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Benefits and Impacts of an EU community-wide Hydric Appliances Efficiency Classification

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“Gutta cavat lapidem”

(Lucrezio)

Executive Summary:

My thesis aims to delve deeply into the topic of sustainability in the European water sector. The research intends to codify a way to achieve a successful implementation of an efficiency classification of hydric appliances with the ultimate goal of encouraging the sustainable production and use of water resources.

Seems that Europe has enough water to satisfy all existing needs, but this is not true for all states equally. According to the Environmental European Agency, households is considered the fourth largest economic sector in terms of water use. In addition, the population in urban areas is expected to grow, a factor that will exacerbate this data if no efforts are made to improve it.

Currently, the European water sector is already regulated in many of its aspects. This resource, being fundamental to life, is highly controlled and based on very complex structures. The usages are many and so are the appliances. Given the multiplicity of installations, the continuous advancement of production technology, and the European directions pushing for diminishing waste of resources, the introduction of a unified and mandatory tool to clarify the efficiency of installations would bring many benefits.

The classification tool would make the market dynamic, stimulating both consumers and producers to be part of the transition, trying to climb the rankings. It could allow consumers to have reliable indications for an informed purchasing decision and gives manufacturers of classifiable products the opportunity to emphasize their focus on the responsible use of water resources.

Without intending to be purely technical, the study is intended to motivate the introduction of a classification giving a theoretical demonstration of its feasibility. It also does not want to focus on water quality but only on the efficiency of water use. To enhance the proposed tool, the study will be supplemented by existing literature on impacts of ecolabels and type of labelling in general. Considerations include the existing energy efficiency classification and other water case studies, summarizing the state of the art and laying the foundation for the final discussion.

With introduction of a hydric appliance classification, the water-saving efficiency of European appliances would be easily recognizable; there is the need for the European Union to give a way forward to align on the water sector in this sense.

Sommario

1. Introduction

1.1 Introduction to the European context

Europe has considerable freshwater reserves, unlike other regions of the world. However, these resources are not evenly distributed across the continent and are unlikely to be sufficient for everyone in the future at current levels of consumption[1].

Europeans, with Italy in the top three countries for water withdrawal[2], use billions of cubic meters of water each year (1). Despite the thousands of freshwater lakes, rivers, and groundwater sources available, the rise in water demand across Europe has increased so much over the past 50 years that it has resulted in an overall decrease of 24 % in renewable water resources per capita across Europe (2).

In 2000, the domestic sector accounted for about 24% of total water abstraction in Europe, of which 70% was used by households, 24% by small industries and services and 6% by public services (3). More recently the European Environment Agency (EEA) estimates that about one third of the European Union (EU) territory is exposed to water stress, where demand exceeds available supply (4). EEA showed that water in Europe is used primary in 4 sectors: 58% for agriculture, 18% for energy cooling, 11% for mining and 10% households[3] (and services (3 %)) (5). In designing policy, it is therefore important to focus attention on the main drivers of household water consumption.

The European population has increased by 10% in the last two decades and the average water consumption of European households is 53 m3[4] per person per year. This trend is expected to continue, and, at the same time, more and more people will move to urban areas, which will put more stress on urban water supplies (5) (3). Estimation of population growth and the competing needs of water users resulted in an increase of global water demand of 35-60 % by

[1] The World Resource Institute predicts a 56% gap between water supply and demand by 2030;

[2] Average of 424 liters per user of potable water in Italy, this loss would satisfy the water needs of 43.4 million people for an entire year (Istat, 2022) (to compare with 142 liters per person per day in UK and 15-35 liters per person per day in Ethiopia);

[3] An average of 60% of personal water usage is in the bathroom;

[4] One cubic meter (m3) of water corresponds to 1,000 liters, this is an annual figure, so on an EU average a person consumes about 147 liters of water per day in Europe;

2025. This could double by 2050. According to another scenario simulation, the urban population will reach 80% of the total population around 2050 (6).

Although agriculture is clearly the sector with the highest water consumption, there is scientific evidence that there is an increasing need to have a focus on the domestic economy. The potential gross domestic product (GDP) is projected to increase by 1.3 % per year in the period 2016-2070 in the 27 EU Member States. (7) Furthermore, by focusing on citizens, sustainable habits and awareness can be developed to the benefit of all sectors. With an average of only 10% of water consumed in households for drinking and eating, there is the expectancy to move to a more efficient use of the remaining 90% through innovative practices. (8) In order to improve household water efficiency, pragmatic solutions and structural changes need to be initiated, focusing policies also on this under-exploited potential.

Although technological solutions exist, the barrier appears to be a lack of awareness and motivation to take full advantage of water efficiency measures. Improving consumer understanding of water use and the benefits of efficiency can be achieved by integrating household water efficiency into water management, construction, and consumer behavior policies across Europe.

Once the relevance of water efficiency within households is acknowledged as a crucial factor for the sustainability of appliances and buildings would also direct the focus of all stakeholders in the industrial sectors, thereby stimulating enhanced supply. For example, a 25% reduction in household water use can be achieved simply by replacing high-consumption taps and showers with water-saving technologies, without any loss of comfort or significant investment. In fact, according to the evidence of various studies, the average reduction of water leakage through water-saving devices and more efficient appliances can be up to 50% (3).[5]

However, both higher regulatory standards and greater consumer acceptance are needed to increase the uptake of these advanced technologies in Europe. Given the increasing number of detailed global and European regulations, policy makers are now expected to take action and create incentives to design adaptable solutions to the challenge of water scarcity that take into account water reuse facilities. Since the implementation of the Water Framework Directive in

[5]Any reference to reducing water use in the context of changing a system will be based on equal use. This is the reason why the raising of consumer awareness will be mentioned several times; the two must run in parallel.

Europe, the European Commission has consistently recognized the challenge and emphasized the seriousness of the issue through various communications that include policy options centered on demand management. Indeed, the world of water is very complex and water efficiency in the home needs to be tackled with a cross-sectoral approach and strong political support as in most cases it is a shared resource managed between the public and private sectors.

The present research aims to codify a way to achieve the implementation of a hydric appliances classification where the incentive function is the main attribute of interest. Thus, focuses on how classifications might foster the application of new technologies and/or induce changes in behaviors and production patterns in different sectors.

The following section will outline the main regulations and directives dealing with regulating the European water market, with a focus on those most relevant to water efficiency. In addition, for the purpose of the research, the most relevant theories on labels will be outlined, starting with characteristics and typologies, ending with highlighting their impacts; ecolabels and the successful case of energy labelling will be recounted as examples. Finally, global examples of water labelling will be presented to conclude the state-of-the-art study. Section 3 will explain the methodology that led to the research question and to the discussion on the topic that is given in Section 4. Finally, there will be conclusions.

2. Theory/Licterature Review

2.1 The European Water Regulatory Framework

It is important for the purposes of this research to first define the regulatory basis of the water world at the European level. Since the EU water efficiency regulatory framework comprises various directives, regulations, and initiatives aimed at promoting sustainable water use and management, only the most coherent ones will be outlined here in chronological and relevance order.

2.1.1 The WFD

Since 2000, the Water Framework Directive (WFD) (EU, 2000) has been the EU's reference water legislation, under which the EU's wide range of regulatory instruments, strategies and policy mechanisms that have emerged and evolved over the decades are coordinated.

The WFD establishes a framework for the protection and sustainable use of all surface and groundwater bodies in Europe. It covers all pressures and impacts on water and its objectives include the absence of deterioration and the achievement of good ecological and chemical status by 2015 and in some cases by 2027. In addition, the directive calls on Member States to promote the sustainable use of the resource, as well as to reduce its pollution and the effects of droughts and floods. (9) The WFD is very complex, as the water system is complex, but its functionality and efficiency has recently been successfully tested. It is introduced because it is the first and largest directive from which the numerous subsequent provisions on the subject branch off. It is introduced because it is the first and most important directive from which the many subsequent provisions on the subject are derived, necessary to cover the aspects that will be dealt with most in this research paper. In fact, the WFD sets objectives to be achieved by all Member States, but water quantities are relatively less considered than water quality.

2.1.2 The European Green Deal

Since the Paris Agreement of 2015, a legally binding international treaty on climate change adopted by 196 countries that goes by the name of Agenda 2030, the EU has been the first major economy to present its own emissions reduction target as part of the agreement, and it was in December 2019 that the European Commission presented the roadmap for a climate-neutral Europe: The Green Deal. At the very center of Agenda 2030 policy there are Sustainable

Development Goals, and it is based on these that the integrated approach of EU legislation and funding is based.

It is a set of political initiatives and strategies introduced by the European Commission to make the European Union climate neutral by 2050, as well as to promote economic growth and social cohesion. It is composed of several objectives, the main ones of which include climate neutrality, decarbonization, circular economy, biodiversity and ecosystem restoration, sustainable food system and just transition. As ambitious as it is, the Green Deal represents an approach that at the macro level aims to increase sustainable finance, target habits, and channel public and private investment into sustainable activities and projects to speed up the process and make it fair and just.

Within the Biodiversity Strategy, but not limited to it, there are several targets related to water policy. These include standards for "rigorous" protection and preservation of land and sea, restoration of freshwater ecosystems, implementation, and enforcement of EU environmental legislation (including the WFD, which is not yet fully implemented and enforced), biodiversity conservation, and finally, most significantly for what this research is concerned with, focuses on encouraging action for transformative change.

In light of the Agenda 2030, The European Green Deal intend also to pursue SDG 6, "Ensuring the availability and sustainable management of water and sanitation for all", where also water-use efficiency is encouraged. It is aimed to enshrine developments that support systemic change, and its action plan, and to enable a comprehensive transition in Europe also in the water world.

In addition to specific water policies, there are a wide range of strategies, tools and measures that directly or indirectly address the impacts of water stress and drought. Indeed, the EU with the Green Deal is outlining in increasing detail on how to assist the transition. So, in the field of water sustainability, it encourages member states to implement water efficiency measures and best practices to reduce water consumption, minimize leakage in distribution systems and promote sustainable water use in all sectors.

The strategy thus recognizes the need not only to "restore the natural functions of groundwater and surface water," but also to address "excessive consumption of natural resources." As such, it sets out a series of reforms to facilitate the transition to circularity and a greener, more efficient economy. To achieve its goals, the Green Deal includes legislative proposals,

financing mechanisms and more, in conjunction with various stakeholders from all points of the quintuple helix (10), to promote systemic change across the EU. A key tool in this regard is the EU's sustainable finance taxonomy, through which the Green Deal aims to establish financing standards to increase the efficient use and protection of resources, including water, in the European economy.

2.1.3 The European Taxonomy

It is with Regulation 2020/852 of the European Union that the European Taxonomy was established to make clear what is considered a sustainable activity or not. According to it, an activity is considered sustainable when first substantially contribute to at least one of the six environmental objectives outlined in the regulation, second it do not significantly arm any of the other five and finally comply with minimum safeguard.

Regarding the purpose of the research the two relevant lines of the Regulation are article 12 and article 13.

First, ex Article 12, “An economic activity shall qualify as contributing substantially to the sustainable use and protection of water and marine resources where that activity either contributes substantially to achieving the good status of bodies of water, [] by [] improving water management and efficiency, [] through any other activity that protects or improves the qualitative and quantitative status of water bodies;”.

Second, ex Article 13 “An economic activity shall qualify as contributing substantially to the transition to a circular economy, including waste prevention, re-use and recycling, where that activity: [] Uses natural resources, including sustainably sourced bio-based and other raw materials, in production more efficiently, including by: reducing the use of primary raw materials or increasing the use of by-products and secondary raw materials; or resource and energy efficiency measures; and [] increases the durability, reparability, upgradability or reusability of products, in particular in designing and manufacturing activities;”.

The taxonomy sets clear standards for water efficiency, emphasizes the responsible use of water, and includes water-saving recommendations for new buildings. Consequently, we can say that even according to the European Taxonomy, efficiency in the use of water resources is placed at the center of attention. Again, the economy is urged to move towards a better water management system in all economic sectors, thus also in the household sector.

2.1.4 Further studies and reports

The WFD provides the basis for addressing water stress. Water stress management in Europe has traditionally focused on supply-side measures. In the last three decades, there has been an increasing adoption of strategies that shift the focus to the management of water demand (11).

Other European bodies like the Bio Intelligence Service, The Ecologic Institute, and others, also together with the European Commission, created and are still engaged in the preparation of policy documents for water conservation. These not only focus on impacts on water consumption of households in the countries of the union but also on impacts that would occur if the current systems were replaced with those with high water efficiency.

The two most relevant and comprehensive are presented below. Both formed the basis of the research as they are, although slightly dated, the most comprehensive in terms of information and theories.

First “The Commission Communication on Water Scarcity and Droughts” (2007), which includes guidelines on "putting the right price on water", "allocating water more efficiently" and "promoting water-efficient technologies and practices". In particular, in Section 2.5 we find explicit references to the production of models similar to the one we wish to highlight in this paper. Seven policy options are included for water scarcity and drought management at European, national, and regional levels. Within these, two are particularly coherent: 'promoting water-efficient technologies and practices' and 'promoting a water-saving culture in Europe'.

To support the impact assessment of the document, the “EU Water Saving Potential” (2007) was produced, and it is in section 6.4 that the water classification is also assessed.

The second 'The Blueprint to safeguard Europe's water” (2012) outlines a new strategy that reaffirmed the need for action against water stress. This includes a focus on the need to increase resource efficiency and shift away from overuse of resources to enable growth (the same requirement has more recently been emphasized in the Circular Economy Action Plan as part of the European Green Deal). The plan emphasizes key issues such as increasing water efficiency and resilience and improving governance by water management stakeholders. Within this framework, the 'Water Performance of Buildings' study was also commissioned to give robustness to the strategy. The final report was fundamental to the research as even more policies are analyzed including voluntary and mandatory classification of facilities, the same

for buildings, the creation of minimum efficiency standards and other policy mix assessed from an ESG perspective.

To conclude this part, having outlined the major policies to be considered for the water sector concerned and highlighted the objectives behind the European water policies, we can assume that the European Union, in addition to the agricultural and industrial sectors, also looks at the domestic sector and is in favor of a classification to reduce household water consumption.

2.2 Incentivize by classifications: label types, considerations and limits

This section provides an overview of existing labels and their implications. Since ranking tools are part of the subject of this thesis, it is preliminary to set out the characteristics of these tools in support of the claim. All labels aim to reduce water consumption by encouraging consumers to choose efficient products, but in different ways.

In most cases, consumers lack complete information regarding the environmental consequences of their purchases, making it challenging for them to fully consider the environmental impacts. They may struggle to grasp complex environmental factors and often rely on incomplete or misleading information, as environmental attributes are typically difficult to verify prior to purchase and cannot be determined solely through usage of a product or service.

Labels aid people in understanding differences. In general, there is a distinction between 'certification' labels and 'rating' or 'scale' ones. The main difference is that the former indicate that a particular product meets certain criteria, while the latter provide more detailed information about the product by comparing it to others on the market. Even if the former are easy to read, the result is that there is in some cases less emphasis on the meaning behind them, because the mark does not show additional details of the product to which it is applied. By having only one level to reach, certification labels can in addition hinder the process of continuous improvement (‘climbing a ranking’), a feature that instead favors rating labels.

It is then appropriate to identify labels according to a number of criteria. The communication channel must be selected (12), whether the label is business-to-consumer, business-to-business, government-to-consumer, etc. Then the target category of goods or services and the associated attribute by which the goods or services will be labelled. Ownership, distinguished as public, private, hybrid and not-for-profit. The regulatory approach, distinguished as voluntary or mandatory, and the scope of application, distinguished as regional, national, international, etc. (13)

For the purposes of the research, the three most important elements are ownership, as this is where much of the credibility of a label rests; regulatory approach, as it determines the scale of governance and thus the achievement of objectives in the shortest possible time; and scope of application, as it is the basis for consistency and cohesion in the achievement of EU objectives. Public labelling has the potential to be a policy option to replace taxation and norms.

Moreover, the process becomes much more powerful if it is done at the community level. More controversial is the choice of governance.

Voluntary schemes give the market time to change but rely on strong sectoral involvement and commitment to be successful. Another problem with voluntary schemes is elective labelling, when suppliers voluntarily choose to classify only their best products. There's also the potential for consumer confusion, as a voluntary label suggests water efficiency, while the absence of a label doesn't necessarily mean inefficiency.

Conversely, mandatory programs inform consumers about every product on the market within their scope, since applies to all manufacturers and suppliers, stimulating competition and thus creating more consumer choices. Binding systems are recognized as being the most effective in incentivizing producers to become more efficient, although they are often the most complex to implement, mainly for three reasons: possible resistance and opposition from groups or sectors that perceive such regulations as a burden or a restriction on their activities; the economic costs of complying with the policy, mainly for companies, then partly also for consumers, especially in the short term; and finally monitoring and compliance, where strict monitoring and enforcement are often required to ensure compliance, which can be costly and complex to administer.

Information is the key factor. Once all primary characteristics are set, in order to be considered valuable, labels should typically figure details such as product identification, performance and savings; the more information are given, the better the product is perceived.

2.2.1 Eco-design and Ecolabels

An example of the ‘certification’ type is the European Eco-label. EU eco-design and eco-labelling policies are internal market standards that contribute to the transition towards the EU's objectives of the comprehensive European Green Deal (14).

Label origin allows differentiation between labels declared by companies themselves, like on their own product packaging, and those awarded by external organizations. Technically, an eco-label means that the product or service in question has been approved by an independent third party after being tested against a set of environmental criteria. The types of tests carried out on each product are specific to the product's life cycle. Without differentiating between products, as an example, ideally a shower can be classified efficient by the same label (with the same standards) that certify toilets.

In Europe, the European Commission's objectives for resource efficiency, comprising energy and water, include eco-design and eco-labelling. Indeed, to promote water efficiency in the buildings sector, it decided to develop voluntary EU Eco-label and Green Public Procurement criteria for key water-related products and to include water-related products in the “Eco-design Working Plan” (14).

Eco-labelling started to become popular in the 1970s. Consumers can be easily confused by the many different labels on the products they buy, and there is no easy way to interpret a label without a handy reference guide. In addition, consumer confidence in a labelling scheme requires consistency in labelling practices. The "European Eco-label" is the only environmental quality label certified by an independent organization and valid throughout Europe; the only example of a label that meets consumer expectations. There are currently twenty-three different product groups, and more than 250 licenses have been issued for several hundred products. Suddenly, only some of these groups explicitly address water savings (15).

In summary, Eco-design sets mandatory minimum criteria for the consumption and environmental impact of each product throughout its life cycle. It sets specific standards that products must meet to ensure that they are designed and manufactured in a way that minimizes their environmental impact from production to disposal.

2.2.2 The Energy Label

The Energy Label (EL) is an example of the ‘scale’ type. The EL is perceived by consumers and defined by researchers as a new purchase aid and information source (16). Introduced in 1994, it has become a widely recognized standard across Europe and is constantly being adapted to meet changing needs. This labelling system uses a grading structure to assess energy-using products. By evaluating their performance, an arrow is positioned on a scale that uses letters and colors to indicate the product's performance. Class A (green) appliances are recognized for their minimal energy consumption, representing peak efficiency. Conversely, Class G (red) appliances are identified as the highest energy users.

Prior to the introduction of the single European classification system, some Member States had independently established voluntary programs to inform consumers about the energy consumption of household appliances, often through labelling initiatives. Subsequently, one Member State formally proposed to introduce its mandatory labelling scheme, leading other

Member States to recognize that multiple mandatory national schemes could hinder trade within the European Community.

Providing accurate, pertinent, and standardized data on the energy consumption of household appliances can encourage consumers to choose the most energy-efficient options. This in turn encourages manufacturers to implement strategies to reduce the energy consumption of their products and promotes the prudent use of these appliances in households.

Data has a significant impact on market dynamics, which is why it is imperative to implement a consistent labelling system for all appliances within a category. This initiative aims to provide potential buyers with consistent and additional information on the energy and resource consumption associated with these appliances. Even in the case of scale labels, the use of completely optional systems would mean that the label would only be introduced for some appliances, which could lead to confusion among some consumers, since the current system must guarantee information on the energy consumption of all such appliances (17).

In summary, both types of labels are currently working together in the energy sector. Once the EU minimum eco-design criteria are reached, energy labelling will allow energy-using products to be ranked according to their efficiency, from highest to lowest. Would it be a European best practice also for the water sector?

2.2.3 Examples of existing water labeling

There are already examples of water classifications around the world, even in Europe. The point is that sadly these are not recognized in the same way as energy classifications, which makes the issue less familiar to citizens, EU included.

On the basis of these concrete cases, it is essential to study and build on the existing features to understand the limitations of the current systems, the reasons why water labelling has not been a success story in some case and find the water labelling best practice.

At present, water labelling is limited to certain categories of equipment, mainly those commonly used in private and public buildings for domestic functions, then extended to certain "water-related products"[6]. In general, these products and the consumption rates indicated on the label vary according to the type of product. Moreover, these lists have been expanded over

[6] Items or systems that influence water consumption during their use;

the years. Considering diverse already existing classification, the usual list of appliances can be summarized as follows:

- Showers (liters per time)
- Taps (liters per time)
- Toilets (liters per average flush)
- Urinals (liters per flush)
- Flow regulators (liters per time)
- Dishwashers (liters per wash)
- Washing machines (liters per wash)

Each of the following global examples is slightly different in the way the water label is managed. Differences can be found in the choice of classifiable products and/or in the choice of water consumption standards, mainly due to the relevant national requirements and national water saving policies and correlated to the application, i.e. the compulsory nature of the schemes, the level of information provided or even the factors considered, focusing some only on water consumption, others also on quality and related energy expenditure.

As anticipated, labels generally help to make it easier for consumers to obtain product information. In a technical field such as water, it is even more important to raise the awareness of the buyer. The characteristics of a water system must therefore be simplified, as they are less easily understood by the less experienced, and labelling is potentially the best tool if it succeeds in presenting the right information by making it relevant, clear, and instructive. Again, existing classifications differ and give us different parameters in the ongoing search for European best practice.

This compilation is not complete, but the labels included can be considered exhaustive in order to conclude the state-of-the-art section and then move on to the discussion section. Their status and relevance to the European context are the main features.[7]

[7] I would like to point out that the following part take inspiration to the Kelly's paper, which is rather outdated. I have preferred not only to cite it but also to update the case studies of global classifications, both in terms of developments and impacts (e.g. what happened in Europe with the Portuguese case of ANQIP, which merged with the previous European classification).

2.2.3.1 Global examples: The WELS’

Australian WELS (18):

The Australian Government has a strong commitment to water efficiency, through a variety of projects and incentives that target many sectors, including the domestic one. In 2005, the Australian Government, building on an earlier voluntary labelling scheme, introduced the scheme called “Water Efficiency Labelling and Standard” (WELS). Australia's WELS is one of the world's most successful water labelling schemes.

The oversight of the scheme and the enforcement of compliance fall under the jurisdiction of the WELS Regulator. Collaborating with industry stakeholders as well as state and territorial authorities, the Regulator strives to maintain the scheme's effectiveness and efficiency. The role of the WELS Regulator is set out in the WELS Act. The role is carried out by the Head of the Water Policy Division of the Department of Climate Change, Energy, Environment and Water.

The WELS Division of the Department of Climate Change, Energy, Environment, and Water is entrusted with the routine management of the scheme under the auspices of the WELS Regulator. This division's duties encompass tasks such as product registration, communication, standards formulation, and oversight of compliance and enforcement efforts.

It is a mandatory scheme and there are plans for products expansion. Under the mandatory WELS scheme are now included showers, tap equipment, flow controllers, lavatory equipment (toilets), urinal equipment, dishwashers, clothes washing machines, dryer function of combination washer-dryers, where they use water to dry a load.

The rating system is characterized by six stars that signifies the water efficiency of the appliance, taking into account factors such as water consumption or flow rate. The presence of more stars on the label indicates higher water efficiency of the product. Conversely, a zero-star rating indicates either a lack of water efficiency or failure to meet the relevant standards.

In addition, registration and product information can always be found at the bottom of the label. This includes the company that registered the product, the license number and the standards that guide how products are tested. There is also a database on the site to check the authenticity of the label attached to the product (Fig. 2).

The Australian Government website has all the schemes and reports, including reviews and evaluations, which show that the scheme is constantly being updated, both as technology develops and by measuring consumer insights to see if they are meeting our targets; as public awareness is one of the main tools on which the scheme is based, it is very well researched and the reports are also shared on the website. To get even closer to the consumer (as other schemes do), they provide water saving tips on their website.

Already in 2017, an impact assessment of the WELS program estimated that the scheme saved 112 billion liters of water, reduced greenhouse gas emissions by 1.9 million tons of carbon dioxide equivalent, and saved consumers more than $1 billion on their utility bills. (19)[8] The largest economic benefits of WELS came from the energy saving from reduced water heating. (20)

Singapore WELS (21):

Introduced as a voluntary scheme in 2006, from 2009 the Water Efficiency Labelling Scheme (WELS) became mandatory. As of 2017, the new labelling version includes the Registration Number displayed on the Mandatory WELS Label, while Serial Number is displayed on Voluntary WELS Label (only showerheads).

In addition, there is the WELS Products webpage to search for the list of brands, their respective registered suppliers, and all WELS labelled devices. There is also a section on incentives and grants to encourage organizations to look for efficient and innovative ways to manage their water needs. For example, the Water Efficiency Fund (WEF), launched in 2007, has been strengthened in 2023 to further encourage businesses and ensure long-term sustainable growth in Singapore's water demand.

The scheme include shower taps and mixers, basin taps and mixers, sink/bib taps and mixers, low-capacity flushing cisterns, urinal flush valves and waterless urinals, clothes washing machines, dishwashers, flush valves with water closet pans, commercial washer extractors, commercial dishwashers, high pressure washers and showerheads.

[8] For the following examples of labelling, no reliable sources were found to obtain data on impacts, probably because, as pointed out several times directly or indirectly in this research, water labelling is not only a new tool, but also not a very investigated one;

The label employs a four-tick rating system to figure the water efficiency level of the product, with more ticks indicating greater efficiency. Similarly, devices lacking water efficiency are assigned a zero-tick rating. The label also shows the water consumption data (Fig. 4).

Hong Kong WELS (22):

Honk Gong's water conservation strategies are varied and can be found on the government website. They demonstrate the country's commitment in a variety of ways, including the sharing of licensed plumbers, various requirements for facilities, ongoing training programs for workers and safety inspections, explanations on understanding good practice and reading systems, and internal plumbing maintenance programs; solutions include the WELS initiative.

From 2009 the Hong Kong government decided to create a voluntary water efficiency label scheme (WELS). Started with only shower heads, the labelling later extended to other appliances: showers for bathing, water taps, washing machines, urinal equipment, flow controllers, water closets.

The label employs a four-drop water rating system along with color codes to illustrate water efficiency. Ranging from grade 1 (green), denoting the highest efficiency with one drop of water, to grade 4 (red), indicating the lowest efficiency with four drops of water. The label also presents information on brand, model, water consumption (liters/minute) and registration number. Again, consumers can check the registered products on the website (Fig. 5).

2.2.3.2 European examples

The WELL (23)*:*

The Water Efficiency Label (WELL) was launched in 2011 by the European Association of Valve Manufacturers (EUnited Valves). In addition to water consumption, the WELL label also focuses on energy-related parameters such as temperature control (mixer or thermostatic valves) and time control (self-closing or sensor valves). This voluntary label distinguishes between private (domestic) and public use.

The WELL classification system applies to wash basin valves (bidet valves are rated in the same way), shower valves, shower heads and shower hoses, urinal flush systems, WC flush systems, accessories. Excluded from this classification are kitchen valves, bath filling valves

and connections to water-supplied domestic appliances and valves for garden watering systems.

The label uses a color scale like the EU energy label, together with a star rating system. The number of stars available depends on the application. Products for the domestic sector are rated on water consumption (max. two stars) and thermal regulation (max. two stars) for a maximum of four stars (efficiency classes A to D). Products for the public sector are rated for water consumption (max. two stars), thermo-regulation (max. two stars) and time control (max. two stars), for a maximum of six stars (efficiency classes A to F).

This labelling system also does not include water consumption, but consumers can check the registered products on the label's website. Classification is valid for five years, with the possibility of renewal for a further five years (Fig. 3).

The UWL[9] (24)*:*

The project, initially called European Water Label (2014), has its origins in the Portuguese ANQIP (25) (Associacao Nacional para a Qualidade nas Instalacoes Prediais) scheme of 2008. The inclusion of other labels (such as the Swiss and Swedish labels) is the first attempt to unify existing classifications in Europe. The first version of the European Water Label was developed by the UK Bathroom Manufacturer's Association (BMA) and the European Industry for Taps and Valves (CEIR). The same team presented the Unified Water Label in Brussels on 13 March 2019 and the non-profit association of manufactures still manages the operation of the scheme.

The Unified Water Label Association (UWLA) is a voluntary program developed and supported by the European Taps and Valves Industry Association (CEIR (26)). It replaces the European Bathroom Forum (EBF), which was established in 2017 to host the Unified Water Label; the scheme that is trying to give a uniform classification system for all member states.

This label, which is still voluntary, uses a color scale to indicate water efficiency. The color bands range from red (least efficient) to green (most efficient). In this case, however, the label clearly indicates the amount of water the product will use (liters per minute) and the associated energy consumption. There is no license or registration number, but there is an online database

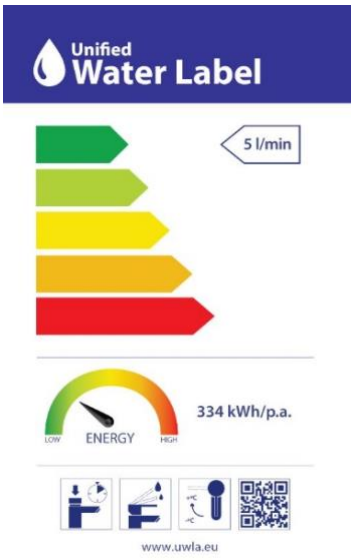
[9] In addition to the website, the information comes from an interview with an official UWLA member (Skinner).

of categorized products. The figure also gives an idea of energy consumption, not precise but approximate (Fig. 1).

The UWL classification system applies to showers, taps, WC's, urinals (including bowls, independent flushing cisterns, controllers and flush free), baths, recirculating shower criteria, spray WC's and seats under production.

The UWLA Manifesto (27), published in May 2024, illustrates how the Uniform Water Label is increasingly becoming a credible tool, accepted by the entire industry and recognized by international standards such as ISO31600. It is gaining visibility every day, with over 160 brands currently supporting it. There are 28,000 registered products and it is expected that there will be 34,000 by the end of 2024. Analysis of registered products shows that product performance continues to improve, but it has also shown that products alone are not enough to bring about the desired change in water use. Consumers also need to be encouraged to replace existing products with more efficient ones, and the label is trying to reach out at all levels to influence this through competitions and workshops in primary schools, a showroom package for KBB dealers, training videos for installers, a communications campaign and so on.

Fig. 1



Unified Water Labelling Association web site

Fig. 2

Australian Government web site, Water Rating page

Fig. 3

The Water Efficiency Label web site

Fig. 4

Pub web site,
Singapore's National Water Agency

Fig. 5

Water Supplies Department,
Government web site

3. Methods

Starting from the problem of excessive water consumption at the household level, my research initially focused on the existing instruments at the EU-community level. There are countless existing technologies and many European initiative focus on stimulating engineering-technological improvement of plant efficiency. But how to stimulate people to buy installations with new technologies, given that this usually involves a higher initial investment?

Next, I focused on what seems to be the most functioning way to convince civilians to switch electro domestics in this period, the energy classification. In fact, I believe that starting from the operation of this successful example we can gain a lot of useful information for success in other sectors as well. It has now entered in various forms into the common interest of households and industries, and the great potential of this classification lies precisely in the stimulation of the masses to move up the ladder because of the economic savings that result in the medium term, in addition to the environmental benefits correlated.

Since water is also a resource that can be measured by the volume used, I immediately thought that the tool of classification could be suitable for this world as well. I therefore began researching similar tools that already existed in Europe and then in the world to finally also study their potential, limitations, and effects.

From researching the existing literature, it turned out not only that it is still a partially unexplored field but also that few real examples of classification in the water world exist, surprisal also at European level. In fact, it took some effort to find data on water classification instruments. Having independently attempted to understand the current application and functioning of these tools, my research question arose from studying these examples:

Would a common water label at the European level help countries achieve water efficiency in a cohesive way?

Since my studies are primarily from an economic-social rather than engineering standpoint my research on the feasibility and potential success of the proposal wanted to focus on qualitative studies. My reflections are based on the primary data I could find in the literature on the topic and very much on my perceptions, experiences, and interviews both of an informal exploratory type initially, then followed by both a structured online survey and a semi-structured type of interview with some professors and professionals in the field.

In order to understand whether one of the most important stakeholders of the classification, the citizens, had a basic knowledge of the subject, has been used a structured survey (which can be found at this link (28) and the results of which are available in this document (29)) containing eight basic questions. The questions were designed to be easy to understand and to answer in order to reach as many users as possible. In fact, although the survey was mainly distributed to fellow students and university staff, as well as professional contacts close to the construction and water sectors, the aim was to determine the current state of user behavior[10] of civil society in general.

Once a sufficient number of responses had been collected (172 users at the time of processing), the most relevant results for research were selected and simplified as follows:

- Although the majority of users pay attention to water waste[11] and 83% are aware that the cost of the resource is partly related to its consumption, 78% have never bought a high efficiency appliance;
- The data also shows that most users are not even aware of the existence of a water efficiency rating and are unaware of the significant efficiency gains that could be made by replacing appliances;
- Finally, up to 92% of users would be inclined to buy water-efficient products if a water efficiency rating, equivalent to energy efficiency, was available.

In short, the proposed survey showed that environmental technologies are not sufficiently used, partly due to a lack of clear information, and water conservation awareness is, thus, a significant tool.

Given the obvious limitations of this type of public survey, I then moved on to semi-structured interviews. The main purpose of which was to understand whether the data from the online survey of citizens was consistent with that of academics and experts in the field. In particular, based on the background of the interviewee, the questions proposed through an interview protocol focused on an entrepreneurial point of view with Marijana Krstic, Founder of 'Shades of Blue'; on a scientific/ projectual point of view with Fabio Ugolini, Professor at *LUISS* and project manager at *INNOVA,* and Fabrizio Traù, Industrial Economics Professor at *LUISS;* on

[10] This survey would be interesting to repeat afterwards, in the case of a pilot project, for empirical demonstration;

[11] As the 2024 ISTAT study (2022 data) also shows, almost 70% of people care about saving water;

a technical point of view Maria Luisa D'Amico, Architect at *Regione Lazio,* Manuel Bogoni, Hydraulic Civil Engineer and Filomena D'Arcangelo, Engineer and *Federazione ANIE* Technical and Regulatory Office Manager.

The most important finding was not only that these individual actors were not aware of the European UWL classification, but also that they considered the proposed tool as innovative and potentially functional. However, it was through these interviews that the critical aspects of the research emerged; each interviewee, in their own way, was able to add value and highlight limitations.

First, from a scientific/projective standpoint, I have been given an overview of the process in which my thesis aims to fit. To write a valid proposal it must follow a roadmap to open a communication channel with the relevant EU bodies. While thesis can be necessary for the preliminary conceptual demonstration of the tool's potential, as would be done in the 'Results and Discussion' section, then the process would include a subsequent empirical demonstration of the success of the project (pilot project), from which a policy brief would be developed to arrive at first a national and then a European proposal. Having this information, my dissertation focused more on the theoretical feasibility of the project, also based on the study of case studies and secondary data proving the functionality of new technologies in the water industry.

In addition to this concept, which saw the thesis from a generic planning point of view, a second particularly fundamental concept was given by the water field professionals.

The great complexity of water systems starts with the division between civil and industrial purposes. The primary differentiation lies to the fact that in some domains the resource must necessarily be potable while in others it is not. Also, from the difference in purpose the sector can be resubdivided into reuse and nonreuse plants. The interviewees were most concerned to highlight how the system dealing with this resource is not only highly fragmented but also highly regulated. The sector is very broad (water resources are fundamental to pharmaceuticals, agriculture, food, construction, etc.) and a solution that reduces water consumption in one segment may fail in another (a classification for domestic systems may not be valid for the systems of a clothing industry). Given this complexity of applications, is considered preferable to introduce a classification primarily to civilian facilities, with the hope of implementing it for all types of facilities in the future.

Furthermore, the areas of water sustainability are also diverse, and it is difficult to group them into a single solution (water scarcity, water pollution, water efficiency, etc.). This contribution

gave the confirmation to focus only first on domestic facilities and to focus only on one environmental attribute, the efficiency. It was also made clear that for this and other more technical reasons it is important to keep the classification of water separate from the energy one.

The problems of ownership were highlighted then. These are mainly due to the fact that the water sector is a sensitive and vital sector, which obviously makes it mainly managed by the public sector (D'Amico); to work in the water sector, it is the multi-level governance that is the biggest complication (Krstic). All these insights were essential to have a more precise overview of the subject to decide where to start and focus: a unified solution that give coherence, simplifying the domestic sector appliances regulation, organized, and imposed by the EU commission, and directed from the private sector (appliances industries) to the private sector (families).

Then the problem of the actual structures came up, that are mostly old and need maintenance (that is long and expensive), since we are talking about reducing leakage[12] and saving water in general. As stressed by technical experts, the criticality in this sense is that at this time the classification is a solution that cannot work alone. It must be accompanied by upstream maintenance of the systems since systemic losses are the main source of waste.

In this sense it is good to make it clear that this thesis is intended to stimulate solutions that go hand in hand with the macro-one, that do not completely eliminate the problem and therefore do not replace those that already exist and that are functional (maintenance at macro-level). In addition, acknowledging how little consideration is given to water efficiency at the household level, has spurred the importance in pointing out that leaving the solution to the problem upstream is an un-educational way of solving problems, while involving the demand side in the search for efficiency has its advantages. Without educating people about conscious use, the problem may be alleviated in the moment, but the sustainability of the solution is not addressed, which could lead to a new crisis in the future.

Subsequently, the point of view of industrial economics gave a clearer view of the supply side acceptance. Theoretically the mandatory classification approach will initially be perceived as an obstacle by the domestic appliance industry, but this does not detract from the fact that,

[12] 42.4% is the potable water lost due to the inefficiency of municipal distribution networks (ISTAT, 2022);

since it is obviously a non-retroactive policy, it may in the medium term become a stimulus to innovation and thus to market differentiation, which is not an irrelevant factor. Additionally, if the classification starts in the private sector (industries adapting) and reaches the private sector (households buying), the process is somewhat simplified and can give inspiration to other economically related activities (marketing, advertising, etc.).

The experience of industry with energy classification allows us to imagine the impact of a similar policy, albeit in a different sector. Indeed, engineer D'Arcangelo explained that the logic of the classification is to identify and harmonize European sustainability criteria for the production and sale of products, which for industry translates into eco-design criteria (European Ecodesign Directive (30)) that allow citizens to choose the best performing products, but also applies to non-consumer equipment. For example, even in the industrial (business-to-business) sector, there are eco-design regulations that give industry a guideline for placing increasingly energy-efficient products on the market, then throughout their entire life and production cycle. ANIE, but potentially in general, sees these schemes as a burden but also as a great opportunity. The sector has approached these challenges with conviction, but also with some trepidation, because it needs clear criteria to work that are easy to read for those who have to produce. The industry is not afraid to raise the limits, energy classification has never been seen as a critical element, but if you look at the situation of industry in the market, the picture is clear: without incentive mechanisms, companies struggle. In conclusion, to confirm the theoretical statement for industrial economics and to return to the theme of the thesis, water classification is potentially seen as a competitive factor in the EU and beyond, in the wake of energy classification, initially perhaps for consumer products, but in the future also for business and so on.

Before completing the interview section, I had the great opportunity to interview Paul Skinner, a technical consultant at the Unified Water Label Association, who not only provided me with the missing information on the scheme, but was also able to report that there is currently no proposal in the European Commission to make the scheme mandatory and the same for all states, although in the UK (where the UWLA is based) the government is actually calling for a similar classification scheme.

According to the interviewee, the biggest obstacle to the scheme becoming an EU directive is the wide variation in regulations between member states, as well as the fact that the cost of water in Europe is too low.

Skinner was also able to give me a better understanding of the soul of the project, which is "by industry for industry", in the sense that it is created and managed by the European Faucets and Valves Association to give industry sensible criteria to produce efficiently. As he pointed out, the UWLA is a not-for-profit organization which, for the time being, only aims to improve the current vision and use of water resources in Europe.

At the end, the state-of-the-art section was supplemented with a summary of the existing classification cases in view of the critical issues that arose when comparing the research idea with the interviewees. In fact, the feedback, although essential, was quite controversial, probably due to unfamiliarity with the tool in question.

The comparison is necessary to simplify the argumentation in order to derive the basis for the final discussion. This simplification starts with the schematization, which compares the most successful case with the European one, in order to highlight the differences that could also lead Europe to success, and then integrates other considerations on limitations and potential solutions, also based on the other cases listed. The answer to the research question in the final discussion will be an explanation of how it can be confirmed that the classification tool is suitable for standardizing and steering the European water market towards a less wasteful future.

4. Results and Discussion

4.1 Potentiality and impacts of a water classification

Water resources need to be better managed. Regardless of consumption, since structural losses are at the heart of the problem[13], it is clear that the macro-restructure of existing systems should be prioritized. However, as previously discussed, there is evidence that a reduction in freshwater abstraction in urban areas can be achieved through changes in population habits, the use of more efficient technologies and water-saving devices. While individual Member States are committed to reducing losses due to deferred maintenance, citizens can play their part in the fight against waste. In particular, domestic water saving measures includes technical measures, such as installation of water saving devices, and non-structural measures, such as information, education, and pricing. All this can be reached by legal, informational, and economic ways, three dimensions that ranking instruments match perfectly.

By examining existing legislation, ranking tools and real cases, the thesis aims to understand whether the classification of water uses is the right instrument. The following reasons provide the basis for demonstrating that the three dimensions can be addressed by classifications.

Consumers' growing awareness of environmental issues is leading them to choose products for their energy and resource efficiency, mainly due to cost-saving considerations. This growing awareness underlines the possible need for a single classification system that transcends national boundaries and ensures consistency of evaluation criteria also in the water sector. However, the current landscape is full of different labels and eco-symbols that do not promote clarity but confusion among consumers.

The current regulation we have seen is favorable to the implementation of such an instrument, and the current state shows that there are already initiatives in the European market, where on the one hand there are industries trying to prove their efficiency through the labels that currently exist, and on the other hand there are entities and organizations trying to improve these labels more and more.

[13] As an example, according to the latest ISTAT data, in 2022 in Italy's drinking water distribution networks, compared to the 2.3 billion cubic meters of water injected into the network (364 liters per inhabitant per day), 0.8 billion cubic meters, 35.2 % of the volume injected, went missing (1);

Following the empirical evidence from the state-of-the-art study, based on the label characteristics highlighted in section 2.2, the following table aims at providing the theoretical basis for subsequent considerations of potential European success. This is carried out by schematizing and clarifying the differences between the European UWL case and the Australian WELS case, as it is the most successful case study that has not only been consolidated over several years (the Australian government can also be seen as the promoter of this instrument in the water sector), but also where most of the sources can be found.

Characteristics	Australian WELS	European UWL
Communication channel	Business-to-consumer[14]	Business-to-consumer
Target category	Taps, showers, flow controllers, toilets, urinals, dishwashers, washing machines, dryer function of combination washer-dryers	Taps, showers, toilets, urinals (including bowls, independent flushing cisterns, controllers and flush free), baths, recirculating shower, spray WC's and seats under production.
Environmental attribute	Efficiency	Efficiency
Ownership	Public	Not-for-profit
Regulatory Approach	Mandatory	Voluntary
Scope of application	National[15]	Not-defined[16]

Since there are three differences that can be clearly deduced from this table, there are three points on which action can be taken to improve the European case.

[14] This type of transaction is where a business sells a product or service directly to a consumer;

[15] The Water Efficiency Labelling and Standards (WELS) scheme are detailed in Commonwealth, state and territory legislation, with two Commonwealth Acts and associated legislation;

[16] Ideally, it should be European or Communitarian; it is not clear because it is a voluntary scheme;

Firstly, the different ownership of the scheme, which obviously affects the credibility and legitimacy of the label. Presumably, both criteria would be enhanced if the scheme were made available on the European Commission's website (like the energy example (30)) and managed by selected authorized agents. The credibility of the tests would also be enhanced if, as the standards were EU-wide, laboratories had to follow the same requirements.

Second, the transition from voluntary to mandatory labelling schemes is essential to achieve widespread adoption and ensure the effectiveness of water efficiency initiatives. The economic, environmental, and social implications of this transition underline its importance. First, from an economic perspective, mandatory labelling schemes create a rapid market incentive for manufacturers to innovate and develop more water-efficient technologies; if the system is voluntary producers will for obvious reasons only label their better products. In addition, the environmental benefits of limiting water consumption and reducing the use of energy to heat water (and thus reduce air pollution) [17] will be enhanced if the classification requirement is mandatory and then applies to all. Lastly, the social dimension is also amplified since mandatory and common provision make clearer that the system can be trusted. A culture of responsible consumption and environmental stewardship, where consumers are likely to become more engaged in monitoring their water use, identifying potential leaks, and using water more efficiently, depends on public acceptance and uptake. This is enhanced if the classification system not only address the immediate need for water savings, but also meet evolving consumer expectations, highlighting the responsible use of water and energy without sacrificing comfort or convenience.

Finally, there is the issue of scope of application, which obviously depends on the fact that the European case consists of a large number of states that are part of a community and therefore, unlike Australia, potentially have different forms of government, water distribution structures, customs, and habits and, for example, different criteria for defining an efficient system. The key aspect here is to make it clear that, as in the case of energy classification, the European institutions will create the system into which the individual states will then have to fit, thus enabling not only the adaptability of the instrument but also its acceptance.

[17] In the EU, energy production accounts for 44% of total water abstraction, primarily serving as cooling water (EEA).

The empirical findings show promising prospects for substantial water savings and strong regulatory alignment with European policies such as the Green Deal and the Water Framework Directive. The following table is used to schematize these statements:

Key Results	Empirical Findings	Comments
Water Saving Potential	• The structured survey revealed that most users are unaware of the existence of water efficiency classification system but would use high-efficiency products if such scheme were available. • The use of water-saving technologies could reduce water leakage up to 50%.	• A uniform and mandatory water efficiency classification could lead to significant domestic water savings. • Availability and awareness of such information would encourage the adoption of more efficient technologies.
Regulatory and Political Support	• Literature review shows that the proposed classification system aligns with existing European policies, like the European Green Deal and the Water Framework Directive.	• Aligning with existing policies facilitates acceptance and implementation of the classification system across Europe.
Stakeholder Involvement	• Semi-structured interviews with academics, industry professionals, and entrepreneurs revealed that a water efficiency classification would be seen as innovative and potentially effective. • 92% of surveyed users would purchase water-efficient products if such a system were available.	• Involving governments, industries, and consumers is crucial for the success of the classification system. • Clear and reliable information would promote changes in consumer behavior and industrial practices.
Long-term Benefits	• A mandatory water efficiency classification system can promote sustainable water use, stimulate technological innovation, and educate consumers.	• Highlights the extended benefits of a unified system, contributing to long-term sustainability and innovation goals across different sectors.

	• These changes can lead to broader social and economic transformations, such as improved urban planning and resource management.	
Policy Recommendation	• Gradual introduction of mandatory regulations, integration with other policies, and economic incentives for producers to develop and market water-efficient technologies are necessary (based on case study analysis and semi-structured interviews with experts).	• Provides a clear roadmap for policy implementation, ensuring a cohesive and effective rollout of the classification system across member states.

In conclusion, while the thesis strongly demonstrates the significant potential of implementing a common water efficiency label at European level to achieve coherent and effective water efficiency, several barriers need to be addressed to ensure its successful implementation. Based on successful case studies, the following section outlines barriers that may hinder the benefits of implementation and possible solutions:

1. Regulatory and Political barriers:

The transition from voluntary to mandatory regulation may face significant resistance. In addition, different levels of implementation and enforcement of existing water policies across Member States can complicate the establishment of a consistent system.

Solutions may include, drawing on the Australian WELS experience, the EU adopting a phased approach to mandatory regulation. Starting with voluntary schemes and gradually integrating mandatory standards will allow industry to adapt while policymakers harmonize enforcement mechanisms across member states. Ensuring minimum standards of water efficiency would also enhance EU common market perspective. At first glance, what appear to be just an additional cost for manufacturers, with a mandatory classification for all Member States, would allow all exporting companies to sell the already valid product without having to adapt it according to national regulations. With a single label across Europe, manufacturers cross-

selling into different countries avoid the duplication and increased costs that multiple labels can bring.

2. Economic and Financial barriers:

Implementing a mandatory classification system entails economic costs for both producers and consumers. Manufacturers may need to invest in new technologies to meet efficiency standards, which may increase product prices and discourage widespread adoption.

Solutions can be drawn from the Australian and Singaporean models, which provide insights into addressing economic barriers through government incentives and subsidies. Offering tax rebates or grants to manufacturers who invest in water-efficient technologies and providing subsidies or low-interest loans to consumers to purchase high-efficiency products, can reduce upfront costs and encourage adoption. Moreover, where domestic water consumption is metered and paid by volume, the incentive to purchase a product with a higher water efficiency is increased; the classification tool would be much more powerful if it is connected to such type of policies[18].

3. Technological and Infrastructural barriers:

The current infrastructure in many European countries may not support the rapid introduction of new water-saving technologies. In addition, systemic problems in ageing water systems need to be addressed.

Solutions from the Hong Kong WELS initiative shows the importance of integrating infrastructure upgrades with the introduction of efficiency labels. The EU can support Member States by providing funding and technical assistance to modernize water infrastructure and ensure that systemic improvements are aligned with the introduction of new efficiency standards.

4. Consumer Awareness and Behavioral barriers:

Changing consumer behavior and raising awareness requires robust education campaigns and consistent dissemination of information.

[18] Although in the majority of cases in Italy the water bill has both a fixed and a variable fee, this is not the same in all situations at national level, nor is it the same at EU level.

Solutions should include effective public awareness campaigns, as seen in the Australian WELS program, which are crucial. The EU can launch coordinated campaigns across Member States using multiple channels - social media, traditional media, educational programs, and community workshops - to educate consumers about the benefits of water-efficient products and behaviors.

5. Stakeholder Engagement barriers:

The success of the classification system depends on the active participation and cooperation of these stakeholders. Learning from the success of the Unified Water Label Association, a collaborative approach involving public-private partnerships can be effective.

Solutions might involve the establishment of a central coordinating body within the EU to facilitate dialogue and cooperation between stakeholders to ensure coherence of efforts and common goals.

As a result, the proposed common water efficiency label at European level holds great promise for improving water efficiency. By addressing regulatory, economic, infrastructural, awareness-raising and stakeholder engagement barriers with strategies drawn from successful international examples, Europe can more effectively implement a single and binding water classification system. This comprehensive approach will promote sustainable water use, support existing environmental policies, and drive market transformation towards more efficient technologies. Addressing these challenges will ensure that the benefits of a coherent water efficiency labelling scheme are realized, contributing to sustainable water management and a resilient future for Europe.

To complete the theoretical dissertation would be necessary to carry out an impact assessment study based on factors such as the changes in water consumption, both public and private (from a demand perspective), the market transformation from a supply perspective, and the public acceptance of the classification, both in terms of recognition and consideration of the label.

5. Conclusions

Our starting point was the problem of growing awareness and overconsumption of water in urban areas. As a significant proportion of water use occurs at the household level, the issue was researched and the most effective tool to tackle domestic waste was identified as water classification. This tool works on several fronts to reduce unnecessary water use.

The main objective of this research was not only to update the current state of water classification, but also to support the improvement of the current European classification system. Currently, there is a proliferation of solutions that include different labels and ecolabels for products that unfortunately often leads to confusion, especially when consumers do not understand the meaning of these labels.

The ultimate goal is to facilitate the implementation of a European Union-wide water labelling initiative that can realize its full potential in terms of water savings influencing consumer behavior and stimulating market growth towards the adoption of highly water-efficient products, thereby reducing household water consumption, and promoting water saving awareness.

Fortunately, there is no need to start this journey from scratch, thanks to the foundations laid by the Unified Water Label Association. However, by examining the different labelling mechanisms and analyzing various case studies, it is clear that improvements can be made to the current European scheme.

Six distinctive characteristics have been identified to schematize the findings of the research. Specifically, based on the comparison of these between the European and Australian cases, there are three which are proposed to be worked on: ownership, regulatory approach, and scope of application. The next step is therefore to move to a mandatory system to ensure the uniform dissemination and effectiveness of water efficiency measures, to be set up and regulated by the European Commission, as the move to public management can increase the credibility and legitimacy of the UWL system, which must be coherent and applicable to all Member States, a pan-European initiative to create a harmonized regulatory framework at EU level. By standardizing criteria, empowering consumers, and encouraging innovation, such classifications have the potential to reshape markets, save resources and protect the planet for future generations.

The other three, of course, could also be interesting to develop. For example, the current communication channel for labels is generally business-to-consumer, which means that they are tools aimed at demonstrating an attribute of a particular product or service to the consumer of that product or service. However, it may be interesting to explore new tools or communication methods that work with business-to-business or government-to-consumer channels to increase dissemination and uptake. The target categories could be further expanded to include all household appliances. Finally, the current environmental attribute, which in both cases focuses on water efficiency, could be complemented by other attributes; for example, since water-saving systems can consequently reduce energy consumption for heating purposes, the associated reduction in energy consumption or CO2 emissions could be included.

Once all successful features have been clarified, suggestions for further applications includes the possibility of adding to the classification figure information about future cost savings of purchasing this equipment, which may also make it possible to overcome what appears to be a price barrier to consumers. Furthermore, this perception is distorted since the most efficient products are not always the most expensive ones. No existing classifications figure this type of information at the current time, even the Australian one; some does but only on their websites. Certainly, to do so would require generalizing and specifying that savings from efficiency are based on equal consumption, but it is certainly a potentially interesting novelty to introduce.

Moreover, the potential of this tool is not limited to reducing domestic water waste but can be significantly extended to create value in different sectors of the economy. In the long-term impacts of mandatory water efficiency labelling could go beyond consumer choice and includes broader social and economic changes, bringing about a paradigm shift in resource management, employment opportunities and urban planning. In fact, future studies could focus on extending the classification to future regulatory measures, such as mandatory water performance certification of buildings[19], promoting a culture of continuous improvement and accountability. In addition, at the building level, sustainable and efficient buildings can create economic benefits for the owner, increasing rental value in the residential sector and new marketing strategies in the non-residential one.

Other studies could focus on investigating the applicability of a classification in other industries and sectors. Indeed, the paper also highlights the limitations of the water sector, which shows

[19] As was done in Italy with the '*Attestato di Prestazione Energetica*' (APE, (31)), so could, for example, the water performance certificate be created;

that the proposed ways to improve the current European classification scheme for domestic installations do not necessarily apply to all existing water installations.

To date, the EU does not have a solid policy framework to objectively promote water efficiency in appliances and buildings. It is therefore imperative that the EU accelerates the process and moves into a new era of environmental management and sustainable development. In doing so, it can lead the way to move into a new era of environmental management and sustainable development.

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