption per individual” metric is that many non-residential buildings do not have fixed numbers of users. Schemes that use a “per person” metric that cover non-residential buildings use an approximative figure for the number of users, based on assumptions. There are other methods used to approximate building user numbers; BREEAM, for example, bases its user numbers on the building floor area.

There is also an issue over the complexity and comparability of metrics. The more complex the calculation of the metric, and reflective of an individual building, the less comparable it is to other buildings (the complexity is reflected in the calculation of the metric, rather than the metric itself).

> Which are “best” metrics?

Depending on the purpose of the WPB scheme, either an “active” metric (for ongoing metered water consumption) or a simpler “passive” metric (for homogenous comparative purposes) is required.

As regards the most effective metric form to use, there is evidence that “floor area” is the more accurate definition of likely consumption in offices. An office and public building water benchmarking study conducted by the Australian Department of the Environment, Water, Heritage and the Arts in 2005 of approximately 132 office buildings showed that the coefficient of correlation between water consumption and “per person” was only an insignificant 0.0008, whereas the coefficient for “floor area” was much more significant at 0.6899 (1.0 indicates complete correlation between two variables).

However, the study also demonstrated that for office buildings with other significant water end uses (such as retail food courts) the resulting measured metric may be skewed, thereby making it impossible to benchmark performance against other building types. In these instances, it would be necessary to include sub-metering, so that non-office consumption can be deducted.

A similar study of public buildings had too small a sample size to conclusively determine the consumption driver for this building type. However, based on the sample set of 17 buildings,
the “floor area”/consumption correlation was shown to be 0.86, similar to that indicated for office buildings.

There is no evidence to suggest that a “floor area” metric would be appropriate to all types of building, but it is a more stable and reliable parameter and, as well as being accurate for certain building types, and thus enables a consistent assessment across different building types.

Studies comparing metrics statistically was not found for households, but one metric is consistently used in rating systems: litre from supply system / person / day (or year). This is probably due to the likelihood of a stable number of inhabitants, although there is evidence that single-person household consumption varies significantly from the “per-person” consumption of a multi-resident household, hence normalised assumptions may not be valid for all types of residential building.

### 3.2.3. Types of Buildings

Overall, all building types seem to be addressed by either a voluntary or mandatory instruments (see Table 29). Most of the green building rating tools (except NABERS) were originally designed for new buildings. However, systems for the environmental assessment of existing buildings have been developed in the BREEAM, Green Star and LEED programs.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Residential Single-residential</th>
<th>Residential Multi-residential</th>
<th>Non residential Offices</th>
<th>Non residential Hotels and restaurants</th>
<th>Non residential Retail</th>
<th>Non residential Education</th>
<th>Non residential Healthcare</th>
<th>Non residential Offices</th>
<th>New buildings</th>
<th>Existing buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM (UK)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>AECB (UK)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQE (FR)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H&amp;E certification (FR)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSBC (DE)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Star (Australia)</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NABERS (Australia)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEED (USA, Canada)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU Eco-label</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Nordic Eco-label</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument</td>
<td>Residential</td>
<td>Non residential</td>
<td>New buildings</td>
<td>Existing buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building codes (ES)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordenanza de Gestión y Uso Eficiente del Agua en la Ciudad de Madrid</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local building codes (IT)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SAGE Gironde (FR)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code for Sustainable Homes (UK)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water Supply (Water Fittings) Regulations (UK)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Irish Building Regulations (amendment to Part G - Hygiene)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

### 3.2.4. REGIONAL AND NATIONAL APPROACHES

Water scarcity is frequently a local/regional issue, dealt with through local/regional action plans. Apart from the UK, which has encompassed water efficiency within a larger code on houses, regulatory schemes focusing solely on water efficiency are usually managed regionally. Large national frameworks to mandate water efficiency are perhaps seen as unnecessary and costly, when they are decentralised to regions where scarcity is a real issue. This trend toward decentralised management for water is the general situation in France for instance, where action plans are made at a water basin level. Local authorities appear to be the main driver for water efficiency actions, through having to deal with localised problems of water availability and having the policy competency to carry out specific strategies.

On the other hand, building rating schemes are mainly nationwide tools. They cover many environmental issues, including high priority national issues such as energy efficiency and waste, and are therefore designed and managed at the national scale. It can also be noted that these schemes are usually initiated by stakeholders at the national level, such as building associations, industry, or technical centres. These schemes also include water efficiency, although often as a relatively low-priority issue, and this could reflect the understanding that water efficiency of buildings is seen to be relevant and necessary to pre-empt and address future shortages, but that perhaps it is not yet necessary to implement severe national-scale measures in many countries.
3.2.5. **Assessment costs**

Table 30 summarises an estimate of the cost that consumers (building owners) have to pay to have their building assessed and certified by selected rating schemes. We emphasise that data presented here cover only assessment costs and do not take into consideration the overall additional cost induced by involvement in a rating scheme. In the case of the French instruments for instance, estimations from experts indicate that the construction of an HQE building is 5 to 15% more expensive than a standard building.

Another point is that costs indicated in Table 30 are for a complete environmental assessment of buildings and not solely a WPB assessment. As no rating tool dealing specifically with water has been identified, it is difficult to estimate the cost for assessing the water performance of buildings. Water is just a part of this cost, which can roughly be estimated to be around one fourth or one fifth of the overall environmental cost. But the existence of fixed costs makes it difficult to evaluate the exact cost of a stand-alone water evaluation scheme.

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Costs and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM</td>
<td>2400 – 12 000 €. No info on the link with the building size</td>
</tr>
<tr>
<td>Green star</td>
<td>~3000 € for building smaller than 2000 m$^2$, ~18,000 € for building greater than 100 000 m$^2$</td>
</tr>
<tr>
<td>LEED</td>
<td>~4000 € for buildings &lt; 5000 m$^2$, up to 24,000 € for a combined design and construction review of buildings &gt; 50,000 m$^2$</td>
</tr>
<tr>
<td>HQE</td>
<td>~4 € by m$^2$, tapering charges according to surface area</td>
</tr>
</tbody>
</table>

3.2.6. **Summary**

A major finding of this chapter is that very few policy instruments specifically deal with water performance of buildings, and those which do are often managed regionally. Over the last few years, governments have made little use of regulatory approaches and seem to have preferred information instruments, such as labels and certificates. The UK experience is the most advanced and ambitious in EU as regard building as a system. Activities in UK illustrate that it is possible to set up such building approach and gives precious experiences to further actions on this field.

Elsewhere, buildings are mainly perceived as the place for water using products and thus, schemes tend to have fixture approaches rather than a building system approach. This kind of approaches can be called “pragmatic” as they avoid complex methodological issues and focus on the main water consuming and/or easiest fixtures.

When it comes to instruments really addressing a building as a whole, the tool is always designed for an overall environmental assessment. Water is only one aspect among several others and energy is often the key issue. This point would be important to take into account if developing a new EU tool or promoting specific existing ones is to be considered.
On the other hand, a positive side of environmental building rating is that all major green building rating tools contain a section dedicated to water consumption. Water criteria are outlined and sometimes specific water saving goals are set using the calculation of reference consumption levels. Even in such rating tools, instruments quasi-systematically target the efficiency of key fixtures like toilets or taps, either as a mandatory criterion, or as a proposed action to reduce water consumption of buildings.

Most of the schemes have been identified in areas concerned by water shortage and droughts problems (Italy, Spain, Portugal, and Australia, some parts of France, UK). However, mandatory instruments are more often localised in the most severely affected areas. National or international programs are often voluntary, except the UK Code for Sustainable Homes.

All main categories of buildings discussed in the present study are covered by existing instruments, which is also true when considering only mandatory or voluntary measures. This is something positive as it illustrates that no particular buildings are difficult to be tackled. On the contrary, and even if this study mainly focused on human domestic needs, no instruments on agricultural buildings or industrial buildings were found so far.

### 3.3. COMPARATIVE ANALYSIS

The aim of the analysis of existing water efficiency policy measures was to identify their impacts, benefits, and limitations. Table 31 provides a summary overview of the instruments analysed above. As shown previously, it is difficult to make a comparison at an aggregate level because the sample of investigated schemes is not very balanced or representative. Moreover, the number of current instruments is limited and there is a lack of in-depth information. In particular, the estimated water savings achieved through individual instruments is largely based on projections rather than actual savings, making it difficult to judge their real impact. Furthermore, inconsistency between calculation methods makes it difficult to compare their effectiveness. Schemes also vary in the types and range of products and geographical regions covered, and would necessitate a more differentiated analysis for more in-depth assessment.

However, we can make some general statements, drawing from the literature and previous studies, for example in the context of energy efficiency. This comparative analysis is organised around the following key themes:

- Regulation vs. information instruments
- Voluntary vs. mandatory instruments
- Single issue vs. multiple issues
- Single measures vs. policy mixes
Table 31: Comparative overview of outcomes, impacts and barriers of investigated instruments

<table>
<thead>
<tr>
<th>Investigated policy measures</th>
<th>Outcomes/ Impacts</th>
<th>Success factors</th>
<th>Failure factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary measures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>Rating tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BREAM (UK)</td>
<td>110808 projects in total; 26606 registered assessments; 9137 certified</td>
<td>Broad coverage, Straightforward calculation tool, Reputation, Many buildings assessed</td>
<td>Cost of certification and administration</td>
</tr>
<tr>
<td>AECB (UK)</td>
<td>Only recently launched</td>
<td>No information on this particular tool</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td>HQE (FR)</td>
<td>280 buildings certified (4.5 million square meter)</td>
<td>Strong tool with feedback stages</td>
<td>Heaviness and cost</td>
</tr>
<tr>
<td>GSBC (DE)</td>
<td>Recently launched (16 buildings already certified)</td>
<td>System is based on the involvement of interest parties</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td>Green Star (AUS)</td>
<td>152 building certified.</td>
<td>Can rely on existing mandatory label for water using products</td>
<td>Cost of certification and administration</td>
</tr>
<tr>
<td>NABERS (AUS)</td>
<td>Estimate annual water saving thanks to NABERS: 220 million litres.</td>
<td>Easy and fast benchmarking tool</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td>LEED (USA)</td>
<td>35,000 projects, over 4.5 billion square feet of construction space in all 50 US states and 91 countries</td>
<td>Broad coverage, Reputation, Many buildings assessed</td>
<td>Cost of certification and administration</td>
</tr>
<tr>
<td>Labels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Eco-Label</td>
<td>No information on this particular tool</td>
<td>Reputation of the scheme</td>
<td>Different levels of consumer environmental awareness in the member states.</td>
</tr>
<tr>
<td>Nordic Swan (DK, S, FIN, NOR, ICE)</td>
<td>≈ 150 hotels swan labelled</td>
<td>No information on this particular tool</td>
<td>Differences between countries</td>
</tr>
<tr>
<td>Investigated policy measures</td>
<td>Outcomes/ Impacts</td>
<td>Success factors</td>
<td>Failure factors</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Regulation</td>
<td>Building codes</td>
<td>Local Building codes (Italy)</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building codes (ES)</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irish Building Regulation – amendment to Part G (IRE)</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water Supply (Water Fittings) Regulation (UK)</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amendment to Part G Building Regulations (UK)</td>
<td>Not yet applied on this particular tool</td>
</tr>
<tr>
<td></td>
<td>Strategic plans / planning guidelines</td>
<td>Ordenanza de Gestion y Uso Eficiente del Agua (ES)</td>
<td>No information on this particular tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAGE Gironde (FR)</td>
<td>Target: 20% of water saving within public buildings</td>
</tr>
<tr>
<td>Information</td>
<td>Rating tool</td>
<td>Code for Sustainable Homes (UK)</td>
<td>Recently launched</td>
</tr>
</tbody>
</table>
3.3.1. INFORMATION VS. REGULATION INSTRUMENTS

The literature review shows that regulatory instruments, as a generic policy tool, are highly effective in achieving their objectives, are relatively easy to set up and provide clear and transparent procedures for affected businesses (e.g. GTZ et al., 2006 and ECOFYS, 2006). The major benefit of norms and regulations, such as building codes is that (most) water savings are guaranteed, as developers will only be able to equip new buildings with efficient fixtures. Furthermore, regulatory instruments are irreversible, meaning that developers and architects cannot revert by providing consumers with appliances not meeting the specified requirements (Boardman, 2004).

One of the major disadvantages of regulatory instruments, when compared to information instruments is that they fail to create environmental awareness among the public. However, whether and how this awareness actually influences purchasing behaviour is difficult to establish. Another drawback of information measures can be the existence of many different labelling and certification schemes. Although all this is unlikely to be the case for schemes that address WPB (as there are currently a limited number and rarely more than one or two in a country), the introduction or development of various schemes has the danger of creating confusion among consumers. Critics further argue that there is no point in labelling or rating if regulatory standards are in place, as long as these are strict enough to eliminate the worst offenders. A label then exists only to provide the public with more information, which may not necessarily be linked to their needs or wishes (MTP, 2008).

3.3.2. VOLUNTARY VS. MANDATORY INSTRUMENTS

As the MTP study (2008) highlights, voluntary schemes require that developers, architects or home owners have an incentive to participate, e.g. the need to distinguish a new building technology or highlight aspects of existing building stock. Voluntary schemes might struggle to interest target groups to participate, particularly in light of their costs, for example the uptake of the Green Star scheme in Australia is fairly low.

The case of BREEAM, however, shows that strong promotion and commitment can significantly push the success of a voluntary information scheme. It is also important to note that voluntary labels indicate that a product is water efficient, but that does not necessarily mean that products without a label are inefficient. Developers may choose not to participate in a rating or labelling initiative, for reasons ranging from cost to effort.

3.3.3. SINGLE ISSUE VS. MULTIPLE ISSUE

Currently, informational instruments in particular tend to address multiple environmental issues, such as the BREEAM scheme in the UK, the German Sustainable Building Certification or Australia’s Green Star; fewer initiatives target water efficiency exclusively. Whilst a multiple issue approach certainly helps to keep programme costs down by bundling human and financial resources, it might, in the case of information instruments, lack clarity for
home owners and the general public, who have to rely on an aggregate measure to judge the overall environmental performance of a building. Furthermore, addressing water efficiency as one concern among many might not help to raise awareness of the issue of water performance, as other environmental aspects might be prioritised.

3.3.4. SINGLE INSTRUMENTS VS. POLICY-MIXES

The experiences reported above illustrate that WPB measures are frequently single instruments and do not have national policy mix frameworks to support and strengthen their position. Voluntary instruments need to be embedded in a comprehensive policy framework which motivates target groups to take action by offering incentives, organising information and education campaigns as well as acting as role models. A good example is the UK, where a well established and wide ranging voluntary scheme (BREEAM) is complimented by a mandatory scheme (Code for Sustainable Homes) and recently regulation (Water Supply (Water Fittings) Regulation). This will both push minimum standards, through regulation, and incentivise the development of improved best practice, through information and certification of best practice.

Finally, based on the previous analysis and prior research on environmental policy a number of factors can be identified which are important to ensure that policies achieve their objectives (Müller 2002; Vreuls 2005; GTZ et al. 2006; Khan et al. 2006). Successful policy implementation:

- avoids ambiguities by clearly describing the goals and functioning of the instrument;
- uses instruments that provide economic incentives, combines several instruments, is based on strategic planning, target setting and takes into account the process and different phases of innovation;
- encourages the participation of stakeholders in the design and implementation of the instrument;
- ensures the availability of sufficient financial and human resources to operate and enforce the initiative;
- specifies clear compliance procedures and sanctions;
- engages in continuous and wide-spread information, education and training activities; and
- makes provisions to revise, update and evaluate the initiative in order to enhance its functioning and effectiveness.

The following table summarises the benefits and limitations of different categories of policy measures and briefly outlines the conditions for which these instruments seem most appropriate.
Table 32: Benefits and limitations of different policy instruments

<table>
<thead>
<tr>
<th>Voluntary measures</th>
<th>Information</th>
<th>Benefits</th>
<th>Limitations</th>
<th>Relevant / appropriate for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating tools</td>
<td></td>
<td>Adaptable to cover many building types.</td>
<td>Cost of administering schemes and of certification.</td>
<td>Commercial/industrial buildings where affordability is less of an issue and building types are highly variable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raises awareness.</td>
<td>Potentially too many different rating tools.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rewards leadership.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labels</td>
<td></td>
<td>Raises awareness.</td>
<td>Requires supporting measures, e.g. economic incentives, large-scale information campaigns.</td>
<td>Commercial buildings or buildings associated to a service (hotels, restaurants, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rewards leadership.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mandatory measures</th>
<th>Regulation</th>
<th>Benefits</th>
<th>Limitations</th>
<th>Relevant / appropriate for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building codes</td>
<td></td>
<td>Can cover every building</td>
<td>Fails to create consumer awareness.</td>
<td>Key fittings approach, definition of minimum performance standard or technical standard for key water-using fixtures within buildings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coherence of the measure.</td>
<td>Adaptation to local context on water.</td>
<td></td>
</tr>
<tr>
<td>Strategic plans / planning guidelines</td>
<td></td>
<td></td>
<td></td>
<td>Public buildings (to set an example) or large offices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cost and heaviness</td>
<td>Involve building managers, occupants and owners in sustainable water management</td>
</tr>
</tbody>
</table>

| Information | Rating tools | | Cost of administering schemes and of certification. | When planning to introduce a performance standard at a later stage. |

(GTZ et al. 2006, Khan et al. 2006)
3.4. SYNTHESIS OF ANALYSIS OF EXISTING INSTRUMENTS

The following important points summarise the analysis presented above.

1. Even if a small number of MS have moved ahead in developing WPB initiatives, water savings are just starting to be integrated by constructors or building managers. Because of this recent move, gathering real feedback on their impacts is usually challenging, and in certain cases not possible, due to lack of data collection by the scheme management bodies or building managers. A rough estimation is provided for a few countries which implement WPB, as outlined in the following section, to provide an order of magnitude of what could happen in the next ten years following implementation of these instruments.

2. This trend is surprisingly slow when considering all the evidence supporting at least the implementation of first stage savings:
   
   • As shown in the first chapter, technical solutions exist. It has been suggested in UK that reaching a certain water reduction level should be studied thoroughly, as it mainly impacts the water supply and sewage system, and has direct and rather low implementation costs.
   
   • It is not expensive to reach significant saving levels without changing the comfort level, and payback time can be very short (estimated at 1.1 years for first level retrofitting in Table 33 below).
   
   • Water is a regulated area with several organisations managing it closely, and strict regulations governing its use.
   
   • Environmental benefits of water savings are not discussed sufficiently.

3. This points to other forces playing against such changes. These barriers are summarised in Table 34. Water being a renewable and seemingly low-cost public good, lack of drive from the public and building stakeholders is probably the main barrier. Water bills are not that high when compared to other housing charges. On the issue of water price, the table below shows an estimation of payback period for the three different savings levels defined in the first chapter (Table 22). This aims to provide an indication of payback period and should not be seen as an accurate forecast. The complexity of full Life Cycle Costing and the uncertainty of water prices prohibit more in-depth analysis in this study. With an average European price estimated at 2€/m³ in 2008 (Ecologic, 2008), payback time ranges from one year for first level retrofitting to around 30 years for building intrinsic water network changes, and almost 6 years if efficient white goods are bought (which is currently the average lifespan of such products). The low cost of water hampers the adoption of most efficient changes in Europe. Economically speaking, cheap retrofitting is used more broadly.
### Table 33 - Payback period for direct saving investments in a dwelling

<table>
<thead>
<tr>
<th>No behavioural changes</th>
<th>Water price = average EU 2008 = 2 €/m³</th>
<th>Water price = most expensive EU 2008 price = 4.5 €/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Investment costs</td>
<td>Annual m³ saved</td>
</tr>
<tr>
<td>First level retrofitting</td>
<td>25</td>
<td>11.0</td>
</tr>
<tr>
<td>Best efficiency fittings of key fixtures</td>
<td>250</td>
<td>21.9</td>
</tr>
<tr>
<td>Best fittings, plus water reuse</td>
<td>1700</td>
<td>27.4</td>
</tr>
</tbody>
</table>

All data are given per capita

4. Other reasons can also explain this situation: Water shortages may be thought of as unusual events for most people, hindering the integration of preventative actions. Curative solutions such as water restrictions are perhaps perceived as the less complicated solutions. Changes in climate are not easy to model and thus limit anticipation of the need for water saving awareness. Qualitative aspects and agriculture abstraction seem to hold the stage within water management bodies. Private companies that run water facilities are often paid on the quantity of water distributed, whereas they could play a key role in promoting water efficiency in countries where they have water delivery responsibilities, and to help cope with foreseen water shortage (UK).

5. Potential barriers to implementation, data gaps or investor-users issue do not appear to play a key role in this situation. The participation of a building in a global rating tools for instance can have some drawbacks but give important advantages, such as to provide coherence and stakeholder knowledge and recognition of the tool. Genuine water awareness among building stakeholders could be an issue to address more in detail, to check if this important policy instrument has been sufficiently addressed. It could also help to understand the reasons for seemingly low priority in green building “eco-ranking” schemes, and thus try to assess environmental drivers pushing people to choose, or preventing people from choosing certification schemes. Barriers inherent to energy-related measures (cost, heavy technical solution) could appear to hamper larger use of green building certification tools.
**Table 34 - Barriers to WPB requirements**\(^{19}\)

<table>
<thead>
<tr>
<th>Type of barriers</th>
<th>WPB context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>Technical solutions are readily available today. They can also be directly implemented by an individual or with the help of a plumber.</td>
</tr>
<tr>
<td>Training and information</td>
<td>Actors may not be informed about possibilities for water efficiency improvement:</td>
</tr>
<tr>
<td></td>
<td>• Water saving awareness is low in population and among builders and architects.</td>
</tr>
<tr>
<td></td>
<td>• Water consumption patterns are not well known and thus less efficient solutions are sometimes the focus of attention (rainwater harvesting for instance as the more visible solution).</td>
</tr>
<tr>
<td>Economic</td>
<td>Costs for first level investments are low. Payback time is short.</td>
</tr>
<tr>
<td>Institutional</td>
<td>Water is managed by few and clearly defined public bodies and private companies, which is a help as regards institutional issues.</td>
</tr>
<tr>
<td></td>
<td>Several regulations apply to it and can make it more complex to understand.</td>
</tr>
<tr>
<td></td>
<td>Sanitary issues are slowing down the spread of rainwater harvesting and greywater reuse.</td>
</tr>
<tr>
<td></td>
<td>Companies or builders don’t seem to have well-defined or empowered structures to decide upon and carry out water efficiency investments.</td>
</tr>
<tr>
<td>Implementation</td>
<td>Making a critical judgment on implementation stages is rather difficult, as more information needs to be gathered to provide sufficient evidence. Gathered information shows that:</td>
</tr>
<tr>
<td></td>
<td>• Instrument implementation is not seen as difficult. Questioned during the literature review were: the lack of aggregated data, reliability of needed average and default data. However, these uncertainties don’t seem to have hampered development.</td>
</tr>
<tr>
<td></td>
<td>• Implementation means that mandatory measures rely on public bodies, and there appear to be no specific implementation difficulties discussed in the literature.</td>
</tr>
<tr>
<td></td>
<td>• If one aspect should be looked at in greater detail, it would be the information provided regarding the water sections of rating tool instruments among building stakeholders, and above all the building industry and architects. This point is critical for the efficiency of such instruments, as explained in the policy analysis.</td>
</tr>
<tr>
<td>Investor-user</td>
<td>As an significant part of buildings are not occupied by the owner and so water bill is not paid by the one who would really benefit from large investment, this can have a negative impact on incentive to invest in the building. However, we saw that fist level changes are associated with fixture retrofitting to more efficient products, which is rather disconnected to the building as a whole.</td>
</tr>
<tr>
<td>Lack of interest in water efficiency improvement</td>
<td>For the vast majority of actors, the costs of water are so small compared to their total (production or consumption) costs that water efficiency improvement is even not taken into consideration. Furthermore, there is a tendency for companies and households to focus on rather few activities only, and neglect other matters which do not directly affect their core values. A lack of interest in getting more information could be explained by this lack of incentive. This is probably the main point explaining why water consumers are moving so slowly in seeking greater water efficiency.</td>
</tr>
</tbody>
</table>

\(^{19}\) Derived and adapted from ECOFYS 2006
For rating tools, it has to be kept in mind that they are in general integrated with wider environmental assessment. It is important to understand the meaning of these close links between all environmental issues set through building tools. This wider scope has advantages (a building is studied as a whole, for a range of possible impacts) and drawbacks (trade-offs can be made between environmental issues, and impacts such as water can be set aside, hence water-related tools cannot be easily used in other places where another energy tool is used, as regards EPBD). This last reason is hindering the share of tools among MS who have advanced further in development of these tools; the only way of taking advantage of interesting ideas coming from instruments developed in another nation is to modify the tool to suit oneself. This issue is generally applicable to all locally developed instruments. The experience gained with EPBD could help to draw conclusions on what position to adopt between either letting subsidiarity and local initiatives lead development, or having a harmonised and optimised approach.
4. NEED FOR AN EU-WIDE WPB APPROACH

The main objective of this chapter is to evaluate the need for EU action for establishing water performance of buildings. Such evaluation requires analysis of two issues:

- Do local actions carried out by Member States on building performance seem enough to tackle water scarcity issue or is there a need for EU action on water scarcity?
- Is the water performance of buildings appropriate, considering the range of possible tools?

Discussion on the first question is already provided in previous research made after the EU’s Communication on Water Scarcity and Droughts. The answer to such a question is of course underpinned by the accuracy of the water scarcity problem and its perception within society and policy makers. It is not the aim of this report to deliver a comprehensive answer to such a question. However, by analysing the ongoing activities in Member States, some arguments for EU action in this direction are presented here.

More importantly, different routes to water savings are discussed, and WPB is one of them. The objective of this chapter is to highlight specific interests and the feasibility of introducing policy measures for water performance of buildings at the EU level. The analysis takes into consideration whether introducing EU requirements for buildings will deliver further benefits in comparison to the current situation, and what might be the potential environmental, social and economic impacts, and their affect on different stakeholders (manufacturers, consumers, etc.). Furthermore, the potential advantages and disadvantages of such approach at the EU level are analysed. To this end, different options are considered and analysed (quantitatively and qualitatively when possible) in terms of their possible impacts. The results are presented in an impact matrix (policy options against impacts).

4.1. EU ACTION ON THE WATER SCARCITY ISSUE

4.1.1. GENERAL INTEREST FOR EU ACTION

When the need for a public intervention is clearly proved, the EU can present clear benefits in approaching adaptation in an integrated, coordinated manner at EU level. However, these advantages are closely linked to the specific impacts of the issue, which will determine if EU action is more suitable.

The main reasons for calling for EU actions are summarised in the Box 5 below.
Subsidiarity:

It should be kept in mind that an EU action is not always the best solution. Finding the proper level of action is constantly reviewed before any EU scheme is implemented. This notion is known as the subsidiarity principle.

Box 5 - Main reasons for developing EU actions

- EU actions offer measures based on the cooperation from different MS, which is in general a necessity for all issues with transboundary impacts.
- Some measures may need to be taken in another MS than the one who suffers the impacts and would reap the benefits; therefore, there is a need for coordination at EU level.
- There is a need to ensure that solidarity is enshrined in any strategies, so as to avoid measures leading to shifting of the impacts or exacerbating the problem in another area, country or social group.
- If the targeted problem impacts sectors which are largely integrated at EU level through the single market and common policies, it makes sense to have a common approach and integrate water performant buildings goals directly into them (e.g. agriculture, water, biodiversity, fisheries and energy networks).
- Some issue have very different spatial effects and a very strong variability, and the EU is committed to ensure territorial, regional and social cohesion and will contribute to monitor MS in order to ensure that the poorer and disadvantaged regions and those regions that will be hit hardest by water scarcity or climate changes will be able to take the necessary measures.
- Measures can be taken into account in EU spending programmes (e.g. research, cohesion, trans-European networks, rural development, agriculture, fisheries, social fund, external actions and the European Development Fund) to compliment the resources spent by MS, particularly as some potential responses may be so costly that only centralised funding from combined EU funds will enable the action to occur.
- Due to the scale of the EU mechanisms they can leverage greater results and magnify the efforts in capacity building, research, information and data gathering, knowledge transfer, exchange of best practice, development and cooperation. This will contribute greatly to a robust knowledge base for policy making at all administrative levels.
- In some cases measures taken solely by an individual MS, or lack of Community action, would significantly damage other MS interests and would hinder the internal market.
- As regards external action, for some sectors, the increased negotiating power of the EU, rather than individual MS, may confer a leading role to the EU in, e.g. with regard to external actions for development and adaptation.
4.1.2. **Specific interest of EU action as regards water scarcity**

**General rationale for EU action**

Since 2000, the flagship for addressing water management at the (international) river basin level is the European Water Framework Directive. The Floods Directive (2007) follows the same river basin approach to address water issues. EU plays a major role in water management regulations. Water problems are also closely connected to other main common policies (Agriculture, Energy, Biodiversity, Climate Change).

Water management is a transboundary issue. Water is by nature trans-national and requires a coordinated approach within each river basin. This situation means that any action taken upstream of a river basin in a given country will have direct impacts downstream, potentially in other countries. The absence of a coherent approach could lead to increasing conflicts between countries or regions in the context of climate change, be it scarce water, more floods or impacts on water quality. Upstream regions could be tempted to carry on their economic development without looking into the problems that this may cause downstream. For example, an increase in abstraction from water resources regardless of the downstream context could leave downstream regions with serious problems of water shortage. Further, development activities that minimise the retention capacities upstream might lead to unnecessary floods downstream. These effects need to be addressed at river basin scale.

It is true that water scarcity affects some river basins or local areas more than others, and that unlike electricity for instance, water is slow and very costly to transport. Thus some MS can feel less concerned. But this ignores the solidarity and cohesion objectives of the EU, especially on the issue that could require heavy investments in certain areas. Financial support from the EU could bring much appreciated leverage for some structural investments.

Furthermore, the many links between water ecosystems and water-dependent users (agriculture, navigation, energy, tourism, etc.) also justifies action at the European level.

Lastly, policy options like the ones studied in the present report will impact water using product manufacturers, whose markets are more European or international than solely national. Giving them a common rule to follow has several advantages in terms of visibility, competitiveness, costs of adjustment; but this may be outweighed by the difficulty of adapting to the level of required change. For a firm selling both normal and efficient products, a narrowing EU market (in the case of minimum product standards for instance) is more difficult to cope with than the same regulation in one MS only.

On the other hand, an EU action has some drawbacks that need proper consideration. Depending on the design, it can put the same pressure on unaffected MS and thus add an undesirable administrative burden. It can also impede development of interesting local initiatives, and limit flexibility in proposed solutions.
These elements need to be taken into account, even if we have seen that it seems that existing initiatives on building performance are eager for stronger incentives. As they are targeting the same kind of fixtures, the number of offered solutions is not very high and flexible, as shown in the analysis, can also have drawbacks on the result achieved. Depending on the design of a policy, the administrative burden and the cost could also be reduced by using existing tools (Energy Performance for Building Directive, existing eco-labels and rating systems, etc.). Scope for tightening minimum performance standards is certainly evident.

**What is the need for an early action?**

Early action is needed to build capacity to adapt in the water sector, but also in other sectors that are water dependent (agriculture, transport, energy, tourism, industry, etc.).

Extreme events like droughts already pose a problem in Europe and their frequency and intensity will be exacerbated by climate change. Damages from these events are enormous, and justify early action. Moreover, recovery of natural water systems from unsustainable use (e.g. over-abstraction of groundwater aquifers) may take a long time and these eventualities need to be prevented.

**4.1.3. ARE MS ACTIONS ENOUGH TO TACKLE THE PROBLEM?**

This part, by summarising and estimating outcomes of potential MS actions, describes the case of no further EU action. From previous parts of the report, and by integrating the main findings of the study on Water Efficiency Standards, a rough estimation of water saving potentials is made. Other gaps and barriers have also been highlighted.

As certain data was lacking and real evaluation of impacts not available, these calculations are based more on estimations and are not to be perceived as exact figures, but only a scale of magnitude. They were mostly overestimated, so as to integrate potential new actions or missed instruments. It was developed with the assumption that no major changes, drought or other events, were to come in the coming years that would speed up development of these measures. This calculation should be seen as a rough estimation, and not to be a response to particular objectives of this study.
It can be observed that existing options seem able to bring water quantity reductions of about 10% within ten years. Only UK seems to have regulations to achieve higher savings. When integrated within overall water consumption (see table below), this becomes 0.2% of total water abstraction.

Table 35 - Estimation of the potential savings to the water supply system, of reported WPB requirements for selected Member States, in a 10 year timeframe

<table>
<thead>
<tr>
<th>Country</th>
<th>Instrument</th>
<th>Type of building and other assumptions</th>
<th>Estimated part of total water from water supply system (in %)</th>
<th>Average estimated saving (in %)</th>
<th>Estimated saving to water supply system (in %)</th>
<th>Total saving from water supply system abstraction (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>HQE if made mandatory with Environmental Grenelle</td>
<td>Public buildings</td>
<td>7.0%</td>
<td>-20.0%</td>
<td>-1.4%</td>
<td>-1.6%</td>
</tr>
<tr>
<td></td>
<td>SAGE Gironde</td>
<td>Public buildings, 20% of 1% French water use</td>
<td>0.2%</td>
<td>-20.0%</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other actions (Brittany, tax allowance)</td>
<td>1 000 000 rainwater tanks, estimate 1/30 buildings</td>
<td>3.3%</td>
<td>-5.0%</td>
<td>-0.2%</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Building regulation minimum standards</td>
<td>0,5% new home per year</td>
<td>0.3%</td>
<td>-20.0%</td>
<td>-0.1%</td>
<td>-3.6%</td>
</tr>
<tr>
<td></td>
<td>BREEAM</td>
<td>7000 new building / year, out of 1 million offices</td>
<td>1.1%</td>
<td>-30.0%</td>
<td>-0.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Code for Sustainable Homes</td>
<td>Sold or refurbished every 20 years, 20% making effort (30% savings)</td>
<td>32.5%</td>
<td>-10.0%</td>
<td>-3.3%</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>3 local regulations</td>
<td>Assess that 10% of Italian population under the schemes</td>
<td>8.0%</td>
<td>-10.0%</td>
<td>-0.8%</td>
<td>-0.8%</td>
</tr>
<tr>
<td></td>
<td>CTE</td>
<td>All taps in public buildings, saving 20%</td>
<td>7.0%</td>
<td>-4.0%</td>
<td>-0.3%</td>
<td>-0.7%</td>
</tr>
</tbody>
</table>

Table 36 - Water abstraction sources and quantities within EU 27 (Ecologic, 2007)

<table>
<thead>
<tr>
<th></th>
<th>Total abstraction (10⁶ m³/year)</th>
<th>Urban (10⁶ m³/year)</th>
<th>Industry (10⁶ m³/year)</th>
<th>Agriculture (10⁶ m³/year)</th>
<th>Energy (10⁶ m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total EU 27</td>
<td>247 020</td>
<td>46 197</td>
<td>30 685</td>
<td>73 775</td>
<td>90 565</td>
</tr>
</tbody>
</table>
Apart from these local initiatives, the Water Framework Directive will result in water abstraction reduction in the next few years, as MS have to ensure good ecological health in terms of quantity and quality of water resources. More metering and more economically balanced prices could push for the reduction of water consumed. Main impacts could come from agriculture and industries, if real pressure would be put through increasing water prices for large consumers, although the Ecologic study shows that elasticity and farmers’ behaviours are complex to model. CAP for instance is also playing a key role in water use. For “urban water uses”, metering and pricing could have an influence. However, these approaches are more widespread in urban areas than in agriculture, and finding a socially fair but effective price for water may be challenging.

With all these elements in mind, it seems that the forthcoming reductions of the no further EU action option could mainly come from the Water Framework Directive, but with uncertainty of the level and effectiveness of the impact and, with more certainty from some MS initiatives, but with varied and fairly low savings. It can be estimated that these savings will be roughly a few percent of the total water coming from water supply systems. The question is whether this will be enough to alleviate water scarcity related risks or not.

Such analysis is of course limited by the diversity of the cases and by the fact that for some areas, reaching even a small water use reduction is important to get back to a more sustainable situation for groundwater or river ecosystem. This more qualitative approach is difficult to assess here, but on the whole, it doesn’t seem to counterbalance quantitative gaps.

We have seen in the previous sections that several reasons hinder further development or success of MS initiatives. Among these are limited competencies to use adequate tools, or limited area to reach interesting objectives, and the lack of communication or visibility of schemes. Technical or price barriers do not appear an important factor, though it has been reported in the UK that reaching a certain water reduction level should be studied thoroughly, as its main impacts are on the water supply and sewage system. It was also quoted that barriers are presented by the existing technical norms, with for example the NF norms on taps, which fixes a minimum flow for tap of 12 litres/minute and is mandatory before receiving the NF guarantee for the building. This slow development is rather surprising, considering that we have seen that easy and cheap measures can be installed for saving water in domestic uses.

But the main barrier is probably the lack of strong incentive for general public, public bodies, manufacturers and building designers, to move towards more water efficient fixtures or buildings. Water shortages are still perceived as rare and natural events that are managed with curative tools such as water restrictions. And even when the high value of water is integrated widely, for some reason it has not led to overall water reduction actions.
To fill this gap, the majority of responses collected with questionnaire and interviews supported the argument that it would be useful and feasible to develop and introduce water saving requirements at EU level and EU could provide this needed incentive. A common approach and requirements at EU level will also allow fixing of targets, and help MS in achieving water efficiency.

On this point, it is important to underline that many water using products are produced and marketed across the EU. Manufacturers are always a key stakeholder to consider when changing the market structure. In general, manufacturers usually prefer having a level playing field with consistent standards across EU. But for some of them, adaptation to EU market changes can be more challenging than in limited number of MS. This aspect needs a deeper analysis to investigate whether any water efficiency requirements would be more acceptable if introduced at a EU level.

### 4.1.4. SUMMARY

The need for public intervention to address water performance of buildings seems undisputed: public authorities have an undeniable role to play in planning adaptation in their areas of responsibility, either to avoid negative effects of autonomous adaptations, or to cover domains where autonomous adaptation is not likely to happen, and to ensure a coherent policy across different sectors.

As seen in the previous section, national planned adaptation is slowly taking place and, to a greater extent, the public authorities in national, regional and local governments are starting to take actions to adapt to water scarcity. Interesting initiatives fostering water efficiency have been reported in previous sections of this report and places where water shortages are most acute are moving the fastest.

And yet, all actors are not fully mobilised on tightening water consumption, even in water scarce areas. It seems that water quality has held centre stage on water issues during the past years, partly obscuring the quantitative objectives of “good ecological status of water masses” outlines in the Water Framework Directive.

Several rationales are pushing for new EU action, the major being the difficulty in achieving even small savings in abstraction from the public water supply system. This means that the question of the level of efficiency to reach plays a key role in whether or not the EU has to urge for action. In other words, if objectives are set to target savings of over a few percent to the water supply system, an EU action is likely to be needed to achieve the targets. Other gaps could also be filled by such an EU action, which has the advantage of being a common and harmonised approach.

### 4.2. ANALYSIS OF POSSIBLE APPROACHES

The purpose of this section is to analyse options for EU actions, and especially discuss the interests and difficulties of specific instruments targeting buildings. Three options dealing with WPB are suggested and benchmarked against options focusing on
Following three policy options are conceived in addition to the business as usual (BAU).

- **Mandatory water performance rating of buildings**: Develop or promote a WPB rating tool at the EU level taking into account not only the water efficiency of key fixtures but also possible reuse systems like rainwater harvesting and greywater reuse. It could be inspired from the existing methodologies developed in green building rating systems. Only a rating would be mandatory, not meeting a certain certification level. This could also be integrated with an EU green building rating system.

- **Whole building water performance requirement**: As planned in the UK, the idea would be to introduce a regulatory standard of maximum water consumption for every new building. This option also implies the development of a calculation methodology to assess WPB. Metrics should be adapted according to the type of buildings.

- **Mandatory water auditing and WMP in public buildings and commercial buildings**: Impose water auditing and the implementation of a water management plan in every office and public building. The idea would be to involve every company and administration in water saving strategies, without setting specific requirements for WPB. The WMP (actions plan, water-saving objectives, etc.) would have to be controlled and validated by an independent organisation.

Another option, focusing on water using products, has been taken from the parallel study addressing the possibility and interest of setting up water efficiency standards for water-using products.

- **Mandatory requirements for key fixtures through regulatory instruments**: This option will introduce new water performance or technological standards for key fixtures found in every building. It could be implemented through changes in building regulations.

The base case consists of a no new action option (BAU), which has already been discussed in the previous section.

Only mandatory options were chosen, as this section aims at assessing comparative advantages of each option (rather than describing all the possible options). But above all, the purpose is to highlight possible options that could, result in savings of more than few percent.

### 4.2.1. Analysis of options

A qualitative approach is adopted for the analysis of the options proposed in the previous section. For each of the issues, the relative advantages and disadvantages of the options are evaluated. The impact assessment matrix shown below is the summary
of the results of the analysis, and the thought process behind the rating is explained in
the following sub-sections.

In each cell a qualitative score of Y/N or ‘+’, ‘0’ or ‘-’ is given. A ‘+’ signifies beneficial
impact with respect to the criterion in question; ‘-’ indicates a negative impact; and ‘0’
no impact. Increased magnitude of the impacts will be indicated using the notation ‘++’
or ‘--’. In some cases, when there are other external influencing factors, a range is
used, for example ‘0 to -’ or ‘+ to -’.

Table 37 – Impact assessment matrix of options

<table>
<thead>
<tr>
<th>General Issues</th>
<th>Option 1: Business as usual (BAU)</th>
<th>Option 2: Mandatory requirements for key fixtures though regulatory instruments</th>
<th>Option 3: Mandatory rating of the WPB</th>
<th>Option 4: Whole building water performance requirement</th>
<th>Option 5: Mandatory water auditing and WMP in public buildings and commercial buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue addressed</td>
<td>Y/N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Legislative change</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Environmental Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential Water Savings</td>
<td>0 to +</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Economic Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact on firms: cost and market modification</td>
<td>0</td>
<td>--</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Impact on customers (buildings contracting owners, occupants)</td>
<td>0</td>
<td>0</td>
<td>0 to +</td>
<td>0 to +</td>
<td>0 to +</td>
</tr>
<tr>
<td>Impact on public authorities (budget; human resources)</td>
<td>0</td>
<td>- to 0</td>
<td>-</td>
<td>-</td>
<td>0 to +</td>
</tr>
<tr>
<td>Social Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public reaction to the policy</td>
<td>-</td>
<td>+</td>
<td>0 to +</td>
<td>- to +</td>
<td>++</td>
</tr>
<tr>
<td>Other issues: Practicability and Enforceability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicability: is it practical to implement?</td>
<td>n/a</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y/N</td>
</tr>
<tr>
<td>Clarity and consistency (e.g. with other national and EU legislation)?</td>
<td>n/a</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y/N</td>
</tr>
<tr>
<td>Is it enforceable?</td>
<td>n/a</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

‘++’: substantial beneficial effect; ‘+’: slight beneficial effect; ‘-’: negative effect; ‘--’: substantial negative effect; ‘0’: no effect; N/A: Not applicable; Y/N: yes/no

---

20 This question looks at whether the design of the option actually addresses the real problem – in the sense of focus rather than effectiveness. Effectiveness issues come after. Hence it is the intention and targeting of the option that is assessed here and not its effect.
4.2.1.1 General issues

➤ Issue addressed

Reduction of water consumption is the main objective of all options, except no further EU option for which it is “only” one of the objectives of the Water Framework Directive and targeted through several local instruments.

➤ Legislative change

Implementation of options 2, 3 and 4 would require changes in EU legislation and hence the impact of these options would be negative on this aspect. However, it could be advantageous in terms of harmonisation. Indeed, there are differences between the requirements for key fixtures among the existing schemes identified within the EU.

In order to be mandatory, option 5 would also require new legislation. However, in the case of companies, this option could also be implemented by means of environmental agreements.

In the case of option 2, it would be possible to introduce minimum water efficiency standards via amendments to the existing legislation. Indeed, an important aspect that has to be taken into consideration, when considering the introduction of water efficiency standards at the EU level, is the possibility of streamlining and achieving synergies with existing legislation. In the case of option 2, the Ecodesign Directive provides a framework for setting compulsory minimum requirements and voluntary benchmarks for EuPs. All energy-related products (those that do not consume energy during use but have an indirect impact on energy consumption) are also expected to be covered in the future. This will allow the EC to address products such as key water using fixtures in buildings. For example, water-saving taps and showerheads reduce water consumption and therefore also the amount of energy used for hot water, all without altering the user’s perceived well-being. These products are already identified as priority products in the current action plan of the Ecodesign Directive.

4.2.1.2 Environmental issues

We tried to estimate realistic savings stemming from the different options. As the reality of such changes is complex, we have provided in the box below orders of magnitude of potential cut-offs. These calculations try to find levels of savings that could potentially be reached, and not attempting to predict the future. This is especially true, when considering that all options could be implemented in diverse ways (i.e. applied to all buildings or only dwellings; to new buildings or to all sales, etc.).

Under the assumptions made, option 2 appears to be the more effective in terms of potential savings, as it could achieve 10%-15% reduction within 10 years of implementation. This is linked to the fact that all toilets, showerhead, etc., would be concerned, and to the assumption made that such fixtures are changed more often than major refurbishments commonly occur for buildings.
Option 4 is close to the product approach, option 2, with the assumption that all buildings will have to reach the same reduction targets. The main difference comes from the rate of buildings entering into the scheme: depending on the scope given to the scheme (mandatory requirement for new building only, or when the building is sold, or when refurbished), the potential impact of the measure can be more or less significant. With existing building construction rates (0.3% to 0.6% of the building stock per year), the new buildings category is the least important one in terms of quantity. When including properties sold or refurbished, between 4 to 7% of all buildings would be affected per year (every 15 to 25 years, according to our estimations).

Rules for a building to enter the scheme are also one of the main affecting parameters for option 3. Assumptions regarding the efforts of owners to be rated is the second major driver into the final impact of the scheme. The data presented below are calculated with rather optimistic assumptions regarding building owner interest in participation.

Option 5 achieves lower impacts, as it is assumed here to target first only public building water consumption, and half that of all other offices (but all of them are supposed to make such management plan). Assumption on their efforts is also the main variable for success.

Lastly, it has to be noted that all the previously assessed savings have to be added to due to potential savings from the Water Framework Directive impacts on quantitative use of water, which we saw previously as one of the main potential impacts of the no further EU action. Indeed, more metering and price pressure will help achieving more important savings than what is described here in the assessed options. However, a part of savings stemming from the Water Framework Directive, that would result in behavioural changes to minimise prices, would add momentum to technical changes impelled by technical requirements of options 2, 3, 4 or 5. With the same idea, existing MS instrument impacts would partly compliment EU action. Thus, a direct comparison is difficult between option 1 and other options. Water abstraction reduction is also less certain through the Water Framework Directive than through a specifically targeted instrument.

In summary, we estimate that a mandatory WuP option would achieve higher savings than WPB options or the no further EU action option, and its results do not rely on variable factors that affect the other options, such as building owners’ participation or rate of buildings entering the scheme. However, it must be highlighted that such results are not derived from intrinsic differences between products and buildings approaches, but mainly depend on the number of buildings that could be covered under such a program. The minimum standards for building performance could reach the same saving potential as minimum product standards if all buildings could be covered, although the building policies discussed here have not considered that it would be feasible to oblige all building owners to have a thorough assessment of their building at specific periods during the building’s life, making their shift slower than that of fixture changes.
Potential saving assessment:

Attempts to estimate what could be the impact of various policy options on water saving is a difficult exercise and prone to criticism. An attempt is provided here, as it is felt that all options cannot achieve the same level of reduction, as they all function in a different manner.

The reduction estimations are given in the table below and major assumptions for these rough calculations are described under the table.

<table>
<thead>
<tr>
<th>OPTION 1 : No further EU action</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>After 10 years</td>
<td>After 20 years</td>
<td></td>
</tr>
<tr>
<td>-1% in EU + framework directive impacts</td>
<td>-2 to 3% + framework directive impacts</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 2 : Mandatory WuP</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-10 to - 15%</td>
<td>-20 to -30%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 3 : WPB, mandatory rating, for new buildings or sales</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-2 to 5%</td>
<td>-5 to -10%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 4 : WPB, global standards, for new buildings or sales</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-5 to -10%</td>
<td>-10% to -20%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 5 : WPB, water management plan, For public buildings and half of offices</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-2 to -4%</td>
<td>-4% to -8%</td>
<td></td>
</tr>
</tbody>
</table>

The calculation considers three parameters:

- The proportion of buildings from the total building stock that will be affected by the scheme in a given time (10 or 20 years). This is calculated from new building and sale rates assumptions.

- Average potential water saving assumptions. We stay for all cases to the same first level of saving potential of 20%, so as to be able to compare the options.

- Estimation of the consumption of buildings as part of the total water supply system abstraction.

For the 20 year assessment period, it is assumed that levels would be updated and that a building sold for a second time within this period (in the case of a 15 year average rotation for buildings) would be improved again.

It should be highlighted that major determinants for water performance of buildings scenarios are the part of building concerned and the improvement effort that owners will make when this choice is left open (option 3 and 6). For instance, imagining that mandatory rating of option 3 would have to be carried out for major refurbishment could improve success of this option.

### Assumptions

<table>
<thead>
<tr>
<th>General assumptions :</th>
<th>New building rate : from 0.3% to 0.6% /year, sale rates : every 15 to 25 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic uses: 80% of total water delivered by the supply system, 7% for public buildings and 15% to all offices.</td>
<td></td>
</tr>
</tbody>
</table>

| OPTION 2 : Mandatory WuP | Products such as toilets, showerheads or taps are changed every 10 to 15 years. When changed for more efficient products, a 20% global saving is reached. All domestic uses are concerned (around 80% of water supply system). |

| OPTION 3 : WPB, mandatory rating | Only happens for new buildings or when the building is sold. 20% saving are made in 20 to 30% of cases, and 40% savings in 10%. |

| OPTION 4 : WPB, global standards | Only happens for new buildings or when the building is sold, and these buildings abide to a standard defined of 20% savings. |

| OPTION 5 : WPB, water management plan | Only for public buildings and half of other offices (around 11% of total urban water), who all achieve a minimum 20% savings, 20 to 40% of them going up to 40% savings. |
4.2.1.3 Economic issues

Three targets of economic impacts have to be taken into account: the impact on companies, the impact on consumers, and the impact on the regulatory authorities.

- **Impact on companies**

The economic impact on companies refers here to the cost implied by compliance to each option.

Option 2 has no direct economic impact on the building sector; it would rather affect water fixtures manufacturers. However, the adoption of requirements for key fixtures at the EU level would prevent the development of multiple schemes, developed at the national or the local level, which could require replicated testing/rating/registration costs for manufacturers. The main impact for these companies would probably be seen in market changes: manufacturers that have not developed efficient products would have to adapt quickly in order to cope with such requirements. The present study was not able to assess the risk represented by this possibility. Giving adaptation time and visibility could soften such a problem. On the other hand, well developed and efficient products will progressively lead the market.

Option 3 and 4 will have, in the long run, the same impact on water using product market, but the flexibility in changes that they allow (use of a very efficient tap to keep larger bath, for example) would introduce the changes smoothly. On the implementation cost, they mainly imply that someone has to pay for the certification process. It is unlikely that all costs will be borne by public administrations. A financial contribution would need to be paid by construction companies, contracting owners, or by buildings users. Such extra cost is rather marginal in comparison to global construction and operating costs, and if added alongside energy performance for building requirements, it could be very limited.

In the case of option 5, companies would have to bear the cost of implementing WMP for their buildings. However, since the objective is water saving, this could also lead to reduced water bills that would in general payback the extra expenses.

This important point needs to be stressed again: as with energy savings, for major changes, new costs due to water saving strategies will be rapidly recovered by financial savings.

Furthermore, these win-win strategies have a positive role on employment, creating new jobs in the assessor sector and boosting, for a few years, the water fixtures market.

- **Impact on consumers and building owners**

Within these 5 illustrative options, none of them lay a strong financial burden on consumers. Water using product options have a low direct cost in general for consumers, more efficient products being not that much more expensive today, and
the price of labelling or of tightening standards is unlikely to cause significant price changes in products on the market.

Building owners could have added costs through the building assessment options, as all options need water assessment to be provided by specialised assessors or a specific control system (the option 4, water performance standards for buildings, can be implemented through ex-ante assessment or ex-post monitoring). But such costs would be marginal, as overall costs linked to the building (construction phases or just operation costs) will be counterbalanced by water savings that could even bring financial savings within a short time.

Importantly, after having implemented water saving measures, building owners would probably be more aware of water consumption and savings and look carefully at water bills for their buildings. Having evaluated building options 3, 4, and 5 the supposed or real water consumption, this would give them a basis for analysis and performance improvement strategies. Water metering, which normally carried out at the entrance of a building, will become a readily accessible performance indicator for building managers.

Among the building options, option 3 gives specific incentives to building designers or owner to build a highly efficient building. Giving objective information on building efficiency, through a rating system, could lead to a higher market value of the building. This role to develop awareness and market value of the building is a key argument in favour of the building assessment approaches.

Impact on public authorities

Option 3 and 4 would require more resources since they imply the implementation of a whole new European instrument with certification, inspection and calculation procedure, whereas option 2 could rely on the existing Ecodesign framework. As for implementation costs in general, one way to reduce such costs would be to try to integrate these options in existing schemes, such as the Energy Performance of Buildings Directive.

In the case of option 5, fewer resources would be needed in the implementation of the policy, as no methodology has to be set up. However, public authorities would have to organise the verification and validation process of WMP (which could also be managed through third party certification). This option would be “lighter” than other options because, as it would target major offices first and public buildings, the number of buildings would be far much lower. Also, public bodies would have to directly finance water management plans within their buildings. But as for private stakeholders, return on investment could be achieved in little time, if cheap initial measures are implemented. Thus, this option seems to be the less expensive option for public budgets, and might even provide greater financial benefits.
4.2.1.4 Social issues

An important aspect that has to be taken into account is consumer behaviour, which determinates potential “active” savings. Unfortunately, available information suggests that, in general, awareness about water savings issues is low. In this regard, options to increase water-efficiency may be missed because of low awareness of water issues and water prices and poor access to water efficiency information.

In this regard, option 3 would contribute to overcoming the lack of information through WPB rating, the aim of which is to ensure that occupants are presented with information on water efficiency and/or water use within the building they live or work in. Option 3 would probably be better accepted and understood than option 4, since it provides comparison keys without imposing mandatory changes. However, the direct cost paid by a building owner for both options could outweigh, in the public’s opinion, this positive signal given to buyers.

More harmonisation and better interpretation would lead to a more uniform approach on a European level. This may also affect public confidence in regulatory measures. On the other hand, overregulation of a sector may also cause scepticism, harm the trust of the public and give the impression of poor governance. That is why mandatory minimum performance standards on buildings (option 4) may be less appreciated, as it might be directly perceived as a burden, more so than mandatory minimum performance standards on products (option 2).

In the case of option 5, provided that the public is aware of the effort made by companies and public authorities, the impact could be very positive through the example set by public bodies.

In summary, as they would be more visible to the public, building approaches might also be regarded with criticism amongst public opinion.

4.2.1.5 Other issues

None of the options can be immediately designed and implemented. They would all require in-depth discussions and arbitrations to set up the details of the requirements. However, option 5 seems the most straightforward to implement, as only public buildings could be targeted first.

If requirements and a rating system are defined at the EU level and do not take into consideration local water resources context, the enforceability of options 2, 3 and 4 might be compromised.

In terms of consistency with other existing legislation, option 2 and 4 could interfere with local and national regulations identified in previous sections.

For options 2, 3, and 4, new standards would have to be developed. A uniform calculation procedure for WPB would be needed for options 3 and 4. Minimum performance levels would have to be defined for fixtures (for option 2) or for the whole building water performance (for option 4). In the case of options 3, standards
would also be required for the levels of efficiency required for successive ratings ("algorithms").

4.3. IS THERE SPACE AND SUFFICIENT INTEREST FOR A WPB APPROACH?

As a synthesis of this illustrative comparison and with other elements developed throughout this report, we derive and summarise below the specific interests and difficulties of developing water savings strategies through a buildings approach. The first section gathers the reasons in favour of a building performance approach. The second section highlights limitations. In a third and last section before the general conclusions, we address the need for development of a “first step” action toward methodological work.

4.3.1. SPECIFIC INTERESTS OF BUILDING PERFORMANCE SCHEMES

Water scarcity can be addressed by different schemes. Trying to improve water efficiency of fixtures and appliances is the most direct way. When considering the energy performance of buildings, the building approach was clearly relevant, as the energy consumption of households was important and strongly dependant on building characteristics (size, isolation, orientation, and heating system). This link between water consumption and the physical building is less direct: water travels through pipes and as there is scarce leakage within the indoor plumbing system, the size of the building does not have a direct impact on water consumption. Water is delivered by specific fixtures added to the building, fixtures that can be easily changed if not efficient.

So what is it specifically about buildings in a water saving scheme, making it interesting to have a general approach?

Buildings have specific characteristics relevant to potential water savings:

• Firstly, major uses of water are carried out through and within buildings. Estimations from different sources agree that 70 to 80% of water delivered from the public water supply system is used for domestic needs within buildings, or related to buildings’ outdoor areas.

• Buildings are the best place to promote water saving behaviours and improve global awareness of the value of water, as the residential sector encompasses the entirety of society.

• Above all, metering is mainly carried out at their entrance for pricing reasons: thus, buildings are the most common and often smallest metered unit. Any water efficiency impacts will be judged from buildings’ water bill. Someone entering into a water saving strategy will be very disappointed not to see any results for their
efforts, which could happen if they have not integrated thinking on “what is my building’s water consumption?”.

- A building is an overall system integrating different technical options. On the water using side, the main facilities are rather simple, conceived to fulfil standard functions (drinking, sanitary uses and for comfort). Having common, simple and inexpensive water using equipment helps in setting up standards and spreading information. Architects and construction companies can also play a favourable intermediary role in information dissemination.

- Apart from adopting efficient fixtures, achieving further savings involves heavier transformation works of the building’s water system. Greywater reuse or rainwater harvesting imply modifying the plumbing system and installing specific systems. This kind of change becomes an intrinsic characteristic of the building itself.

- Such changes can give higher value to the building. One has to keep in mind that buildings are long-term marketable goods, from which efficiency improvements, whether publicised (or not) under label schemes, can be seen as an investment for the owner.

- In terms of implementation, and even if assessing the hundreds of millions of buildings throughout Europe is a challenge, the existence of the equivalent Directive on energy performance of buildings can help in reducing administrative burden and implementation costs. Labels or rating tools also have similar practical advantages, by gathering all the environmental objectives associated with buildings into a single tool.

For all these reasons, a scheme to reduce water consumption in buildings appears to be relevant. To counteract arguments that water using products are not linked to the building design itself, it should be noted that this was also true for energy efficiency, where simple and cheap savings can come from fixtures replacement (more efficient light bulbs, refrigerator, etc.), but a specific Directive was still implemented. EPBD Directive also aims at going further and tackling problems stemming from design characteristics of the building such as isolation, building orientation, heating system, etc. Looking at previous rationales for energy saving, it appears that the same approach could be used for water savings, even if fixture changes still provide greater savings for water than energy.

### 4.3.2. SPECIFIC DIFFICULTIES FOR BUILDING PERFORMANCE SCHEMES

It has to be acknowledged that reaching 20 to 40% water savings within buildings could potentially be achieved through more direct and straightforward routes, as shown on page 125, summarising water savings potential in buildings. Easy and low-cost changes, not related to the building characteristics, but to its fittings, could lead to these levels of reduction.

Indeed, the WPB approach presents some difficulties and potential limitations:
• An apparently efficient building, in light of its featuring efficient fixtures, such as taps or showerheads, can in reality be inefficient if the fixtures are changed by inhabitants who could be unsatisfied with the performance of their efficient fixtures. The ranking or label obtained is thus not that linked to the building.

• WPB option needs in most cases an assessor and assessment tools (except maybe for water management plan approach, if a building manager is informed enough or is allowed to make a water management plan on their own). As there exists a large number of buildings, far more than types of water using products, implementation costs for WPB options would be far higher than water using product options. Harmonising with the EPBD Directive could partly reduce such costs.

• The flexibility that a whole building rating option can also lead to slower changes, or undesirable choices (optimising choices with ultra low and potentially ineffective products such as less than 6 litre/min taps, in order to be able to keep a huge bath or less efficient toilets), or even in cheating by adjusting the number of uses per day to reach a certain level, if this parameter is allowed to be changed.

• From these three first points, we can conclude that any certification/control system will have the same problem of cost and burdensome organisation.

• Also, one should keep in mind that, for the moment, water performance of buildings rating or labelling instruments are integrated in other wider-scoped tools dealing with the overall environmental performance of a building. For this reason, the water categories of such tools cannot be understood directly.

4.3.3. **IS THERE A NEED FOR METHODOLOGICAL WORK TO ESTABLISH WATER PERFORMANCE?**

We have seen that in the requirements addressing water use within buildings, some have found ways to avoid entering precise definitions of the performance of a building as regard water consumption: one is a more pragmatic approach through a more fixture by fixture methodology, the second one by targeting water management improvements more than defining performance levels.

Among existing initiatives, rating tools are the ones with the most precise and detailed calculation for assessing performance. The methodology followed is always based on integrating a building’s fixtures’ consumption and trying to assess this consumption against pre-defined levels, to give it a ranking. The ranking tools approach, though presenting some difficulties in real implementation, appears to be the dominant and accepted method to rate the performance level of a building “system”. These tools also offer methodologies for a very wide range of buildings (buildings with major domestic forms of water use at least).

Thus an interesting and comprehensive basis exists to set up tools for defining water performance of buildings.
However, the different tools have methodological specificities. Further investigation could be carried out on the following topics so as to develop methodological choices and by establishing a common methodology:

- **Metric:** The metric used is mostly the same. The first element, water used, taken as “water abstracted from water supply system”, is undisputed. The standardisation of this metric is more of an issue: it is always normalised with an occupancy-based index for dwellings (litre from public water supply/capita/day or year). As for offices, an Australian study shows that a metric based on net lettable (i.e. usable floor) area (litre/m² offices/day or year) was the metric with the best correlation to assess real water consumption in most case studies with collated data, whereas few tools use an occupancy index. A hostel can be evaluated by litre/bed/day. Apart from this study, little work seems to have been conducted on such issues. Deeper statistical analysis would be required to evaluate whether one single metric, such as litre/m²/day could be used. And above all, such work would allow assessment and preparation of the potential correction factor, if needed, for non-integrated effects (for example, is there a need to model the non-proportional effect on per capita water consumption for a large family?).

- **Flexibility in the calculation tool:** we have seen that within rating tools, some water consumption calculators can have large numbers of parameters that can be chosen by the assessor. More precise and realistic, this methodological choice makes any comparison difficult between buildings as they can have very different calculation assumptions. Tools with fewer and fixed parameters allow widespread comparison, but offer a less realistic performance assessment. Here, analysis will help to measure differences and acceptability of taking an average value; but in the end, the trade-off will be decided by the objectives of the tool.

- **Type of water use covered:** the different methodologies target the major uses; but uses such as outdoors use are not always integrated. Such uses increase the complexity of the model, particularly as their impacts stem more from water management practices than technical characteristics of fixtures. By setting apart outdoor uses, levels can be changed and this makes it difficult for calculated savings to fit with real consumption data. Clarification of water uses to cover would be a part of further methodological work.

- **Giving extra bonuses for some management practices** could be a way to deal with outdoor uses. Some methodologies thus add points to features other than pure water consumption: leakage tracking, precise metering, etc. Here again, attempts to reach a common methodology could investigate the need and interest in more complexity by including these other elements that are linked to management practices. Again, the idea is to assess the trade-offs, to find a balance between reality and assessment, between complexity and an easy-to-use tool.

Once the objectives for a tool are agreed, deriving or putting forward a specific methodology from existing tools is something that can be achieved once the main
problems are targeted and addressed. Nonetheless, having all the rationales to explain and justify certain choices could need further research and statistical analysis.

4.3.4. **Questionnaire Replies**

Within the questionnaire sent to MS representative, opinion about the relevance of an EU action specifically targeting buildings was gathered.

While MS representatives are overall in favour of EU action on water scarcity, they are divided on the need for a specific EU action on buildings. In particular, regional variations on water availability or patterns of use are seen as major barriers. Indeed, restrictive and mandatory requirements on the WPB would be less accepted in regions not threatened by water scarcity issues. Moreover, if a methodology to evaluate and rate WPB were to be set at the EU level, parameters of the calculator would have to be adapted regarding local behaviours and equipment. Representatives fear long and difficult discussion to come to an agreement if EU was to define very precise methodology and datasets.

A potential approach for the EU would be to set different water saving goals for buildings according to regional contexts. Regarding a possible water calculator, an idea would be to delineate the specification of the tool at the EU level and to delegate the definition of the parameters to MS.

4.3.5. **Are the Building and Product Approaches Compatible?**

Mixed approaches could also be pursued and the compatibility of having the two approaches simultaneously can be considered. It should be clarified first that a “pragmatic fixture by fixture approach” for buildings is actually a product-oriented approach. No real differences exist between the two approaches. Thinking about it through a building perspective is only useful during the implementation stage if building regulations are a more appropriate route to tackle domestic product standards. Therefore, this section focuses on describing relations between “real” building-oriented methodology (building rating and water management plan) and the products approach.

Complementarities clearly exist between the labelling of domestic WuPs and the two building approaches: rating of the WPB could be technically facilitated by requirements or labels on key water using fixtures of buildings and thus reduce implementation cost for the building part (labels making it easier to find and buy efficient WuPs); having a well-established building scheme would foster public interest in choosing efficient, labelled WuPs. By raising general water awareness, both instruments would benefit each other.

Building approaches may be less beneficial after having set up strong minimum standards at the product level. Indeed, building owners’ and stakeholders’ preference would probably be against the participation in building certification and efforts through more efficient fixtures may be perceived as enough. Moreover, product approaches
will probably prioritise efficiency for major domestic goods such as toilets, shower, taps, and thus achieve the cheapest and easiest improvements. Standards on products will enforce changes in the building ranking scales, as minimum performance levels are raised. Building approaches will progressively focus on overall design and complex installations (greywater re-use or rainwater harvesting for internal use), if small fixtures' improvements are sufficiently targeted through product standards.

Thus, increasingly, higher water savings through buildings investments will be challenged by cost saving potential and investment payback period. Water price will be a key driver in reducing this payback period, which is today estimated at roughly 20 to 30 years in the EU. On the other hand, and if such investments are judged necessary to enable the design of environmentally efficient buildings for tomorrow, these projects will need greater support than that which is currently provided. This might be reached through specifically targeted subsidies (e.g. French tax allowance on rainwater harvesting), but they are rather costly for public budgets, although effective and totally under MS competency. WPB instruments can offer a valid tool to integrate investment costs into buildings’ market value. Above all, building rating tools present a broader environmental view that integrates water issues. It would be disastrous to leave water management out of the scope of these tools, if the rationale that water efficiency addressed with product labels or standards is suggested. Also, as explained earlier, the water management plan and building rating approaches provide insight on water consumption patterns. This knowledge is fundamental to achieving any kind of further improvements, and provides grounds to establish actions regarding behavioural changes.

In summary, product and building approaches appear to be complementary rather than competing with each other. Even if strict standards were to be established for buildings’ water fixtures, a WPB scheme could be set up to provide best practice examples, and in preparing subsequent overall environmental standards at the building level.
4.4. SYNTHESIS: PROS AND CONS OF POSSIBLE EU OPTIONS FOR A BUILDING APPROACH

**Option 1: Business as usual (no action)**
No EU action targeting water efficiency of key products or the WPB.

**Pros:**
- No additional burden on manufacturers or builders from additional legislative requirements.
- Leaves each MS free to determine optimal control requirements for water efficiency of products or buildings according to its regional context regarding water availability.

**Cons:**
- Missed opportunity to reduce water use where quantitative aspects are not the priority but could be a growing concern.
- Possible inconsistency of approaches between MS/regions, leading to impacts on competition among European manufacturers and builders.

**Option 2: Setting mandatory requirements for key fixtures though regulatory instruments (e.g. implementing measures)**

**Pros:**
- Strong signal to both users and manufacturers.
- Fast and cheap savings could be targeted first through toilets, taps and showerheads.
- Encourages a higher level of market transformation than voluntary programmes, and ensure a level playing field across all sectors covered.
- Synergies with the Ecodesign Directive.
- Greater harmonisation among the MS.
- Low direct implementation cost.

**Cons:**
- Not addressing the problem of consumer awareness.
- Needs further assessment of indirect impact on manufacturers.
### Option 3: Mandatory rating of the WPB

**Pros:**
- Puts less burden on contracting owners or sellers since only rating is mandatory.
- Allows flexibility in technical solutions.
- Provides comparable information on the sustainability of buildings.
- Could also involve occupants and induce “active” water savings.
- Provides general advantages of using a building approach, especially the reward through increased building value due to specific efforts.

**Cons:**
- Interaction/competition with existing rating systems.
- Validity and adaptation of the calculation methodology.
- Need for adaptation of the rating system to each type of building.
- Cheating possibilities.
- Implementation costs.
- May be slower to reach first savings.

### Option 4: Whole building water performance requirement

**Pros:**
- Strong signal for water saving to both builders and occupants.
- Allows flexible technical solutions.
- Global obligation leading to fast first savings.
- Provides general advantages of using a building approach.

**Cons:**
- Validity of the calculation methodology.
- Need for adaptation of the requirement to each type of building.
- Cheating possibilities.
- Implementation costs.
- No incentive to go beyond the fixed level.
## Option 5: Mandatory water auditing and water management plan (WMP) in public buildings and commercial buildings

### Pros:
- Based on real water consumption data through metering.
- No need for calculation methodologies or specific requirements on minimum water performance levels based on calculations.
- Low implementation cost and potential future financial benefits for public budgets.
- Shows that public bodies are making a good example and taking the lead.
- Could be a way to build extensive and precious database provided that data is gathered.
- Applies to both new and existing buildings.
- Provides other general advantages of using a building approach.

### Cons:
- A verification system is needed to ensure a targeted objective.
- Cheating possibilities if not enough surveillance.
- Implementation costs.
- Seems only feasible for public buildings or maybe private companies’ offices, but not for dwellings.
5. CONCLUSIONS AND RECOMMENDATIONS

This chapter provides final conclusions and recommendations, in light of the previous analysis and of discussions with various stakeholders contacted during this study, and previous analysis.

5.1. ASSESSMENT OF THE NEED FOR EU WPB ACTION

This report highlights the need for a more ambitious reduction of abstraction from water supply system. In terms of recommending which approach should be, tightening water use requirements on the main domestic water using products could be a more efficient option compared to a pure WPB approach as the product approach would:

- Tackle all the main technical changes needed for the WPB approach, to reach first level of savings of 20 to 40% (See 1.6.4.) on domestic consumption.
- Cut water consumption faster: having less methodological procedures and fewer stakeholders could shorten implementation time. Also, the time taken to realise the changes would be under the EU’s control, as it would be achieved by imposing, with immediate effect, the requirements on all products sold, without any potential trade-offs.
- Probably lower implementation costs, if the potential impacts on manufacturers are addressed. For example, no added cost would be needed for assessor training, building assessment, etc.

Such an approach would necessitate setting up a mandatory labelling scheme or a mandatory ranking system for key fixtures such as toilets, taps, showerheads, and white goods. A more strict set of minimum performance standards could also be implemented for these products. An in-depth analysis of water efficient product options that address these issues is given in a parallel report (BIO Intelligence Service, 2009).

However, WPB approaches available also present several advantages:

- We have seen that, apart from technical changes that lead to passive savings, small behavioural changes could provide significant savings. Such changes may be easier to make for water efficiency than those related to energy efficiencies, where minimum comfort levels are relatively fixed. For example, the need for thermal comfort only allows one or two degree change in temperature, whereas small changes in showering time, bathing frequency or use of taps can bring 20 to 30% savings from an average situation. And above all, consideration of users’ behaviour with new water efficient products is needed to ensure that potential consumption reductions of some of the efficient fixtures are not neutralised by changes in the
way they are used. WPB approaches, being characterised by information and management tools more than product focused paths, could therefore be more effective in implying water consumers.

- A WPB approach become more relevant if the policy objective is to achieve further savings, i.e. beyond what is possible through more efficient fixtures. Indeed, if the objective is to reach water consumption reduction of more than 30-40% in new buildings without relying on user behaviour changes, the current technical options commonly used are the installation of greywater reuse or rainwater harvesting systems. Such technical options need major and expensive adaptations in the building, are difficult to implement, and in some circumstances are restricted or prohibited in MS, and thus need to be investigated and installed carefully. The provision of a tool to promote and encourage the development of this form of efficient building is a reason enough to consider WPB approach, as it may prove effective for achieving high water saving objectives on water supply system consumption.

- Whereas complexity and implementation costs are hindering the development of a WPB approach, the existence of the Directive on energy performance of buildings (EPBD) could make it easier to implement this option. It would help to create synergies between these two interrelated environmental issues (energy and water). A buildings labelling or ranking system could help energy efficient buildings being promoted as globally “environmentally friendly” by taking into account water performance parameters. Along with actions targeting water using products, a WPB scheme could bring complementary advantages and synergies on water management practices, as discussed in section 3.4.5. Using an EPBD based approach, in terms of minimum standards and/or mandatory ratings for new buildings, and completing EPBD with additional criteria on water efficiency, may provide an opportunity to pursue and minimise the administrative burdens associated with reduction of environmental impacts of buildings.

Incentives other than developing a regulation on water used in buildings could also be useful, such as:

- seeking a coherent thinking on how and when to authorise greywater reuse or rainwater harvesting in MS, promoting campaigns of existing certification tools;

- implementing water metering and pricing through the Water Framework Directive;

- adapting the European Ecolabel to whole range of buildings could also be an intermediary step in the process. However, if a new specific action targeting water using products was set up, the Ecolabel key fixtures approach would lose its relevance. Modifying it in a way to promote more global water saving approaches for building (i.e. setting up a stricter Whole building water performance requirement for instance, with a calculation tool) could be a way to integrate a methodological tool at the European level and to set a basis for discussion.
Indeed, depending on the WPB approach chosen, defining a calculation methodology would be needed. This could be left to Member States, which would thus use experiences gained from existing tools. It could alternatively be harmonised at EU level, through expert judgement of potential solutions, to bring forward questions arising from rating tools. Experience gained from implementing EPBD could help when selecting the best option.

5.2. FURTHER WORK

This last section underlines, step by step, the stages required for implementation of specific WPB requirements. The focus is not to describe real administrative steps, but rather to suggest a process that may help in constructing the framework required to implement the WPB requirements.

5.2.1. DEFINE GLOBAL WATER STRATEGY, PARTICULARLY FOR WATER USING PRODUCTS AND BUILDINGS

5.2.1.1 Gather and review all studies made on water scarcity

Several studies and working papers have been completed since the occurrence of severe droughts affecting Europe in recent years. Among them, the Communication of the Commission on Water Scarcity and the subsequent impact assessment of the different options proposed, the Ecologic report on potential savings (Ecologic, 2007), the recent WES study (BIO Intelligence Service, 2009) and this study on WPB. The CAP health check has been completed and the Water Framework Directive is well established. All these sources of information, analysis and evidence need to be assessed by the Commission.

This work is important as it would allow evaluation of the coherence between all these studies and verify the current coverage of water uses in the literature. Understanding the potential water savings by agricultural and industrial sector would help in setting accurate and cost efficient targets.

5.2.1.2 Define a water saving action plan

Following this work, with the knowledge held by commission officers in regards to undergoing regulation and possible options, one or two possible EU WPB strategies could be derived.

A very important element to determine here would be the water savings targeted. This objective would be derived from the two elements: how much water will be available in the future and what are the feasible technical options and costs for water savings? Defining this objective is not only a part of good policy definition practice, but above all, is the basis from which all actions will stem and to which all options will be compared. This target will probably be specific to each type of water use, as water savings potentials in different use type are not the same.
From this quantitative target, action paths would have to be defined and a strategy (or a range of possible strategies) set up. Coherence should be sought between actions targeting the different water uses and the position of a potential building approach defined.

Depending on the urgency of the issue, this work could be approached in different ways: solely by the Commission and experts, with MS official participation, or with a wider committee that brings together industrial, agricultural and water using product manufacturers, etc. The creation of a specific network may be of value, linking management bodies of current WPB initiatives within the EU (and also abroad, if possible, as Australia, USA and South Asia have experience in water efficiency issues).

5.2.1.3 **Discuss and validate a global strategy on water scarcity**

As outlined above, depending on the urgency of this work and political commitment, the proposition will need further discussion with stakeholders and official validation by European institutions.

At this point, initial investigations on possible issues stemming from the targeted reductions and suggested routes would have to be organised and discussed at first stage. Potential technical issues for water supply, sewage system and other related impacts should also be addressed as a priority.

5.2.1.4 **Set up a efficiency standards for water consuming domestic products**

The main recommendation of the present report is to achieve quick savings through water efficiency standards approach. The WES report (*BIO Intelligence Service*, 2009) details a potential working plan for such approaches.

The most common domestic fixtures consuming water within buildings could then be addressed.

5.2.1.5 **Set up more a precise Water Performant Building instrument or incentive**

If the strategy selected includes a WPB approach, the following point should be kept in mind.

- **Precise definition of the objectives**

  The objectives of the WPB approach should be clearly defined, so as to be able to design effective instruments. Some of the overlapping relevance of water efficiency standards and WPB instruments would then be clarified and addressed as a priority.

- **Identification of instruments or incentives to use**

  If the main objective is to anticipate and prepare further savings on domestic uses, working on building design and significant plumbing adaptations should be the main focus of the work. A specific working group on harmonising MS approaches toward
greywater reuse and rainwater harvesting could be a first step. A second working group focusing on methodological questions would be useful to understand the benefits from existing initiatives and draw guidelines for any practical tool needed to support the EU WPB approach. Lastly, some questions to be addressed include “should there be a common methodology, or is it better to let MS decline a wider framework obligation and instead use fixed methodological guidelines but with some flexibility?” and “is the Ecolabel a possible tool to set wider and further requirements on water performant buildings?”. To answer the first question, and to prepare the implementation stages, the experience of EPBD has to be taken into account.

If the main objective is to raise public awareness on water saving, the focus should be on designing a communication tool, through a WPB approach. Finding the most effective communication instrument would be the key point for discussion. Adding a mandatory rating for buildings on their water performance, in parallel with the current energy one, could be an adequate and relatively low-cost solution. These issues are relevant to the methodological possibilities, and thus they would also need to be addressed through the formation of a dedicated working group.

Water management plans could be an intermediary measure. Focusing on large buildings, public or private, direct savings would not be their main objective. They would encourage water efficiency awareness and optimised water efficient technical solutions, relevant to the local context and cost-benefit options. No methodological working groups might be needed, as the only incentive would be to implement the improvement plans.

Identification and prioritisation of buildings and water uses

Depending on the water saving objectives to be achieved through WPB approach, the type of instruments and the difficulties encountered in implementation and achieving the savings, a specific step would be needed to define the scope of building types and water uses to be included. The estimations in section 4.2 gives illustrative figures for potential savings depending of the type of approach and the targeted buildings.

5.2.2. IMPLEMENTATION STAGES

The implementation stages need to be anticipated from the beginning of WPB instrument design, as we have seen that some of WPB approaches could necessitate important changes (assessor networks, inspectors, administrative management, etc.).

The description of quantitative savings made earlier could be used as a rationale to explain that any implementation costs would be outweighed by financial savings achieved through the reduction in potable water consumption (and other environmental benefits).

Depending on the progress of current regulatory development at the EU level, synergies between a potential EU WPB instrument and the EPBD and Water Framework Directive should be identified and pursued. These synergies need to be
considered and integrated at the very beginning of WPB development work, due to the significance of potential implementation problems and due to ongoing development of the EPBD and Water Framework Directive.
6. REFERENCES


BIO Intelligence Service (2009) Study on water efficiency standards, on behalf of the European Commission DG ENV


ECOFYS, AID-EE, (2006) Guidelines for the monitoring, evaluation and design of energy efficiency policies

Ecologic (2007), EU Water Saving Potential, European Commission, DG Environment


Good Homes Alliance (2008) A Critique of the CSH Water Efficiency Requirements


Lillywhite, MST, Webster, CJD and Griggs, JC (1987) Low-water-use washdown WCs. BRE. See also the Holmewood Estate trial Bradford.

Market Transformation Program (1) (2008) BNW07: Assumptions underlying the energy projections for dishwashers


### APPENDIX 1: OVERVIEW OF BASIC POLICY MEASURES AND CORRESPONDING SUB-CATEGORIES

<table>
<thead>
<tr>
<th>Type of instrument</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation</td>
<td>Performance standards</td>
</tr>
<tr>
<td></td>
<td>Building codes</td>
</tr>
<tr>
<td></td>
<td>Planning guidelines</td>
</tr>
<tr>
<td>Economic</td>
<td>Subsidies (rebates)</td>
</tr>
<tr>
<td></td>
<td>Taxes, tax exemptions, tax credits</td>
</tr>
<tr>
<td></td>
<td>Fees and user charges</td>
</tr>
<tr>
<td></td>
<td>Reduced-interest loans</td>
</tr>
<tr>
<td></td>
<td>Bulk purchasing</td>
</tr>
<tr>
<td></td>
<td>Grants</td>
</tr>
<tr>
<td></td>
<td>Procurement</td>
</tr>
<tr>
<td>Information</td>
<td>General information</td>
</tr>
<tr>
<td></td>
<td>Labelling</td>
</tr>
<tr>
<td></td>
<td>Certificates</td>
</tr>
<tr>
<td></td>
<td>Information centres</td>
</tr>
<tr>
<td></td>
<td>Audits and sustainability reporting</td>
</tr>
<tr>
<td></td>
<td>Education and training (consumer advice)</td>
</tr>
<tr>
<td></td>
<td>Demonstration</td>
</tr>
<tr>
<td></td>
<td>Governing by example</td>
</tr>
<tr>
<td>Voluntary agreements</td>
<td>Unilateral commitments by industry</td>
</tr>
<tr>
<td></td>
<td>Agreements between industry and public authorities</td>
</tr>
<tr>
<td></td>
<td>Schemes set up by public authorities</td>
</tr>
<tr>
<td>Research and development</td>
<td>Research programmes</td>
</tr>
<tr>
<td></td>
<td>Technology development</td>
</tr>
<tr>
<td>Cross-cutting measures</td>
<td>Plans, strategies etc.</td>
</tr>
<tr>
<td>Combinations</td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX 2: FACT SHEETS OF SOME SCHEMES

<table>
<thead>
<tr>
<th>ORDENANZA DE GESTION Y USO EFICIENTE DEL AGUA EN LA CIUDAD DE MADRID</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Byelaw</td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td>Municipal</td>
</tr>
<tr>
<td><strong>Year launched</strong></td>
<td>2006</td>
</tr>
<tr>
<td><strong>Building specific?</strong></td>
<td>No, buildings are just one target of the scheme, in fact the byelaw deals with many sides of water management in Madrid (from sewage to garden irrigation).</td>
</tr>
<tr>
<td><strong>Type of buildings covered</strong></td>
<td>All new and renovated buildings, specific requirements for public buildings</td>
</tr>
</tbody>
</table>

### ORGANISATION/IMPLEMENTATION

<table>
<thead>
<tr>
<th>Implementing Authority/ies</th>
<th>The municipality of Madrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aims and objectives</strong></td>
<td>The aim of the scheme is to set basis and requirements for sustainable water management in the city of Madrid. One of the general objectives is to reduce the water consumption of 12% by 2011.</td>
</tr>
<tr>
<td><strong>Implementation, and control measures</strong></td>
<td>The water requirements for buildings are supposed to be checked during the delivering process of building permits (new buildings) and refurbishment permits (existing buildings). A special service at the municipality is in charge of the compliance control (the “Oficina azul”). The byelaw specifies deadline for compliance for the requirements concerning public buildings (existing buildings have one year to comply).</td>
</tr>
<tr>
<td><strong>Supporting legislation and auxiliary measures</strong></td>
<td>N/A</td>
</tr>
</tbody>
</table>

### REQUIREMENTS REGARDING WPB

<table>
<thead>
<tr>
<th>Requirements</th>
<th>. Individual water meters are mandatory. In buildings with central hot water, individual water meters for hot water are also mandatory. New buildings with garden must also have a specific water meter to monitor garden irrigation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>. In case of major refurbishment and in new buildings every taps must be fitted with water saving devices so the maximum flow rate is 8 l/mn (2.5 kg/cm²). 10 l/mn for showerhead. Toilets must be equipped with dual-flush and have a maximum flush volume of 6l.</td>
</tr>
<tr>
<td></td>
<td>. In public buildings (offices, hotels) electronic or timed shut off taps are mandatory: maximum volume of 1l/ between opening and closing.</td>
</tr>
</tbody>
</table>
Information about the conformity of water using fixtures of the buildings must be provided to every new residents or proprietary.

**Analysis**

The set of requirements is rather comprehensive. Systematization of individual water metering is an essential step, not only to gather valuable information about water use but also to involve every household in the water conservation strategy. The associated requirements regarding key fixtures (toilets, taps, and showerheads) are clear. However, the fact that there is no differentiation according to the function of the tap may represent an obstacle. Indeed, while a low flow rate is not a problem for hand washing, it might be dissuasive when a large amount of water is needed rapidly (receptacle filling for instance). Finally, the fact that information about the water performance of the building has to be given in case of renting or purchase is a positive way to influence on behaviors.

**PROGRESS/RESULTS**

**Acceptance/ limits**
- **By builders:** N/A
- **By general public:** N/A

**Results/Progress**

Given that the byelaw is rather recent, there is little general information about its progress and uptake, a fortiori we had no specific results concerning WPB.

---

**THE CODE FOR SUSTAINABLE HOMES**

**United Kingdom**

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th>Mandatory green building rating instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coverage</strong></td>
<td>National</td>
</tr>
<tr>
<td><strong>Year launched</strong></td>
<td>2008</td>
</tr>
<tr>
<td><strong>Building specific?</strong></td>
<td>Yes, but water efficiency is only one the 7 key areas assessed (Energy efficiency, waste management, etc.)</td>
</tr>
<tr>
<td><strong>Type of buildings covered</strong></td>
<td>All new homes (new residential buildings), but only government funded housing must meet Level 3/4.</td>
</tr>
</tbody>
</table>

**ORGANISATION/IMPLEMENTATION**

**Implementing Authority/ies**
The Building Research Establishment (BRE), a former UK government establishment but now a private company funded by the building industry. The Code for Sustainable Home standard has been adopted by the UK government.

**Aims and objectives**

To reduce the environmental impact of buildings. All new homes have to be rated against the Code but meeting minimum requirements is only mandatory for government funded housing.

**Implementation,**

All buyers of new homes must be given clear information about the
and control measures

Supporting legislation and auxiliary measures

In February 2008, the Government of UK announced that mandatory rating against the Code for new homes will be implemented from May 2008.

REQUIREMENTS REGARDING WPB

Requirements

Up to 5 credits are available for performance which reduces the amount of potable water used in the dwelling.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Credits</th>
<th>Code levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water consumption in l/person/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;120</td>
<td>1</td>
<td>Level 1 and 2</td>
</tr>
<tr>
<td>&lt;110</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&lt;105</td>
<td>3</td>
<td>Level 3 and 4</td>
</tr>
<tr>
<td>&lt;90</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>&lt;80</td>
<td>5</td>
<td>Level 5 and 6</td>
</tr>
</tbody>
</table>

They are awarded according to the predicted average water consumption calculated using the Code Water Calculator.

Analysis

Water targets in the Code are mandatory and cannot be trade against other environmental measures which makes water saving one of the priority.

This overall consumption approach is based on the Code Water Calculator. It projects water use within new homes based on the water performance of key fixtures and devices and possible rainwater harvesting system. In fact the Code doesn’t set specific requirements regarding water fittings. In theory, it gives more licence to builders, they can chose the performance of each water fittings according the level they want to reach. However critiques highlighted the fact that water consumption thresholds are so low that meeting the Code requires the installation of very water efficient fittings that wouldn’t be accept by every user.

The advantage of this water calculator is to provide a tool directly assessing WPB. However it is only applicable to residential settings and couldn’t be used for other types of buildings such as offices, schools or retails. Another aspect is that the tool assumes a fixed behaviour, improving the WPB is thus only possible through modification in the performance of the water fixtures and fittings.

Giving information about the sustainability of new homes to buyers can influence behaviors in a positive way.

PROGRESS/RESULTS
| **Acceptance** | The Code was adopted after public consultation in 2007\(^\text{21}\). |
| **Limits** | Only applies to new residential settings. |
| **Results/Progress** | Given that it is a recent measure, there is no comprehensive feedback available yet. However, following this mandatory rating, a new building regulation is planned for October 2009. It will set a whole performance standard of 125 l/person/day for all new homes. |

### BREEAM

**UK**

| **Type** | Voluntary green building assessment |
| **Coverage** | Individual buildings or developments – international |
| **Year launched** | 1990 |
| **Building specific?** | There are many variations of the scheme for different building types |
| **Type of buildings covered** | New and existing buildings covered by different schemes within BREEAM |

### ORGANISATION/IMPLEMENTATION

| **Implementing Authority/ies** | BRE Global |
| **Aims and objectives** | To assess the environmental impact of a building, across a range of indicators, and provide a single performance rating for that building |
| **Implementation, and control measures** | Carried out by BRE’s licensed assessor network. BRE Global’s BREEAM schemes and licensed assessors are accredited by UKAS. They are also managed under ISO9001 quality management systems. Assessment can be at different stages - pre-design, post-construction, post-occupation – depending on the scheme. |
| **Supporting legislation and auxiliary measures** | N/A |

### REQUIREMENTS REGARDING WPB

| **Requirements** | For most schemes (Courts, Education, Prisons, Healthcare, Industry, Offices, Retail and Multi-residential dwellings), it uses a scoring system to rank buildings that pass its assessment into one of five levels: PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING. The BREEAM water standards are set out within Water Section (referred to as Wat 1, Wat 2, etc) of the various schemes. However, each scheme has its own set of these central

\(^{21}\) The future of the Code for Sustainable Homes - Making a rating mandatory (2007)
standards (with occasional variations to these core standards) and assessor manuals are available on their website. The website also provides a pre-assessment estimator tool.

The number of credits available through water saving features varies, depending on the scheme, and the overall weighting percentage for water (amongst the 9 sections covered) is 6% for new buildings, extensions and major refurbishments, and 7% for building fit-outs only. One credit is required by all schemes in the Water Consumption category to achieve GOOD, VERY GOOD or EXCELLENT, and two credits in the category for OUTSTANDING. Depending on the scheme, the first credit in Water Consumption can be achieved by overall water consumption between 4.5 and 5.5 m³ per person per day (estimated using BRE’s Water Calculation Tool) OR installation of low-flush volume toilets (less than 4.5 litres – a formula is provided for calculation of cistern volume for dual-flush toilets) and user guidance provided on dual-flush models. One credit is also required in the Water Meter category in order to achieve any rating above PASS, which effectively requires all houses above the PASS rating to have a water meter with a pulsed output installed on the mains supply to each building/unit. BREEAM OUTSTANDING requires a commitment to apply the BREEAM In-Use standard.

- 1 credit where consumption is 4.5 - 5.5m³ per person per year
- 2 credits where consumption is 1.5 - 4.4 m³ per person per year
- 3 credits where consumption is <1.5 m³ per person per year

**Analysis**

The focus is on reduced water consumption and metering, as is demonstrated by the requirements outlined above. The associated requirements regarding key fixtures (toilets) are clear and further credit is available for progressively more efficient toilets, efficient urinals, showers and taps. However, the requirement that only some of these fixtures need to have reduced water consumption is an issue, particularly as the fixtures approach does not consider the whole building consumption – a building may be have efficient toilets, but other fixtures may be very inefficient. The requirement for metering is in all buildings rated above PASS is good, and would assist moves toward water management practices.

The control methodology ensures that features are in place, but does not currently measure performance when inhabited, unless signed up to the In-Use scheme.

**PROGRESS/RESULTS**

**Acceptance**

26606 registered assessments; 9137 included in the certification statistics
The scheme has been operational for a significant time and, as can be seen above, has been involved in many assessments. Its format has been used as the basis for other green building schemes, such as the Code for Sustainable Homes.
## APPENDIX 3: TABLES SUMMARIZING EXISTING SCHEMES AND THEIR WATER REQUIREMENTS

### Voluntary schemes:

<table>
<thead>
<tr>
<th>Name of Measure</th>
<th>Country</th>
<th>Scope</th>
<th>Type of building covered</th>
<th>Water requirements linked to WPB</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM</td>
<td>UK</td>
<td>National</td>
<td>Multi-residential dwellings, offices, retail, healthcare, education, prisons, courts.</td>
<td>Depends on building type. Some have specific consumption targets, others have a requirement to feature certain water saving technologies. Example: for offices, the credits are awarded as follows. 1 credit where consumption is 4.5 - 5.5m³ per person per year 2 credits where consumption is 1.5 - 4.4 m³ per person per year 3 credits where consumption is &lt;1.5 m³ per person per year To determine the water consumption figure for the assessed building, the effective flush volumes and flow rates of WCs, urinals, taps and showers are entered into the BREEAM Water Calculator Tool. Rainwater collection or greywater recycling systems are also taken into account in the calculation. Water metering must be in place and the water meter must have a pulsed output to enable connection to a Building Management System for the monitoring of water consumption and the detection of major leaks.</td>
</tr>
<tr>
<td>AECB</td>
<td>UK</td>
<td>National</td>
<td>Residential buildings</td>
<td>Defines performance requirements for key fittings:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Fitting</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Showers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Basin and bidet taps (domestic)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Basin taps (washroom)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kitchen sink taps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Toilets</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Baths (shower must also be installed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dead legs</td>
</tr>
<tr>
<td>HQE</td>
<td>FR</td>
<td>National</td>
<td>Offices, education, healthcare, hotels</td>
<td>BASE : Real consumption ≤ consumption reference  PERFORMANT : Real consumption ≤ 0,90 consumption reference  TRES PERFORMANT (5 POINTS) : Real consumption ≤ 0,80 consumption reference  TRES PERFORMANT (10 POINTS) : Real consumption ≤ 0,70 consumption reference  TRES PERFORMANT (15 POINTS) : Real consumption ≤ 0,60 consumption reference</td>
</tr>
<tr>
<td>GSBC</td>
<td>DE</td>
<td>National</td>
<td>Offices</td>
<td>&quot;Potable water consumption and sewage generation shall be reduced. Storm water can replace potable water e.g., flushing toilets&quot;</td>
</tr>
<tr>
<td>Green Star</td>
<td>Au</td>
<td>National</td>
<td>Retail, education, offices, healthcare</td>
<td>The tool rewards buildings for water-efficient fixtures, water reuse, use of water meters, water-efficient landscaping, efficient cooling towers, and reduced fire system water consumption.</td>
</tr>
<tr>
<td>NABERS</td>
<td>Au</td>
<td>National</td>
<td>Offices, homes, hotels, retail</td>
<td>No requirements, NABERS just gives a rating for existing buildings. Water rating is based on data on water consumption and the surface of the building.</td>
</tr>
<tr>
<td>LEED</td>
<td>USA</td>
<td>National</td>
<td>Residential, retail, education,</td>
<td>&quot;Reduce potable water use of indoor plumbing fixtures and fittings to a level equal to or below the LEED Baseline, calculated assuming 100% of</td>
</tr>
</tbody>
</table>
### Name of Measure | Country | Scope | Type of building covered | Water requirements linked to WPB
--- | --- | --- | --- | ---
Healthcare |  |  |  | the building’s indoor plumbing fixtures and fittings meet the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code (UPC) or International Plumbing Code (IPC) pertaining to fixture and fitting performance. Fixtures and fittings included in the calculations for this credit are water closets, urinals, showerheads, faucets, faucet replacement aerators and metering faucets. Extra points are granted for more significant reduction (up to 5 points for a 30% reduction)

- Have in place permanently installed water metering that measures the total potable water use for the entire building and associated grounds. Meter data must be recorded on a regular basis and compiled into monthly and annual summaries. Applicants are also encouraged to meter gray or reclaimed water supplied to the building.

- Reduce water use for garden irrigation

**EU Eco-label** | European | Hotels |  | . The water flow of the taps and showers shall not exceed 12 liters/minute.

- Urinals shall have an automatic or manual flush such that no more than five urinals shall be flushed together.

- In the bathroom and toilets there shall be adequate information to the guest on how to help the accommodation save water.

**Nordic Eco-label** | Nordic Countries | Hotels |  | . Water consumption in litre per guest night shall be under limited values (from 200 to 300 l depending on the type of hotel)

- > 90% of the WCs used a maximum of 6 litres of water per flush: 1p

- 50 ≤ 90% of WCs use a maximum of 6 litres of water per flush: 0.5p

- ≥ 90% of mixer taps for washbasins are of the water-saving type, with a maximum flow rate of 8 litres/minute: 2p

- ≥ 90% of the mixer taps for washbasins have a maximum flow rate of 8-10 litres/minute: 1p

### Mandatory schemes:

| Name of Measure | Country | Scope | Type of building covered | Water requirements |
--- | --- | --- | --- | ---
Building codes | ES | National / Regional | Public buildings / All new and renovated buildings | Taps equipped with water saving devices in public buildings (national) / water efficient taps and toilets in all new and renovated buildings (Catalonia)

- Individual water meters are mandatory. In buildings with central hot water, individual water meters for hot water are also mandatory. New buildings with garden must also have a specific water meter to monitor garden irrigation.

- In case of major refurbishment and in new buildings every taps must be fitted with water saving devices so the maximum flow rate is 8 l/mn (2.5 kg/cm²). 10 l/mn for showerhead. Toilets must be equipped with dual-flush and have a maximum flush volume of 6l.

- In public buildings (offices, hotels) electronic or timed shut off taps are mandatory: maximum volume of 1l/ between opening and closing.

- Information about the conformity of water using fixtures of the buildings must be provided to every new residents or property.
<table>
<thead>
<tr>
<th>Name of Measure</th>
<th>Country</th>
<th>Scope</th>
<th>Type of building covered</th>
<th>Water requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local building codes</td>
<td>IT</td>
<td>Local</td>
<td>All new and renovated buildings</td>
<td>. Requirements regarding water efficiency of toilets and taps</td>
</tr>
<tr>
<td>SAGE Gironde</td>
<td>FR</td>
<td>Regional</td>
<td>Public buildings</td>
<td>. No specific requirements. A whole water management plan aiming at reducing water use within the building has to be set up and validated by the local commission in charge.</td>
</tr>
<tr>
<td>The Code for Sustainable Homes</td>
<td>UK</td>
<td>National</td>
<td></td>
<td>. Credits are awarded according to the predicted average water consumption calculated using the Code Water Calculator which enables a comparison to be made between a range of different water fittings and appliances (average use factors based on WRc (Water Research Centre) report, CP187, P6832, March 2005)</td>
</tr>
<tr>
<td>Irish Building Regulations (amendment to Part G - Hygiene)</td>
<td>IE</td>
<td>National</td>
<td></td>
<td>Installation of dual flush toilets is mandatory, both in new buildings and buildings where WCs are being replaced.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credits</th>
<th>Maximum indoor water consumption in l/pers/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
</tr>
<tr>
<td>3</td>
<td>105</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
</tr>
</tbody>
</table>
APPENDIX 4: ESTIMATION OF POTENTIAL WATER SAVINGS RELATED TO POLICY OPTIONS

Trying to estimate what could be the impact of diverse options as regard water saved is a difficult exercise and prone to criticism. An attempt is provided here, as it is felt that all options cannot achieve the same level of reduction, as they are not working in the same way.

The reduction estimations are given in the table below. Major assumptions for these rough calculations are described afterward.

<table>
<thead>
<tr>
<th>OPTION</th>
<th>Description</th>
<th>After 10 years</th>
<th>After 20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No further EU action</td>
<td>-1% in EU + framework directive impacts</td>
<td>-2 to 3% + framework directive impacts</td>
</tr>
<tr>
<td>2</td>
<td>Mandatory WuP</td>
<td>-10 to -15%</td>
<td>-20 to -30%</td>
</tr>
<tr>
<td>3</td>
<td>WPB, mandatory rating, for new buildings or sales</td>
<td>-2 to 5%</td>
<td>-5 to -10%</td>
</tr>
<tr>
<td>4</td>
<td>WPB, global standards, for new buildings or sales</td>
<td>-5 to -10%</td>
<td>-10% to -20%</td>
</tr>
<tr>
<td>5</td>
<td>WPB, water management plan, For public buildings and half of offices</td>
<td>-2 to -4%</td>
<td>-4% to -8%</td>
</tr>
</tbody>
</table>

The calculation considers three parameters:

- The proportion of buildings from the total building stock that will be affected by the scheme in a given time (10 or 20 years). This is calculated from new building and sale rates assumptions.
- Average potential saving assumptions. We tried to stay for all cases to the same first level of saving potential of 20%, so as to be able to compare the options.
- Estimation of the consumption of buildings as part of the total water supply system abstraction.

For the 20 year assessment period, it is assumed that levels would be up-dated and that a building sold for a second time within this period (in the case of a 15 year average rotation for buildings) would be improved again.

It should be highlighted that major determinants for water performance of buildings scenarios are the part of building concerned and the improvement effort that owners will make when this choice is left open (option 3 and 6). For instance, imagining that mandatory rating of option 3 would have to be carried out for major refurbishment could improve success of this option.
| Assumptions | General assumptions: | New building rate: from 0.3% to 0.6% /year,  
sale rates: every 15 to 25 years  
Domestic uses: 80% of total water delivered by the supply system, 7% for public buildings and 15% to all offices. |
|---|---|---|
| OPTION 2: Mandatory WuP | Products such as toilets, showerheads or taps are changed every 10 to 15 years.  
When changed for more efficient products, a 20% global saving is reached.  
All domestic uses are concerned (around 80% of water supply system). |
| OPTION 3: WPB, mandatory rating | Only happens for new buildings or when the building is sold.  
20% saving are made in 20 to 30% of cases, and 40% savings in 10%. |
| OPTION 4: WPB, global standards | Only happens for new buildings or when the building is sold, and these buildings abide to a standard defined of 20% savings. |
| OPTION 5: WPB, water management plan | Only for public buildings and half of other offices (around 11% of total urban water), who all achieve a minimum 20% savings, 20 to 40% of them going up to 40% savings. |