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Authors:	Marlyne Sahakian (UNIGE); Patrick Naef (UNIGE); literature review support by Tania Pereira (UNIGE).
Reviewers:	Charlotte Jensen (AAU); Eoin Grealis (LMU); Edina Vadovics (GDI); Eva Heiskanen (UH); Senja Laakso (UH); Véronique Vasseur (UM); Marfuga Iskandarova (Kingston); Gary Goggins (NUIG); Frances Fahy (NUIG).
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ENERGISE partners	Logo
National University of Ireland, Galway (NUIG), University Road, Galway, Ireland	
Aalborg Universitet (AAU), Fredrik Bajers Vej 5, Aalborg 9220, Denmark	
Kingston University Higher Education Corporation (Kingston), River House High Street 53-57, Kingston Upon Thames KT1 1LQ, United Kingdom	
Universiteit Maastricht (UM), Minderbroedersberg 4-6, Maastricht 6200 MD, Netherlands	
Université de Genève (UNIGE), 24 rue du Général-Dufour, 1211 Genève 4, Switzerland	
GreenDependent Institute (GDI), Eva utca 4, Godollo 2100, Hungary	
Ludwig-Maximilians-Universitaet Muenchen (LMU Muenchen), Geschwister-Scholl-Platz 1, Muenchen 80539, Germany	
Focus Drustvo Za Sonaraven Razvoj (FOCUS), Maurerjeva Ulica 7, Ljubljana 1000, Slovenia	
Applied Research and Communications Fund (ARC Fund), Alexander Zhendov Street 5, Sofia 1113, Bulgaria	
Helsingin Yliopisto (UH), Yliopistonkatu 4, Helsingin Yliopisto 00014, Finland	

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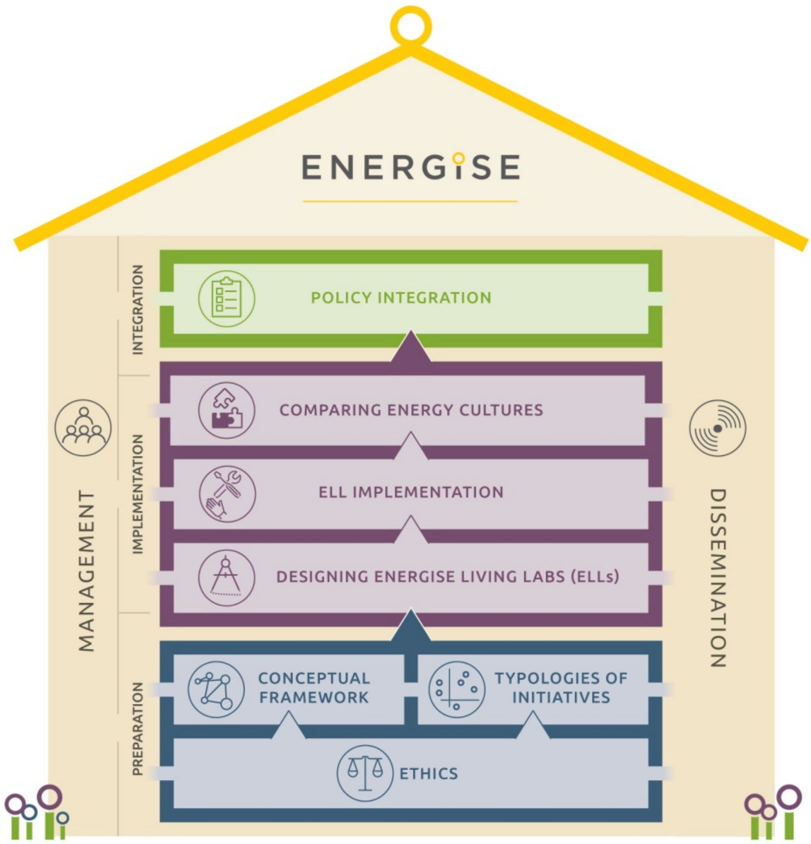
ENERGISE PROJECT

ENERGISE is an innovative pan-European research initiative to achieve a greater scientific understanding of the social and cultural influences on energy consumption. Funded under the EU Horizon 2020 programme for three years (2016-2019), ENERGISE develops, tests and assesses options for a bottom-up transformation of energy use in households and communities across Europe. ENERGISE's primary objectives are to:

- **Develop an innovative framework** to evaluate energy initiatives, taking into account existing social practices and cultures that affect energy consumption.
- **Assess and compare the impact** of European energy consumption reduction initiatives.
- **Advance the use of Living Lab approaches** for researching and transforming energy cultures.
- **Produce new research-led insights** into the role of household routines and changes to those routines towards more sustainable energy.
- **Encourage positive interaction** between actors from society, the policy arena and industry.
- **Effectively transfer** project outputs towards the implementation of the European Energy Union.



EXECUTIVE SUMMARY

Following the roll out of ENERGISE Living Labs (ELLs) in eight European countries – Denmark, Finland, Germany, Hungary, Ireland, Switzerland, the Netherlands and the United Kingdom – Work Package 5 (WP5) sets out to answer the main research question: **In what way do ELLs contribute to changes in everyday practices related to heating and laundry?**

The purpose of D5.1 is to describe different elements of practices and how they inter-relate, inspired by the theoretical framework put forward by WP1 (Rau and Grealis 2017, D1.2) and based on available data prior to ELL rollout. The table of contents, presented above, represents some of the key elements that contribute to shaping practices with a focus on heating and laundry which can be energy intensive. In addition to an emphasis on **social norms and collective conventions, we consider governing frameworks, material systems and arrangements, and socio-demographic characteristics as the meso-level backdrop against which changes in energy usage in the home can be understood**. We assume that no single element, acting alone, can shape practices, but rather several over-lapping elements, placed in relation to practice configurations.

While the policy and technological dimensions of energy distribution and usage have received much attention in the literature, **the collective conventions that hold together everyday practices that use energy services are relatively under studied**. This relates to a key question in social science approaches to energy: "how do conventions around energy services evolve, how do they alter over time, and how can they be changed once they are cemented?" (Sovacool 2014: 19). Comparable data is available on energy-related policies, forms of energy provisioning, technological configurations, climatic factors, or socio-demographic aspects, to name but a few angles, but there is a lack of comparable empirical data on the collective conventions around heating and laundry in and across European countries. The subsequent D5.2: Report on analysis of ENERGISE Living Lab data will contribute to filling that research gap.

In ELL design, an emphasis was placed on the collective conventions and social norms in relation to energy usage, both **towards understanding how practices play out in relation to these elements, but also exploring how practices can change**. This report suggests the following elements could be relevant for further study: a comparative assessment of similarities and differences between heating and laundry practices within and between countries and households, as well as an exploration of different elements which can help challenge normative practices towards reduced consumption or sufficiency. Changes in practices might be explained, among other factors, by social relations and interactions, within and between households; new material arrangements and their usage; accrued skills and competencies around heating and washing less; but also and notably the role of deliberations and reflexivity towards shifting personal standards, societal expectations, and ideas about what is normal.

The analysis of ELLs will therefore bridge a knowledge gap in understanding how heating and laundry practices relate to social norms and collective conventions, and how such practices can be de-stabilised and reconfigured – what we have termed ruptures in routines. The hypothesis is that **contesting everyday practices and representations of comfort and cleanliness, as planned for in ELL heating and laundry challenges, could yield novel insights both on everyday practices (prior to the challenges) and social change (during and after the challenges).**

A note on the methodology: the material collected for this analysis is based on three primary sources: 1) ENERGISE deliverables, including National Summary Briefs on energy dynamics, with a focus on eight European countries for this report; 2) statistical databases, including Eurostat, the World Bank, among others; and 3) a literature review on heating and laundry in relation to social norms and collective conventions.

Towards the overarching question of WP5: In what way do Living Labs contribute to changes in practices? this report highlights the key elements to be considered in D5.2 analysis of ELLs across countries and contexts, related to the policy recommendations that will be put forward in D5.3.

PART 1: SOCIAL NORMS AND COLLECTIVE CONVENTIONS

In this report, we understand social norms following the Durkheimian tradition, where a norm – or a moral rule – is made visible by deviance, and exists through the sanction brought about by transgressive behaviour (Durkheim 1893; 1894). We use social norms interchangeably with collective conventions, related to how the different elements of a practice that make up heating and laundry are held together by shared understandings of *what ought or should be* in relation to how those practices play out. Further, we suggest that 'prescriptions' (Plessz et al. 2016; Godin and Sahakian 2018; Greene 2018a) can be a useful handle for uncovering the various injunctions which guide actions, such as prescriptions found on clothing labels around temperature settings, prescriptions that inform indoor comfort in building regulations, or the less explicit prescriptions put forward in everyday adages that are culture-specific (for example, "Cleanliness is next to godliness", attributed to a sermon by an 18th century English cleric).

Towards addressing the main research question posed by WP5 and in relation to the ENERGISE Living Labs (ELL), we set out to understand in this section how **changes in practices related to heating and laundry might occur in relation to processes of normalisation – or how practices come to be stabilised over time**. Normalisation may be sustained through institutional standards and regulations (Greene 2018a), which are a type of prescription; however, we see normalisation as mostly occurring through the repeated, and uncontested, performance of practices, following Rouse and Warde. For Rouse (2017), a normalised practice is "(…) maintained by interactions among its constitutive performances that express their mutual accountability" (p. 48), with "something at issue and at stake" (p. 50) in the outcome of practices or a goal-orientation of the practice. Similarly, and for Warde (2014), social norms can be observed to play out in the regularities of a practice, but are also a consequence of its performance.

Below, we provide a review of social norms and collective conventions related to first heating then laundry practices. We then consider social norms around environmental issues and forms of engagement with environmental and energy issues. We conclude with some discussions around how normalised practices can be challenged and contested, based on the literature, with relevance to ELL assessments (towards D5.2), and policy implications (towards D5.3).

SECTION 1A. SOCIAL NORMS AND COLLECTIVE CONVENTIONS IN RELATION TO HEATING

1A.1 STANDARDS AND SCRIPTS AROUND COMFORT IN THE HOME

Evaluating indoor comfort reveals the many interpretations of how comfort can be measured and assessed. The first is through what is called a physiological calculation of "operative temperature" (Olesen and Parsons 2002), towards identifying temperature ranges at which the human body can operate without using additional energy for cooling or heating. Comfort is thus understood as 'thermal neutrality', that people should feel neither too hot, nor too cold, to be comfortable (Shove 2003, p.31). As a result, the appropriate indoor climate has been interpreted as one that can be controlled and consistently regulated, and wherein the occupant is considered as a passive subject (Chappells and Shove, 2005; Shove 2003; Wilhite 2017; Brehli 2013; Olesen and Parsons 2002; Bopp 2007). The notion of climate control has been studied particularly in relation to cooling, as a way for people to better manage their indoor environments in hot and humid climates and put forward primarily for health reasons, but also in relation to workplace productivity (Cooper 1998; George 2000; Sahakian 2014).

One of the most oft-cited experiments on thermal comfort in relation to standardisation is by Fanger (1982), which involved "extensive programmes of physiological research designed to determine the universal qualities, parameters and properties of human comfort" (Chappells and Shove 2005, p.34). In a laboratory environment, Fanger tested six dimensions: metabolic rate, clothing, air temperature, radiant temperature, air velocity and humidity. Taking subject's expression of thermal 'neutrality' to indicate comfort, Fanger used the results of this research to develop 'a general equation' which predicts the potential dissatisfaction of all people in general, in relation to indoor temperatures – a form of 'prescription'. **Spaces and their usage, rather than people, became the variables to be considered**: for example, higher temperatures are suggested in the winter in high-end offices and hospitals, with potentially higher energy usage maintained and less flexibility in how people experience comfort.

The second approach is to define thermal comfort as a subjective condition, or a sensation of satisfaction toward thermal circumstances which can vary greatly from one person to the next, and from one context to another. In this conception of comfort, the user is seen as active, in that people react to a situation of discomfort and take actions to "restore their comfort" (Nicol and Humphreys 2002: 46). The user's role is then as important as the building design when it comes to understanding energy use and an adaptive approach is used towards the calculation of official standards (Nicol and Wilson 2011; Olesen and Parsons 2002; Nicol and Humphreys 2002; Boerstra et al. 2015), such as the possibility of putting on more clothes or taking some off, for instance. Weather variability is also accounted for, such as seasonal change and sun exposure, along with building variability, such as categories of comfort expectations in relation to different types of buildings (Nicol and Wilson 2011; Sfakianaki et al. 2011). More recent studies have also considered the gendered dimension of thermal comfort, suggesting that female and male bodies experience comfort differently in relation to varying activities (Gerret et al. 2015).

Studies on thermal comfort reveal the notable differences in how either approach is operationalized, as any number of elements can be accounted for towards measuring indoor comfort levels (Bopp 2007; Kunkel et al. 2015; Nicol and Wilson 2011). The most frequent elements used to apprehend thermal comfort, included in most of the studies and standards reviewed for this report, are: room temperature, air velocity and humidity. The room temperature is one that is most acted upon through heating or air-conditioning systems, leading to either household guidelines (cited in Dreyfuss 1990) or official standards (studied by Brelih 2013; Kunkel et al. 2015; Nicol and Wilsons 2011) on how to manage comfort levels through recommended temperatures in degrees.

A few examples of the different parameters used in standards are provided by Kunkel et al. (2015), in a comparison of different European national requirements for the Buildings Performance Institute Europe (BIPE)[1]. For instance, **Denmark** includes in its temperature

[1] An institute dedicated the improvement of buildings emerging efficiency. The countries considered her are: Belgium

standards a calculation of number of hours spent in the room; **Germany** accounts for shading and sunlight thermal contribution; Sweden allows for national internal variations and differentiate between type of building and inhabitant; and, in the **UK**, different rooms call for different temperature levels, for example bathrooms tend to have higher temperatures (Kunkel et al. 2015: 46). Ultimately, evaluating and measuring indoor comfort is a “complicated field in which debates are full of technical details” (Shove 2003: 28), with engineered mechanical systems and energy calculations contributing to this complexity.

1A.2 INSTITUTIONAL GUIDELINES AROUND INDOOR THERMAL COMFORT

Building on comfort measurements, **institutional standards and guidelines have also been established**, which can be seen as fixed prescriptions around indoor comfort – leading to potentially unintended consequences (Shove and Moezzi 2012). The first institutional interrogations can be traced back to the turn of the 19th century[2], initiated by professionals involved in the development of thermal environment technologies. Academic reflexions on thermal comfort began in the 1920s, towards “the scientific study of comfort conditions” (Shove 2003: 27). In the pre-War and post-War periods, engineers, architects and private interests converged around the need for a better control over indoor thermal environments (Dreyfus 1990), with air-conditioning in the United States positioned as a mean to control humidity, with a promise for ‘ideal’, man-controlled indoor weather (Cooper 1998: 182). In 1947, the International Organization for Standardization was founded, with the aim of producing standards that can be applied to a variety of products and services worldwide. In relation to heating and cooling, the effort to generate unified standards and related national requirements lead to complex calculation methods (Dreyfuss 1990; Shove 2003), which ironically deliver overly simplistic solutions. Based on both physiological satisfaction and seasonal change, universal recommendations for the achievement of thermal comfort was established.

Yet precisely what ‘standard’ is assigned to achieve a ‘comfortable’ indoor climate in the winter period and in Europe has evolved over time, challenging the notion that such recommendations could be universal. Dreyfuss refers to an early 20th century “guide for the good housewife” issued in France, which prescribed: “14° in the dining or living room, 15° when receiving guests, 11° in the bedrooms”; the temperature recommendations were already outdated by 1958, when official guidelines in France suggested 18° as an ideal indoor temperature (Dreyfuss 1990: 25[3]; translated from French). The arrival of mechanical heating systems allowed for higher room temperatures in the winter, which co-evolved with expectations around indoor comfort towards new standards for minimum accepted levels of comfort and social norms around a ‘cosy’ home (Dreyfuss 1990; Chappells and Shove 2005; Shove 2003, Wilhite 2017). Moreover, in addition to varying across time, the recommended temperatures also differ greatly in space. Brelih (2013), in comparing several European national regulations, points out: “The requirements on indoor temperature (...) were all found very inconsistent. Indoor air temperatures in the summer range from 25°c to 28°c and 15°c to 20°c in winter.” (p. 16) [4]. Similar results are found in the Buildings Performance Institute Europe (BIPE) analysis (Kunkel et al., 2015).

[2] The ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) was founded in 1894 (Dreyfuss, 1990)

[3] Translation of original quote : “Au début du siècle, un livre sur l’éducation de la bonne ménagère bourgeoise recommandait 14° dans la salle à manger ou le salon, 15° lorsqu’on recevait, 11° dans les chambres, soit beaucoup moins que le confort modeste selon le R.E.E.F. 58.”)

[4] While the EN 15251 recommends both a minimum winter temperature and a maximum summer one, some countries only have one border value: Sweden recognizes a minimum of 18° in winter but does not have an upper summer

This might be explained by the fact that **the range of temperatures tolerated or appreciated by individuals is wider than what the term 'standard' might imply**. In relation to a standard indoor temperature for artificial cooling in hot climates, Wilhite explains: "There are a number of empirical studies of comfort perception in buildings that demonstrate that this 22° norm is arbitrary and far lower than people in either naturally cooled or air-conditioned buildings are comfortable with. Comfort systems have been designed to provide 22°C in all microclimates and seasons, whereas people have been reported to be comfortable at a wide range of degrees, between 6°C and 31°C." (2017, p.33). What it means "to feel comfortable" can thus vary between different people in the same context or across contexts. Further, climate diversity can indeed be promoted, built on the assumption that some people do enjoy variability in relation to microclimates – for example, coming in from the cold (Sahakian in Roesler and Kobi, 2018; Dreyfuss, 1990), and that for some this might even translate into the notion of "thermal delight" (Heschong 1979).

On the contrary, the homogenisation of indoor temperatures towards one particular temperature setting can lead to a lowering of personal tolerance to variable temperatures; habits created by mechanical temperature management can be difficult to change over time (Sahakian 2014; Wilhite 2017). Olesen and Parsons (2002) compare the thermal satisfaction of people living in mechanically cooled building with people living in free running buildings, demonstrating that: "In such buildings [with no mechanical cooling], the occupants seem capable of adapting to a broader range of conditions and can accept higher indoor temperature than predicted by the PMV" (2002: 543). Wilhite and Shove both have critical views on the controlled environment and the use of mechanical cooling (or heating) systems. They speak in terms such as: "the sealing of the house into a comfort bubble" (Wilhite 2017: 31), or "playing god with indoor climate", or the notions of the "manufactured", or the "managed interior" (Shove 2003: 26-27), deploring the energy-intensity of such buildings towards maintaining standards.

One of the objectives of official standards regarding thermal environments is to maximize the energy performance of buildings (Nicol and Wilson 2011). As such, standards are expected to be "valid, reliable and useable" yet fail to account for physiological factors (Olesen and Parson 2002). Floor temperature and vertical air temperature differences can have a greater impact on a person comfort satisfaction than the mean temperature of the room, but are not assessed in standards (ibid). Nicol and Wilson (2011) argue that the calculation used in the European Standard EN 15251 (Indoor Environmental Criteria) is based on theoretical studies, which leave out many factors contributing to thermal comfort, such as light and sun exposure; Shove (2003), in relation to ISO and ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) standards expressed the same opinion. Nonetheless, recent developments in standardisation seem to be making room for additional parameters, for example in correlating outdoor/indoor climate conditions, or in recommended temperatures expressed as ranges (Boerstra et al., 2015; Nicol and Wilson 2011; Olesen and Parson, 2002). Adaptive factors are also considered in EN 15251, including "considerations not only of the environmental variables (temperature, humidity and air movement), but also of the clothing insulation and the activity of the occupants" (Nicol and Wilson 2011: 186).

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temperatures limit, while Denmark's only recommendation is that the temperature should go higher than 26° in the summer (Kunkel et al., 2015, see Figure 1 on page 45). Other analysed standards show divergence in required temperatures (Nicol, Wilson, 2011; Bopp, 2007).

And yet, **this idea that the indoor thermal conditions must be consistent and controlled, in order to provide the best environment for people to live, work, and relax in, has had profound technological, ecological, social impacts** (Chappells and Shove, 2005; Shove 2003; Wilhite 2007), not only in relation to cooling but heating as well. Further efforts to understand comfort could include other practices towards adaptability, such as reconfiguring indoor spaces, heating people rather than spaces, or considering the different skills and competencies people might engage with to stay warm indoors in the cold months (as proposed by the ENERGISE Living Lab design). Oftentimes, building design and paradigms of the "controlled indoor climate" as preferable can lead to buildings which are sealed off and leave little room for adaptability; in such cases, buildings or structural conditions can be seen as locking in the need for energy usage in relation to mechanical heating or cooling (Sahakian and Steinberger 2011). As Nicol and Wilson (2011) explain, while standards are "not intended to encourage high-energy solutions, there is an implication that more closely controlled environments are superior" (p. 192). To illustrate this argument, Sfakianaki et al. (2011) study the European indoor environmental criteria and note how: "EN 15251 requires indoor conditions to be assessed and to fall within a category system (currently IV, III, II or I) for different levels of expectation and building purpose. In general, the most highly controlled environment (and therefore probably the most energy-intensive) is category I." (p.195-196), suggesting that the mechanically controlled thermal environment is in a first position of desirability.

There is a call for additional research to further develop standards, particularly in linking physiological and social comfort factors. Nicol and Humphreys (2002) propose a new adaptive standard, in which individuals are active in their comfort management, rather than fixed temperatures; ranges "in the region of ± 2°C (are proposed). Giving occupants the control necessary to make themselves comfortable can increase this range. (Nicol and Humphreys 2002: 571). They also suggest that introducing variable temperatures in controlled buildings, following seasonal changes, could induce energy savings. Boerstra et al. (2015) demonstrate how the 2004 ISSO 74, ATG or adaptive temperature guidelines, was established in the **Netherlands**, integrating an occupant's behavior to help reduce the so called "performance gap" between energy efficiency by design and energy usage in practice. Ultimately, the overall ambition of such standards is being called into question: Nicol and Wilson (2011) explain, the European Standard EN 15251 (Indoor Environmental Criteria) "is written to augment the Energy Performance of Buildings Directive of the European Union. [However,] It is not obliged to encourage low-energy solutions and seeks merely to provide the information necessary to make energy calculations" (p. 191).

1A.3 DIFFERENT WAYS OF ADAPTING, AND ADAPTING TO, COMFORT

In this section, we discuss **how people in different contexts understand what is a comfortable indoor microclimate and what adaptation strategies can be considered**, in relation to people and their usage of indoor spaces. As Shove summarises: "There is more to comfort than temperature, but exactly where expectations lie along this range is, largely, a matter of culture and convention" (2003, p.33). Karjalainen's study demonstrates how the perception of thermal comfort is linked with the sense of control and their understanding of their thermal environmental system (2009). His large-scale qualitative study yielded "results [that] show a strong correlation between perceived control over room temperature and satisfaction with room temperature" (2009, p. 1239). A similar observation can be applied in relation to the knowledge people have of their heating or cooling systems: the less a person understands the systems that manages his thermal environment, the more likely he is to feel discomfort (Karjalainen 2009; Chappells and Shove 2005; Wilhite 2017). National context factors are at play here, including the rate of house ownership (as documented in section 4.4 below): in a country in which most people own their homes, home renters may feel more dissatisfied than their counterparts in their lack of control over indoor thermal conditions; which may not be the case in a country where most people rent their homes (Karjalainen 2009).

The ENERGISE National Summary Briefs (D2.5) provide some insights on how people living in the eight countries involved in Energy Living Lab implementation adapt to and adapt their indoor climate. In **Finland**, as in other Nordic countries, indoor temperatures are rather high (approximately 21ºC). Finns are accustomed to stable indoor environments and well-functioning automatized systems. They are also keen on adopting technological novelties (such as heat pumps and LEDs). Moreover, there are about 2 million saunas in **Finland**. Individual saunas have become a standard feature also in apartments, though this trend might be declining in cities due to space constraints, allowing also the resurgence of public saunas as is the case in Helsinki. In the **Netherlands**, 21ºC also seems to be the norm. Vis-à-vis households in other countries, almost all Dutch homes are enabled by a central thermostat and a regulating valve on most radiators.

In the **United Kingdom,** and again from the ENERGISE National Summary Briefs (D2.5), what is considered as a 'reasonable level of warmth' has varied significantly over time. In the last 40 years, the average room temperature in the **United Kingdom** has risen considerably (from 12°C to 18°C in the winter months), largely due to the wide dispersion of central heating and improving insulation standards (BEIS 2017). Most UK households do not keep their heating on 24 hours a day though; 70% homes with central heating heat their homes twice per day, with peaks around 7am and 7pm. On average, UK homes are heated for around eight hours per day in winter. In **Switzerland**, the *Minergie* energy efficiency label prescribes floor heating, which often entails a fine tuning of hydraulic valves for adapting indoor temperatures; thermostats in apartments are unusual. To further complement these first impressions, the ENERGISE D5.2 will contribute new empirical data on indoor temperatures before and after the ELL challenges.

To summarise this section, **we consider indoor climates or "microclimates" to be an artefact** (Roesler and Kobi 2018): rather than a neutral and objective given, we see microclimates are socially constructed over time and in different contexts, affected both materially and spatially by building configurations and usage, but also through both explicit standards and implicit understandings of what makes for a 'comfortable' indoor climate.

SECTION 1B. SOCIAL NORMS AND COLLECTIVE CONVENTIONS IN RELATION TO LAUNDRY

1B.1 STANDARDS AND SCRIPTS AROUND LAUNDRY

While standards and requirements exist for detergent manufacturing in Europe, **the focus of this section is on laundry standards related to washing machines**, which serve to set guidelines for energy usage by these appliances, as well as other parameters such as the load capacity and water usage – which can be understood as 'prescriptions'. These standards then influence the development of new technologies, which are expected to become increasingly efficient in terms of both energy and water consumption. Laundry appliance manufacturers aim to gain the best grade of the EU Energy label, which follows requirements from the EN 60456 standard[5]; however, there is no explicit incentive to surpass the highest level of energy efficiency for a similar appliance category, as is the case with the TopRunner program in Japan. The energy label is now accompanied by the EU Eco Label, which addresses wider parameters revised to include new criteria such as “the availability of a 20°C programme” on washing machines (Josephy et al. 2011: 4). Josephy et al. explain how, “due to the trend towards larger washing machines (6 to 10 kg) as well as the related problem of filling washing machines only partially, it is important that the washing machine has a sensor capable of estimating the weight of the laundry load and able to automatically adjust programme duration, energy and water consumption” (Josephy et al. 2011: 6). However, the trend towards the bigger appliances also means that such appliances can be labelled as “efficient”, even if they consume much more energy than smaller volumes. One of the criticisms of energy labels has been that they compare appliances of similar size and volume. Machine usage in relation to load control currently escapes a clear type of signal, however, leading to the suggestion that “load control features should be accompanied by an eye- catching indication in case of failure”, thus encouraging the involvement of users in energy-reducing practices (Josephy et al. 2011: 6).

Laundry practices can be seen as being “scripted” by washing machine interfaces and the different programs they propose. For instance, default settings that people might use independently of the type of clothes they wash can lead to misuse of the machine (Kruschwitz et al. 2014; Laitala et al. 2012). Available programs can also be misunderstood, thus causing more energy demanding practices, such as the use of short cycle, wrongly seen as ecological (Laitala et al. 2012). Lack of comprehension is not the only problem. In the case of Norway, Laitala et al. (2012) also argue that the more frequent use of short programs “may be a reaction to the increased washing duration of the basic cotton program, which is a result of energy labelling requirements.” (p. 235). Similar results were also documented in a **Swiss study on household energy usage**: few households understood the function of the eco-program, as it resulted in a longer wash duration and was not intuitively understood as being more efficient, in relation to energy but also time usage (Sahakian and Bertho 2018a). This may also be linked to increasing time pressures and a quest for expediency when it comes to domestic chores.

That being said, providing an eco-program, as well as the possibility of low temperatures washing, can induce people to change their practices. The links between users, washing machines, and energy consumption are synthetized here by Mylan: “Not only must washing machines contain 30°C programs and detergents work effectively at low temperatures but consumers’ criteria for sorting clothes and selecting programs must also adapt. **Crucially the meaning of low temperature laundry must also change to become a normal part of the laundry repertoire”** (2015: 17). In her study, she shows how product marketing, when accompanied with official recommendations assessing the quality of low temperature wash, could induce more trust in this practice, leading to energy savings (Mylan, 2015). As Laitala et al. (2012) suggest, clothes labels could include recommendation on wash frequency, which could incite people to reduce energy usage. Campaigns organized by different stakeholders can thus help spread better practices, or at

[5] The EN 60456 standard provide requirements that are then used to develop the grading system of the Eu Energy label.

least provide a unified message from clothing manufacturers, laundry machine manufacturers, detergent producers, and the public sector. However, in the case of frequency, researchers note that it is more challenging to influence practices. **The question of habits and routines is often forgotten when solutions to improve energy usage related to laundry are being proposed** (Wilhite 2011). Part of this may have to do with the intimacy of washing, which relates to how people feel clean or unclean, inter-generational learning around laundry, as well as household dynamics (Sahakian and Bertho 2018a), a question we will now turn to.

1B.2 DIFFERENT WAYS OF DECIDING WHAT IS 'UNCLEAN'

Historically, clean clothes in the Middle Ages: "constituted an increasingly significant indicator of social decency" (Shove 2003: 123), at a time when a clear distinction existed between outer and under clothing: for the former, such clothes were not in direct contact with the skin and were only washed if stained, whereby a visible sign of dirt might signal poor hygiene or a lower social rank. Under-clothes were considered a "second skin", and washing such items was seen as a way to clean the body itself, therefore gaining the sensation of personal cleanliness (Shove 2003: 124). During the 17th century, undergarments were made visible: sleeves and collars appeared and became more and more fashionable, and the whiteness of such clothes was then judged. The motives to wash clothes were doubled: clean clothes meant feeling clean, but also looking presentable (Shove 2003). With Pasteur's discovery on microbes in the 1800s, clean clothes took on a whole other meaning. **Clothes were considered a bridge between the body and the world.** Washing clothes meant preventing exposure to the 'bad influences' of the outside world, or bacteria (Shove 2003). Boiling clothes and ironing them were among the strategies used for getting rid of undesired microbes, and "their destruction represented a social as well as a personal duty" to prevent the diffusion of diseases (Shove 2003: 125). The link between high temperature washing and better hygiene is persistent in public opinion, as we will see later in this section. Where bad odours were first seen as coming from the exterior world, more attention was raised around personal odor in the 19th century: bad smells were seen as emanating from people, who needed to thus manage their body odor in order to prove their hygiene standards and be socially acceptable (Shove 2003). Having clean clothes thus meant to be respectable person, as well as preventing oneself from sickness. This can perhaps be captured **in various adages in the countries under study**: *"Etre proper sur soi"* in French-speaking **Switzerland** literally translates to "being clean upon yourself" but more directly translates to "being presentable in society".

The industrialization of fabric production, as well as the mass manufacturing of cotton, has had a deep impact on people's' relationship with their clothes (Shove 2003; Wilhite 2011). This growth in both quantity and quality of clothes has changed the way people perceive their garments and the frequency at which they used them. The invention of mechanical domestic washing machines, at the turn of the 19th century, and their diffusion in the 20th century, has also had great impact on people's laundry habits. Both Shove and Wilhite show how laundering practices are routinized by people, who wash their clothes to freshen them up, but without really thinking about whether clothes are dirty or clean, and by what standard; laundry has become a habit (Shove 2003, Wilhite 2011). Shove mentions "the 'illuminometer' a special device for measuring the whiteness of a wash" and how it "influenced the development of new washing powder and machines" (2003: 123). Wilhite (2011) also underline how commercial interests have widely contributed to modify practices and social norms, showing how caring for clothes shifted and is now linked to lower temperatures, presented as capable of preserving the fabric by detergent industries and washing machine. Currently, a piece of cloth left on the floor has more chance to be put to wash instantly instead of being reused, for it has lost its freshness and its clean smell (Shove 2003; Wilhite 2011). Sahakian (2018) has similar observations among elite households in Geneva: laundry is dependent on domestic help, who wash regularly to maintain their position in a household, regardless of whether clothing items are truly dirty.

Hygiene still plays an import role in the consideration of cleanliness and laundry, and people have different levels of tolerance depending on types of clothes. For instance, underwear is usually worn only one day, while woollen sweater can be worn seven to eight days before being considered 'dirty' (Laitala et al. 2012). When to wash clothes can depend on a hygienic evaluation, a sensation of discomfort in clothes considered as soiled, but can also be influenced by other factors. As Laitala et al. state: "In Norway, some products were reported to be used longer between washes now than before, such as towels and jeans. In jeans, we have seen a new trend to wash them more seldom, especially dark 'raw' denim materials, in order to keep the fit and colours unchanged" (2012: 235). For some, the visual aspect of the piece of clothing plays an important role in deciding to clean it. The desire to care for the clothes can reduce the frequency of washing or determine best temperature and methods to be used, as was uncovered in household studies in **Switzerland** (Sahakian and Bertho 2018a). Studies demonstrate that some people maintain an organized schedule in relation to laundry, having fixed day for laundering might determine what clothes are being washed when (Sahakian and Bertho 2018a; Jack 2013). Others will wash their clothes when their laundry basket is full, or on the contrary when they find themselves with an empty wardrobe (Costanza et al. 2014; Jack 2013). Still others have a more sensory relationship to what is clean and dirty, and might smell their clothes or look closely for stains before washing (Sahakian and Bertho 2018a). Still other practices might be observed, such as the "whenever I have the time" practice noted by Anderson (2016: 133), also mentioned by Constanza et al. (2016). Anderson also cites the "just-in-time laundry (or ironing) for work/school (Sundays) and for going out (Fridays)" (2016, p.133).

When it comes on to *how* to clean, people adapt their washing to different types of fabrics, as well as to the types of clothing, bedding or other household items that can be washed, but do not necessarily chose the most appropriate program in terms of clothing types (Laitala et al. 2012; Kruschwitz et al 2014). Some people are less receptive to the clothing care message provided on labels or in laundry machine guides, and prefer to stay on basic programs (Kruschwitz et al. 2014). Moreover, while load size can also vary between programs, Kruschwitz et al. (2014) state that people routinely fill their washing machines with similar loads, regardless of the program. However, they will use different temperatures to adapt to the types of clothes (Laitala et al. 2012). For instance, woollen clothes are mainly washed in cold temperatures, while bed sheets and bath towels seem to require higher temperatures (Laitala et al. 2012). Mylan (2015) explained how the perception of cleanliness affects the adoption of low temperature. People will first use low temperature to wash delicates, such as woollen clothes, but will be less keen to use it on items that they consider require a proper hygienic wash, such as baby clothes or bed sheets. The idea that higher temperatures represent better level of cleanliness is still very much present in people's imaginaries. In some cultural contexts, wool is also considered best washed by hand, in order to reduce damages (Laitala et al. 2017). Yates and Evans (2016) draw on data from a quantitative survey of laundry practices conducted in Britain in

2013 to underline the diversity of washing practices in relation to temperature, showing that a majority of households wash at 40 degrees – such detailed information is not available in other countries under study in ENERGISE.

Few studies have considered different laundry practices comparatively across countries and cultures. In a European study, Laitala et al. (2013) explain how: “The main differences found were washing temperatures and frequencies. For example, in Spain the majority of respondents washed cotton t-shirts in cold water, in Greece and **Netherlands** at 40°C and in Norway at 60°C.” (p. 234). The link between high temperatures and hygiene seem to have bigger impact on northern countries. In another paper, hand washing practices within the European continent are examined (Laitala et al. 2017): Southern and Eastern Europe countries used a combination of machine and hand washing more than other regions, due to the fact that the rate of machine ownership is lower. Anderson, while presenting laundry practice in the **UK**, evokes “seasonal contingencies” that can affect countries, influencing practices such as drying clothes outdoors instead of using a tumble dryer (2016, p.127). The trend to lower temperatures laundering is spreading across Europe, as illustrated by Laitala et al. for Norway (2013), and Kruschwitz et al. (2014) for **Germany and the UK**. Moreover, the diffusion of washing machines, on which we will come back later on, is indisputable.

1B.3 THE NORMALISATION OF THE WASHING MACHINE

Today, laundry practices rely mainly on the use of washing machines across Europe. A technological apparatus has replaced human work (Wilhite 2011), with an action transferred from a person’s hand to a washing machine, thus changing the different steps of the laundry process (Shove 2003; Wilhite 2011). Traditional washing includes: boiling, rinsing, wringing and bleaching (typically with sunlight) when modern practices involve: pre-treatment, sorting of clothes, drying and ironing (Laitala et al. 2017; Shove, 2003). In a recent study, the time savings of washing machines are placed in relation to materiality, suggesting that the two should be considered together: material relations, with **a certain type of washing machine or laundry room configuration, for example, can shape the temporal features of everyday practices** (Spurling, 2018).

Shove shows how the “clothing care” discourses emerged with the washing machines (Shove, 2003, p.125). As explained, the number of clothes owned by people increased greatly, and the fabrics diversified. People now had more clothes to show themselves in. And the diversity of their clothes, as well as their conservation conditions, illustrated one’s social prestige. With the idea that clothes were soiled by the human body, and damaged by their daily use, the necessity to tend to them appeared (Shove, 2003). This made way for new markets, for new laundry practices and tools. Watson’s (2015) historical regard on launderettes demonstrates how technology and marketing can change social practices. After the Second World War, launderettes made laundering a visible practice again, people following the trend of going to the laundrette and exposing their drying clothes more freely than before. They were later replaced by domestic washing machines, who took the practice back into the private sphere (Watson, 2015). Watson argues that the accessibility to this appliance, along with the wish to acquire this modern ‘mundane’ technology brought more and more people to use washing machines, because of their inclinations to follow marketed trends (2015, p.882). In **Switzerland** and also in **Finland**, it is not unusual for apartment buildings to have a shared laundry facility, for washing and drying clothes (e.g., in a heated room in the basement), yet the trend is towards private ownership. As in many countries in Europe, laundry machine purchases have grown exponentially in the past decades. In feminist literature, the “industrialisation of the home” through the introduction of various household appliances in the post-war era carried with it new morals and values around domestic chores, which were no longer simple tasks, but became expressions of love (Schwartz Cowan, 1976); strong implicit emotions of shame and blame were communicated, primarily towards housewives, whose homes would not be deemed “modern and progressive” without the installation of various cooking and cleaning automated devices (Sahakian, 2015).

Washing machines are now distributed all around the globe, reaching more people than ever, but they have not entirely replaced hand washing, including in Europe. The criteria of quality of the cleaning process is mobilized to explain why some prefer to personally wash their laundry by hand, for it is considered that a machine cannot achieve the same level of fabric preservation than the manual process (Laitala et al., 2017; Shove, 2003). Washing machines are nonetheless now seen as essential appliances by a growing number of people (Laitala et al., 2017; Shove, 2003; Wilhite, 2011). Wilhite explains that “the global capitalist reach of transnational corporations and media is extending these Western comfort, beauty and cleaning norms to Asia and Africa” (2011: 51). He refers to thermal comfort as well in this quote, his research on air conditioning in India showing how controlled environment norms reached this country as well, as we’ve seen earlier. Shove also links these two domains of comfort: “Just as the built environment has been reconfigured around air-conditioning to the point that there is ‘no way back’, so the washing machine has become enmeshed in daily life” (2003: 133). This relates to a phrase used in the rental market to promote a property offer: “all mod cons included”, with washing machines framed as a “modern convenience”.

SECTION 1C: REPRESENTATIONS OF ENVIRONMENTAL CHANGE

The literature in consumption studies related to environmental issues has become increasingly critical of the dominant framing regarding the role of everyday people in relation to environmental change, or the notion that more informed individuals could be prompted to make ‘better’ choices, in a linear and over-simplistic causal relationship between attitudes, behavior and choice (Shove, 2010). Oftentimes, when it comes to understanding the role everyday people might play in more sustainable forms of consumption, the consumer is put forward as an ‘ideal client’ making rational decisions. **This translates mostly into individual actions in relation to a marketplace of opportunities**, through either boycotting or *buy*cotting (Micheletti and Stolle, 2012). This also relates to notions of reflexivity in modern societies, whereby people ‘freed’ from ‘traditional’ constraints are increasingly seen as responsible for their choices, and in a process of constant re-examination of their lifestyles (Beck and Beck-Gernsheim, 2002).

In relation to environmental issues and towards social change, **such an individualized vision of the consumer is problematic for at least three reasons:** first, people are limited to either being compliant with or resistant to forms of consumption that are represented as being compatible with environmental concerns, or green consumerism. In such a perspective, inequalities are largely ignored, such as unequal access to energy services, unequal recognition of need diversity, and unequal participation in policy-making (Walker and Day, 2012). Second, certain forms of green consumerism – such as riding a bike, planting a tree, or recycling a jar – can exclude more collective action and institutional change (Maniates, 2001). Finally, such approaches tend to reinforce the norm of the free and sovereign consumer, with no envisaged possibility of placing limits on consumption, a norm that has become well-established in the modern capitalist system (Wilk, 2002).

The growing literature on political consumerism reveals opportunities for change: as actors in a marketplace, consumers have the possibility of influencing standards – or collective conventions, governing frameworks and policies – when their actions are put forward by governments or institutions to influences the marketplace, as is the case with the WWF Climate Savers initiative or the Forest Stewardship Council (Dubuisson-Quellier, 2013). There are also increasing trends towards political consumerism whereby people's everyday practices or lifestyles aim towards transforming systems of production and consumption across sectors, such as through the Transition Towns or Degrowth movements (Moor and Balsiger, 2018). Such movements, including in some cases the zero waste movement and vegan lifestyles, are not solely about individual change, but call for collective action towards transformative change. The role of low-carbon communities in relation to shifts in everyday practices has also been studied in Europe, suggesting a distinction between place-based communities, or communities with shared interest, by sector (for example workplace communities) or via social media (Heiskanen et al., 2010).

SECTION 1D: CHALLENGING NORMS AND CONTESTING COLLECTIVE CONVENTIONS

As discussed in the introduction to this section, practices can be normalized over time through their ongoing performance, in relation to a 'goal in mind' or common understanding of what ought or should be in how that performance plays out. In this section, we seek to understand **how theories related to the normalization of practices can lead to insights in how such norms and collective conventions can be challenged, towards destabilizing (un)sustainable laundry and heating practices**. This serves one of the main objectives of the ENERGISE project overall: "Produce new research-led insights into the role of routines and ruptures in shifting energy use towards greater sustainability".

In the sociological tradition, there are different ways of understanding such processes. For Bourdieu (1977), social norms can be contested in an explicit fashion but this can lead to either the reinforcement of the existing norm (*orthodoxy*) or its destabilization (*heterodoxy*). For example, in Sahakian and Bertho's study of laundry practices (2018b), the authors found that in a reflexive exercise that the desirability of "cleanliness" is difficult to contest. Therefore, contesting cleanliness can backfire, with people cleaning their clothes and bodies more often, to reinforce the perceived desirability of representing oneself as clean. This also relates to Becker's (1985) work on **career deviancy, or how people go about deviating from the norm**. In his proposal, people engage in a series of stages which increasingly stigmatize an individual as 'deviant', while also giving him or her the opportunity to meet others who are also engaged in similar forms of deviancy. Forms of engagement become the focus of study, for Becker, echoing work on social practices by Warde (2005), who understands **practices as made up of engagements, understandings and procedures**. This suggests that social interactions around 'deviant' actions (such as washing less often) can help reinforce the normalization of that practice. In Sahakian and Wilhite (2014), the authors found that **different elements of a practice**

need to be destabilized in order to find a rupture in routines – or changes in at least two elements, including social norms, skills and competencies, and material arrangements. Further, **social learning in communities of practice** can lead to shared skills and competencies, as well as societal acceptance of the 'deviant' action within that community (building on Lave and Wenger, 1991).

Emotions also have an important role to play on how practices are stabilized over time. For Norbert Elias and his study on food and cleanliness practices, since the Middle Ages and in Europe, it is through an "emotional economy" of shame, disgust and other emotions that people in society learn table manners or hygiene standards (Elias, 1969 / 2016). In a **Swiss** study, Sahakian and Bertho (2018b) found that capturing emotions in practice is one way of understanding the opportunities for change towards less energy-intensive household chores, including washing and cooking. Positive emotions can help bring people together in collective action, while negative emotions can help towards shaming and blaming people or indeed governments and industries towards social change (extending Jacquet, 2015).

'Deviancy' can be planned for, which is what is implicitly put forward in initiatives that seek to challenge or destabilize everyday practices. In terms of challenging representations of cleanliness in laundry practices, a notable study by Jack (2013) engaged participants in wearing the same pair of jeans for a three-month period, while documenting their experience. Regarding hygiene and discomfort, she demonstrated how: "the expectation of not washing was more repulsive than the actuality, hinting that there may be a perception barrier to changing practices" (2013: 412). As the title of her paper suggests, "nobody was dirty" or people did not feel unclean by wearing the jeans for an extended period of time. Building on this study, a **Swiss jeans challenge in 2018** invited participants to wear the same clothing item for four weeks: during the first two weeks, strategies were shared between participants on keeping clean; whilst during the last two weeks, people expressed comfort in relation to their jeans and also stated that their expectations around feeling unclean by not washing were not substantiated (Sahakian and Bertho, 2018a). Jack explains how "the opaque nature of community expectations leads to hyper-vigilant self-auditing of personal cleanliness" (2013: 415). People desiring to follow collective conventions "tend to go above and beyond basic sanitation requirements, wasting significant quantities of water, energy and chemicals in pursuit of these undefinable and ever-increasing cultural conducts of cleanliness" (Kruschwitz: 275).

The possibility of disrupting everyday practices by challenging norms and expectations around laundry and heating is one of the key features of the ENERGISE Living Labs, which also introduce materials in the challenge kits (in the form of warm socks for keeping warm, or aprons for keeping clean), along with skills and competencies (in the usage of those objects, and sharing of tips). What remains to be answered through D5.2 is to what extent **skills and competencies can contribute to the de-stabilisation of routinized practices, along with social interactions** (both within households for ELL1 and ELL2, and between households in the case of ELL2). In addition, **a more explicit attention can be placed on prescriptions**, or the existing guidelines in different countries that indicate what should or ought to be when it comes to heating homes or cleaning clothes. These 'elements of practices' merit to be further analysed and discussed as part of the assessment of ELLs across the 8 countries under study.

PART 2: GOVERNING FRAMEWORKS AND POLICIES

In this section, we uncover governing frameworks and policies related to energy usage in the eight countries under study. We consider decarbonization and nuclear phase out activities, as well as trends towards 'prosumers' or consumers who become producers of primary energy, and finally the policy landscape in relation to household energy usage and ranging from efficiency measures to sufficiency.

2.1 DECARBONIZATION AND NUCLEAR PHASE OUT INITIATIVES

In 2016, the average of equivalent tones of CO_2 per capita in the European Union was 8.7. The countries under study are dispersed in a relatively balanced way around this value: **Hungary, Switzerland and the United Kingdom** see their consumption below the European average, whereas **Denmark, Finland, Germany, the Netherlands and Ireland** are above. Nevertheless, all countries have signed the Paris Agreement based among other factors on a drastic decrease of greenhouse gas emissions. The percentage of greenhouse gases emissions they represent is of course very different depending on the size of the country and the type of resources they use, which highlights the different challenges that these countries are facing toward decarbonization, and more broadly, toward climate change and pollution mitigation.

The description of policy measures presented below show that there is a consensus toward **decarbonization** (especially regarding the promotion of renewables and the decrease in the use of oil and coal). However, there is **less consensus around nuclear phase out**, with opposition movements that promote the enlargement of nuclear parks. Some countries, such as **Germany and Switzerland**, are engaging in policies away from nuclear, while others, such as **Hungary, Finland and the United Kingdom**, still consider this resource as an important part of their energy portfolio.

In **Ireland**, the average household used 7% more energy than the European Union average in 2016, and emitted 5.5 tonnes of CO_2, almost 60% more than the average European Union home (SEAI, 2018). Continuing dependency on high-carbon fuels (e.g. oil, coal, peat), falling oil prices, and higher incomes are some of the factors that contribute to recent increases in CO_2 emissions across the residential sector. The Irish government has been supporting alternative energy sources since 1994, especially the wind power industry which has grown significantly the last decades. In 2010, a carbon tax was introduced and applied to products such as kerosene, marked gas oil, liquid petroleum gas, fuel oil, natural gas and solid fuels. In terms of decarbonization, the most recent government policy is the 'Ireland's Transition to a Low Carbon Energy Future 2015–2030' which aims to transition towards a low carbon energy system while maintaining the three core objectives: sustainability, security of supply and competitiveness. **Hungary** considers nuclear as an important resource to tackle its energy dependency. In January 2014, the government signed an agreement with Russia to expand the capacity of its only nuclear power plant before 2030. However, government support of nuclear is strongly challenged by the civil and the academic sector. The main argument is that supporting nuclear might disincentivize the development of the renewables sector, not to mention the long-term environmental impacts of nuclear waste.

In early 2000s, climate change started influencing the **United Kingdom** agenda: the government is now committed to reducing carbon dioxide emissions. The 'Climate Change Act 2008' is part of the government's plan to reduce greenhouse gas emissions. It has established a framework to reduce current and future emissions by at least 80% of 1990 levels by 2050. Published in 2009, the United Kingdom's 'Low Carbon Transition Plan' also contributed to the realization of a roadmap for the decarbonization of the country: the 'Renewable Energy Strategy 2009' was the action plan to achieve renewable energy objectives. A catalyst for the growth of renewables was the legal requirement that the United Kingdom provided at least 15% of its energy from renewable energy sources by 2020. Yet, nuclear power remains central in the country's energy future: the government concluded in 2009 that nuclear should remain part of the energy portfolio and the construction of a new generation of nuclear power stations is now facilitated by the establishment of an Office for Nuclear Regulation. Nowadays, government priorities are towards the replacement of coal fired power stations with gas; the establishment of plans for a new fleet of nuclear; the growth of the offshore wind industry; and the development of smart energy systems.

In **Finland**, the current government aims to increase renewable energy sources from the current 34% to more than 50% by 2030, focusing mainly on bioenergy. Additionally, the Finish government aims to phase out coal and halve the use of mineral oil, by increasing the renewable share in transport fuels to more than 40% by 2030. The country also has a Climate Act, which sets goals to reduce carbon dioxide emissions. The long-term target is a completely climate-neutral society. Nuclear power is also still on the agenda, the official energy scenario envisages that the 19% of energy currently produced by nuclear power will shift to 29% by 2030. Historically **Germany's** energy supply mix was primarily dependent on domestically mined coal reaching a peak in the mid-1950s when coal accounted for almost 90% of Germany's primary energy consumption (Renn and Marshall, 2016). Since, the German energy policy pushed for an increase in nuclear power in the 1960s, a development which was slowed down by the brief resurgence of coal during the oil crisis of the 1970s, and the fall in public confidence and trust in nuclear power (associated with the disasters of Chernobyl in 1986 and Fukushima in 2011). Nevertheless, coal still accounts for the greatest source of energy production in the country today. The 'Climate Plan 2050' confirms Germany's commitment to reduce greenhouse gas emissions to between 80-95% of their 1990 levels by phasing out the majority of fossil fuel use by 2050. In parallel of this decarbonization process, the decision has also been taken to decommission all nuclear power plants by 2022, following the Fukushima disaster in 2011.

In **Denmark**, the government plan to become 100% independent of fossil fuels in 2050. Already in the 1970's, oil started to be phased out and was substituted with coal, which is now being replaced with biomass and wood-pellets. Wind power is also very developed in this country, first driven by grassroots initiatives to become later an important industry (40% of the electricity production in 2015). Nuclear has been called into question since the 1980's and only represented 4% of the electricity production in 2015. It is entirely imported as there are no nuclear power plants in the country. Also, partly due to a reaction to the Fukushima nuclear disaster, **Switzerland** has adopted a 2050 Energy Strategy, an energy law which has been adopted through a citizen referendum in May 2017. The first measures of the energy strategy are: lowering energy consumption, improving energy efficiency and promoting renewable energy. Following this scenario, renewables could shift from 20% to more than 60% of the energy mix by 20150. New nuclear power plant construction is now forbidden, and a progressive nuclear phase-out is planned.

The **Netherlands,** who still relies significantly on fossil fuel, is committed to reduce greenhouse gas emissions by 80-95% by 2050. These developments are projected to lead to a decrease of greenhouse emissions by 23% between 1990 and 2020, near stagnation between 2020 and 2030 and a further decrease to 30% compared to 1990 levels between 2030 and 2035. Currently About 10% of the energy produced in the **Netherlands** is nuclear, a resource also imported from **Germany and France**. The construction of a new nuclear power plant is depicted as currently unnecessary but not entirely impossible, should new and safe technological options emerge.

2.2 DIFFERENT TYPES OF ENERGY PRODUCERS INCLUDING "PROSUMERS"

The **type of energy producer** and the degree of investment of consumers from 'active' to 'passive' will without any doubt also shape practices related to energy uses, in the years to come. The local production and usage of renewable energy sources, by individual households and collectives, can for instance enhance the agency of consumers, allowing them to become also producers or so-called 'prosumers' (a term that is debated in the literature, see for example Ritzer 2014). The installation of solar panels on private homes is a good illustration of the way citizens become prosumers, through the resale of their electricity surplus on the grid. In the context of this study, it is generally when renewables and efficient – or smart – technologies are at stake, that citizens are likely to be considered as consumer and producer, or at least as 'active' in the management of energy resources.

In **Ireland**, the policy focus on citizens becoming prosumers is still weak. However, the latest whitepaper on energy (DCENR 2015) emphasises the role citizens could play in the future, from passive to active consumers. This document considers the way citizens can become investor-consumers through energy efficiency investments. It also explores how landowners, neighbours and communities could engage with infrastructure providers and local governments to ensure acceptable outcomes for all energy users and become more engaged in the energy landscape. Moreover, the digital energy economy is seen as an appropriate field to enhance the participation of consumers in more efficient smart energy systems. Likewise, **Finland** did not put forward the role of consumers in the production of energy as a priority. In this Nordic state, energy policies generally focused on the needs of industry, since it consumes more than 40% of all the energy. Indeed, the share of households is relatively small in international comparison and they have not been a major focus of energy policy. The large number of heat pumps however boosts the role of consumers in the production of energy, as these devices are usually owned by private households. **Hungary** does not yet have explicit strategies or guidelines on the development of 'prosumers', but some measures like the support for solar panel installation contributes to the spread of this tendency.

The **Netherlands** is certainly one of the countries under study that emphasizes the significant role of consumers can play as producers in the energy market. In the domain of electricity production, households are expected to lead the transition, especially through the investment in solar panels. Advice and financial incentives are proposed to citizens, and State support for energy cooperatives is growing. However, while the role of citizens as prosumers has been acknowledged on a national level, the government still mostly focuses on the technical and economic implications of these developments. National subsidies for solar photovoltaic panels have been currently discontinued and it is thus stated in the D2.5 Country Reports on the Netherlands that: 'the focus on smart-meter roll-out, flexible tariffs and more informative billing signifies a framing of people as rational actors and consumer capitalists.' This is also how citizens are considered in **Switzerland,** where citizens are considered as consumer capitalists that act as rational actors. Due to their dominance on the energy market, local public utility companies are assumed to be representative of the local population. Therefore, citizens are not seen as key actors – or prosumers – when it comes to energy production and distribution. In the domain of energy in Switzerland, the idea of 'active consumers' is more associated with the investment in efficient technologies and renewables. Citizens have also the possibility to take part in various associations and cooperatives, in order to strength their agency in the Swiss energy landscape.

In **Germany**, citizens can act as energy producers, through their participation in the financing of large renewable energy projects or the purchase of specific energy devices like solar panels (Kress et al. 2014). In 2012, private consumers invested in systems that produced between 34% and 47% of the whole renewable energy produced this year (ibid). Approximately one out of 60 citizens can be considered as a prosumer (Umweltbundesamt: 2011). In **Denmark**, the Smart Energy Network (SEN) consider citizens as 'active users'. In smart energy visions, implying intelligent metering and monitoring systems, the consumer is defined as a 'prosumer', through its participation in a two-way digital communication with the supplier. In the **United Kingdom,** citizens are portrayed as energy consumers for whom policy-makers deliver affordable energy and competitive markets. Government supports the participation of consumers in the digital economy, to enable the development of a more efficient smart energy system. In a recent consultation about a smart flexible energy system, the Department for Business, Energy and Industrial Strategy (BEIS) highlighted the ability of consumers to play an active role in managing their energy needs. However, the emphasis was on the benefits of smart meters and intelligent devices to manage energy use. Therefore, the focus was more on reducing energy demand rather than citizens becoming prosumers. In 2014, the government also launched its first ever Community Energy Strategy with the goal of encouraging communities to play a greater role in energy management.

2.3 POLICY ORIENTATIONS, FROM EFFICIENCY, TO SECURITY, TO SUFFICIENCY

Energy efficiency is now promoted in all national policies and different ways to achieve efficiencies are put forward. As highlighted in Deliverable 6.4, policies often focus on individual choices and household behaviours to enhance efficiency. Efficiency is thus generally promoted through awareness and information campaigns led by local and national governments, utility companies or other actors involved in energy distribution and awareness. Refurbishment and retrofitting of buildings are also seen as a necessary means to achieve these goals, especially in countries where the housing stock is old, along with the deployment of more efficient appliances. Finally, as it has been demonstrated above, innovations in the domains of renewables and smart systems will also pave the way for future efficient energy developments. However, while the energy efficiency narrative is strongly present in the various polices and strategies of the countries under study, actual means and incentives toward efficiency unfold differently on the ground, as we will now turn to.

As documented in D2.5, policy documents in **Hungary** stress the necessity to improve energy efficiency with a strong focus on the household sector and the building stock, but effective policy support has been volatile. As a major step forward, a new framework for energy efficiency improvements was put in place in 2015. Furthermore, the National Energy Strategy 2030 identifies various priorities to tackle the dependency of the country, like energy savings, the increase of renewable energy and safe nuclear energy production. Similarly, there is a strong rhetoric supporting energy efficiency in **Finland**, but actual measures are relatively limited. Finland is already considered as a leader in terms of energy efficiency, especially regarding its industry, since the related energy costs represents a large share of the whole expenses. Buildings are relatively energy efficient, as about 75% of them were built after the 1970s. Although energy efficiency is presented as important in official energy policy, there is no dedicated financial support for energy efficiency or renewable energy investments by households, apart from a tax deduction for installation work. National energy campaigns are organized by a state-owned company promoting energy efficiency, renewables and materials efficiency, as well as NGOs.

In the **United Kingdom**, the policy framework for energy efficiency agenda was underpinned by the Energy Efficiency Strategy 2012, which set the goals for energy efficiency policy. There have been a number of schemes in recent years aimed at reducing fuel poverty using various mechanisms: the Warm Front Scheme ran until 2013, its replacement the Affordable Warmth Scheme began in early 2013. The fuel poverty strategy 2015 for England aims to improve the homes of the fuel poor by 2030 achieving, for as many of them as reasonably practicable, a minimum energy efficiency rating of Band C. In **Ireland**, households are also the focus of energy efficiency policies. In most recent Whitepaper on Energy (DCENR 2015), energy efficiency has been cited as a critical element of the country's energy transition. It is stated that to achieve energy targets, householders will be required to significantly retrofit their homes: a capital investment of close to €35 billion over 35 years would be required to make the existing housing stock low carbon by 2050. It is estimated that deep retrofitting is required to improve building energy efficiency to the required level, including among others, external insulation, installation of heat pumps and installation of triple glazed windows. Like in the cases of **the United Kingdom and Ireland**, the principal issue when energy efficiency is at stake in the **Netherlands**, is the energy efficiency of buildings. Therefore, public support in the domain of the built environment is offered for heat pumps, biomass, wood pellet or solar thermal heating systems. The **Danish** strategy is to achieve 100% independence of fossil fuels in 2050. Here again, there is a general trend associated to the refurbishments of buildings. Yet, despite several steps toward energy efficiency, the energy consumption level in **Denmark** is still increasing. Some argue that refurbishment is not sufficient, as Danish people living in efficient homes develop 'inefficient practices' leading to a performance gap (Gram-Hanssen & Georg, 2017). Energy suppliers thus need to promote energy efficiency through the dissemination of information, as well as consulting.

In **Switzerland**, energy efficiency is part of the 2015 Energy Strategy. There is a significant focus on individual actions like turning off lights and appliances, changing old energy-intensive appliances by more efficient ones (e.g. fridge), realizing technical changes in the household (e.g. buying LED bulbs). Eco-neighborhoods, where energy efficiency and sufficiency are on the top of the agenda, are also progressively gaining in popularity. One of the latest campaigns led by the **German** government was the *'Deutschland macht's effizient'* initiative, where energy efficiency was here again the primary focus. Through this campaign, public authorities provided information and consultations, as well as financial incentives for households, companies and municipalities who undertake to improve their energy efficiency. There are also some government aid projects focusing on the energy efficiency of the housing stock, through the subsidizing of the construction and purchase of energy-efficient buildings, as well as for energy-related refurbishment.

The results presented above show similarities and differences in the policies of the various states under study. When energy efficiency measures are invariably put forward in national energy strategies, these are implemented at various levels and in different ways. Buildings retrofitting seems to be a widely shared approach to enhance energy efficiency, but the nature of renewables used between the countries is for instance far from being homogenous – which is understandable, given the different natural resources and historical developments. Depending on the climate and the resources available (oil, gas, wood, peat, etc.), different energy portfolios and interests are at stake. There is also an important divide between countries opting for a nuclear phase-out and those in opposition who are working on the expansion of their nuclear parks. As deliverable D6.4 reveals, these differences in energy production and management have led to the formation of 'energy islands'; the European Union has expressed concerns about the so-called 'fragmentation' of energy policy (Genus and Iskandarova 2018). The European Union precisely highlighted some unilateral measures taken by member states, which affect the prices of energy and threaten internal markets. There is thus a call for integration, materialized by the **European Energy Union,** of a strategy made up of various dimensions including the reinforcement of energy efficiency to reduce the European Union dependency on energy imports, and climate actions to decarbonize the economy (European Commission, 2018) As Deliverable 6.4 states, the Energy Union is being developed in five domains of European Union Energy Policy: '(i) security of supply (in 2015, the EU28 imported 54% of energy supplied); (ii) sustainability (in 2015 fossil fuels contributed 75% of the fuel mix of EU energy supplied); (iii) greenhouse gas emissions (which for the EU in 2015 was 22%); (iv) the role of renewable energy in energy supply and use (16% of final energy consumption for the EU in 2015); and (v) competitiveness of the EU in the energy sector. (European Commission 2017, cited in: Genus and Iskandarova 2018: 11).

As suggested in the summary provided above, **energy security is a key policy issue** shaping political interest in energy supply. Coutard and Shove (2018) bring a more nuanced approach to the question, arguing that unlimited and reliable energy has enabled the normalization of various forms of energy-greedy consumption, from the use of washing machines and refrigerators, to constant ICT connectivity and air-conditioning in certain contexts. Thus, policy framings around energy could also consider "how much of what is enough?" (Spengler 2016) **or a more explicit focus on sufficiency**, defined by ENERGISE as absolute reductions in energy usage, while accounting for positive and negative rebound effects across domains of consumption. As stated by Shove (2017), the shift to sufficiency is "not simply a matter of recognizing that efficiency is not the same as sufficiency, or that efficiency measures might rebound or backfire. The more important insight is that efficiency measures obscure the politics of the present", which could be overcome by "designing energy-efficiency policies and strategies that are reflexive, historically aware and alert to the forms of service that they enable (...)" (p. 8).

Debates around sufficiency therefore lead into more fundamental and societal questions, such as what services should be enabled, in what contexts, and towards what needs. This idea is echoed in other works that consider how resource efficiency improvements might be contributing to the expansion of the economy as a whole (Pirgmaier, 2017). For ENERGISE, co-design and deliberative methods are being put forward as a way to challenge social norms around energy-intensive activities, with a focus on heating homes and laundry practices and towards sufficiency as a desired outcome (Laakso et al., 2018). This relates to the “energy hierarchy” developed at a SCORAI workshop in Lausanne (SCORAI, 2014), and interpreted in D2.4 as a consumption typology (Jensen et al., 2017). This hierarchy served as an inspiration for the ENERGISE project: while efficiency is a desired approach towards energy transitions, sufficiency is the first level of the pyramid and should be considered as the first step. For D5.2, **a further definition of sufficiency will be proposed, based on an analysis of empirical evidence on reduced consumption and shifts in normalized practices.**

PART 3: SOCIODEMOGRAPHIC CHARACTERISTICS

Socio-demographic characteristics to be an important dimension for consideration in understanding current practices and opportunities for change. Socio-demographics characteristics are thus a backdrop against which we understand energy usage, as captured in ELL design, implementation and assessments. This includes a consideration for population, social class, but also gender, education and age, among other factors.

3.1 POPULATION, SOCIAL CLASS AND AFFLUENCE

Except for the two heavyweights – **Germany** (82,79 million in 2017) and the **United Kingdom** (66.02 million in 2017) – all the countries involved in ENERGISE Living Lab rollout are small to middle-size states. **Aside from these two countries and the Netherlands (17.08 million in 2017) the remaining five countries all have a population of less than 10 million people**. The least populated country of the study is **Ireland** with 4.74 million people, then **Finland** with 5,5 million people. The usual social categories ‘age-gender-social’ class have effects on people’s practices. Gram-Hanssen and Georg (2017) show the link between a person’s economic resource, the type of building they live in and their energy habits. Sahakian (2018) also demonstrates the same link in the context of consumption within privileged class. Economical differences between people lead to different technological acquisition and different habitat conditions, in short, different patterns of consumption. Many authors state that thermal conditions should fit the type of building as well as its occupants (Kunkel et al, 2015; Nicol, Wilson, 2011; Bopp, 2007; Boerstra, van Hoof, van Weele, 2015). The type of occupants and the length of their stay are factors that are classifiable; they allow the standard calculations to apprehend the variability of consumption behaviour. However, as Boerstra, van Hoof and van Weele’s critical analysis (2015) suggests, these classifications do not necessarily fit people’s perception of comfort and they may lead to higher energy cost.

When energy consumption is at stake, social class factors have significant impact. As Dreyfuss explained, using Elias work on the Civilizing Process (1969), the diffusion of social norms starts from the higher social class before reaching lower ones. Shove (2003) and Wilhite (2017) use the example of air conditioning systems to explore how a fashionable product becomes legitimate. Following this idea, Sahakian explains how ‘social acceptance and pressure’ play a role in the acquisition of new technology or in the conformity to a certain lifestyle in her study among elite households in Geneva (2018, p. 62). Interviews conducted with them showed how they linked their behaviour to the one of their friends and families, as well as how they were sometimes influenced by fashion to buy a new technological object (Sahakian, 2018). Having an air conditioning system, a second washing machine or the new juicer that everybody wants can make people feel a sense of prestige. Shove synthesizes as follow: ‘People distinguish between themselves and others through acquisition of new commodities and technologies’ (2003, p. 52). Regarding social comfort, Chappells and Shove (2005) relate the type of building and the occupants with social notion of prestige. Through building occupant’s agency (Wilhite, 2017), architectural style and the use of mechanical thermal management, social practices are transformed and adapted. Wilhite demonstrates as an example how the arrival of air conditioning systems contributed to the dissolution of front porch casual interactions: ‘Screen porches were glassed in and the default position of doors and windows changed from opened to closed. The flow of people, food, and socializing between the living room and the garden was restricted to the cool of the evening.’ (2017, p.32). As we can see, social practices, technology development and official recommendation can be deeply connected.

More generally and **in relation to affluence** in the case of laundering, one can observe that the frequency of the washing cycle is ‘increasing in all of OECD countries’ (Wilhite, 2011, p. 50). People wash their clothes more often than ever before in history (Shove, 2003, Wilhite, 2011). Shove states that the diversification of fabrics, as well as the consumerism at play, led to a specification of different specialized gear. An individual will own various gears, made especially for sports, leisure, or work, and this diverse equipment will not have the same washing requirements. Moreover, these cloths are often supposed to be worn only once, and at regular times, for instance once a week for sports gear. People make more, and smaller laundry loads, not being able to mix in the items, nor wait to fill their basket, in order to have all their different gear ready at any time (Shove, 2003).

3.2 THE GENDERED DISTRIBUTION OF DOMESTIC CHORES

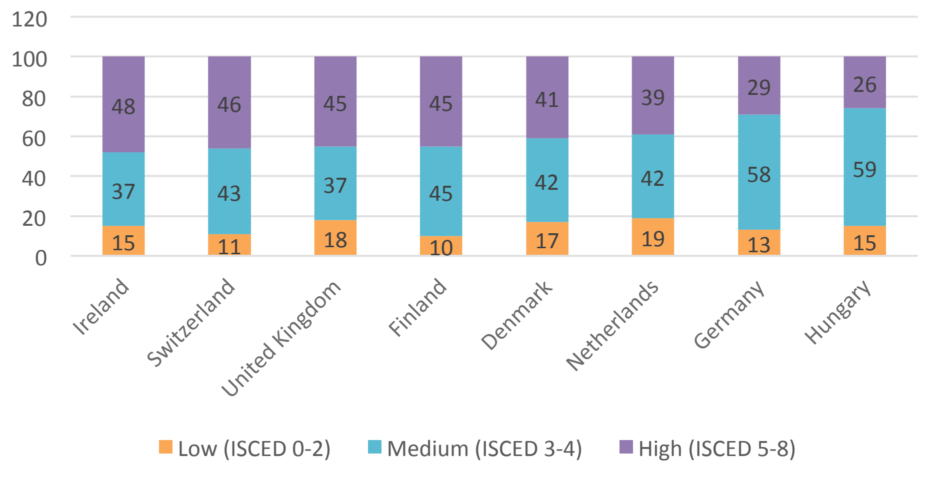
Gender dynamics must also be accounted for in relation to household energy use *vis-á-vis* domestic chores. Laundering practices for instance, as many other house chores, are traditionally, and still remain a feminine responsibility (Anderson, 2016; Baxter, 1997; Kan et al., 2011; Moreno-Colom, 2017). Even if ‘men’s domestic work time has in general displayed an upward trend over the past four decades’ (Kan et al., 2017, p. 236), women still commit more of their time to the duties of housework (Greene, 2018b). The slow convergence of time dedicated by each gender is nevertheless noted by many authors. (Anderson, 2016; Baxter, 1997; Kan et al., 2011; Moreno-Colom, 2017). Kan et al. (2017) argue that, even if men tend to do more housework, the types of chores they usually perform are still deeply linked with gender roles. They show how ‘domestic tasks remain divided as “masculine”-defined and “feminine’-defined.’ (Kan et al., 2017, p.240) Routine work that takes places inside, such as taking care of the cooking and cleaning of the house, as well as looking after the children, is traditionally feminine. Women are then responsible for managing the home in general, while men are more focused on nonroutine such as outside seasonal home-maintenance work (Kan et al., 2017). Kan et al. also demonstrates that the evolution of gender practices does not take place at the same rate in different countries. As mentioned, the gap in time spent on housework between men and women seems to decrease (Anderson, 2016; Baxter, 1997; Kan et al., 2011; Moreno-Colom, 2017), but cultural differences influence the speed at which this convergence takes place. A number of factors can influence social change toward gendered practices. The 'main issues' usually considered in studies on domestic work are 'sex role attitudes, time spent in paid employment, and husband's and wives' relative economic power in the household' (Baxter, 1997, p.221). For instance, working time influences when the laundering takes places, and what is striking is that non-working women's practices seem to converge with women employed full time (Anderson, 2016; Greene, 2018b). Moreno-Colom shows that part-time employment influences time spent on domestic tasks (2017).

In their role as primary caretakers for children, women often engage in more domestic work. The presence of a child is also mentioned by Baxter (1997) as an important factor influencing time spent by each gender on house chores. On that matter, policies and welfare regimes can have an impact on practices. Many studies have suggested that Nordic countries are slightly in advance in the convergence between men and women (Baxter, 1997; Kan et al., 2011; Moreno-Colom, 2017). Kan et al. explains that 'gender equality' is a 'major goal' in these countries, reflections and considerations on improving it have been conducted for a long period (2017, p.248). Women of these countries have received more inducement to follow a full-time career, and ideologies of equality are taught in schools earlier. While studies generally consider Nordic countries as progressive in the context of gender equity, they also agree on the fact that social division of domestic labour is still going on. (Anderson, 2016; Baxter, 1997; Kan et al., 2011; Moreno-Colom, 2017). Gender has for instance an important impact in laundry practices, where women are the main carers for clothes, and are also 'the main targets of marketing strategies for promoting household cleaning appliances.' (Wilhite, 2011, p.52).

3.3 EDUCATION AND AGE OF THE OVERALL POPULATION

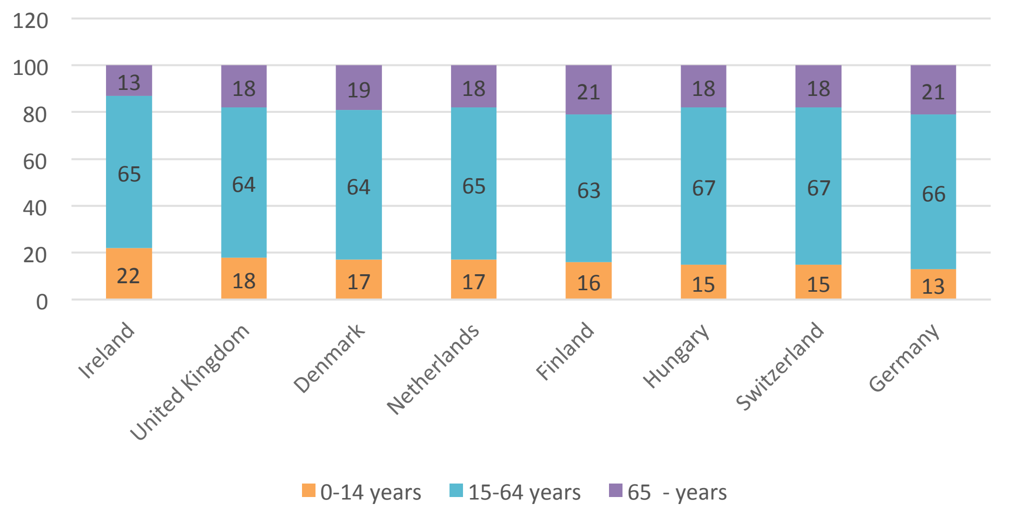
While the links between education levels and energy usage are not linear nor necessarily causal, **education levels as a form of social capital may contribute to environmental awareness around energy issues**. Based on secondary data and for the eight countries under study, the range of people who attained a tertiary education degree (ISCED levels 5-8: from tertiary education to Doctoral degree level) is between 26% (**Hungary**) and 48% (**Ireland**). **Switzerland, Denmark, the United Kingdom and Finland** also see more than 40% of its population in possession of a tertiary education degree and **Hungary and Germany** are the only countries below 30% The category of people in the lowest education range (ISCED 0-2: Early childhood education to lower secondary education) is more homogenous, **Finland** being the lowest (10%) and **the Netherlands** the highest (19%).

Figure 1: Educational profiles, 2016 (%)



Source: synthesis based on ENERGISE National Summary Briefs

Figure 2: Age profiles, 2016 (%)



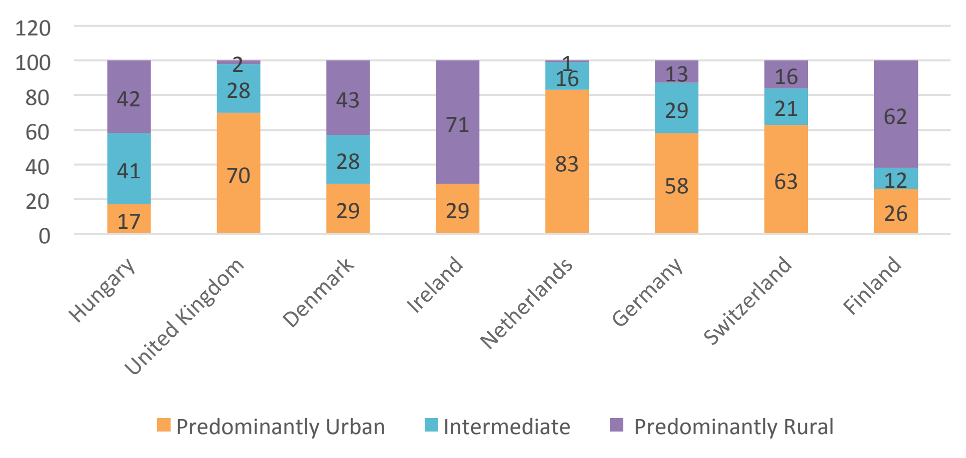
Source: synthesis based on ENERGISE National Summary Briefs

Age is also seen to have an influence on energy practices, as it can be illustrated by the example of laundry. Constanza et al. (2014) suggests that younger people tend to be less predictable in their behaviour and wash at irregular frequencies. Moreover, age has an impact on washing temperatures, as Laitala et al.'s (2012) paper on Norwegian practices indicates. Indeed, they found that 'younger respondents had lower average temperatures': 'A comparison of age groups showed that the elder respondents were more likely to have reduced the temperature, although they would still wash at a higher average temperature than the younger respondents' (Laitala et al., 2012, p.231). On another hand, older people had more embedded habits related to hot temperatures laundry and innovation in terms of machines and detergents. The age profile of the countries under study is rather homogenous: **Ireland** has the highest population of young people (22%), while **Germany and Finland** has the highest percentage of old people (21%). Generally speaking, there are not much difference in the various ranges related to the 'active' population (15-64 years): all countries situated themselves between 63% (**Finland**) and 67% (**Hungary and Switzerland**).

3.4 THE RURAL AND URBAN "DIVIDE" AND TENANT-LANDLORD RELATIONS

The location of households, between rural and urban contexts, has a significant influence in the shaping of energy use. It will for instance influence the type and size of the dwelling (e.g. people are more likely to live in a detached house in a rural area) or the connection to the system (e.g. the size of a grid can depend on the size of the municipality). **Definition of 'urban' and 'rural' varies between countries in Europe.** In some countries such as **Switzerland, Hungary and the United Kingdom**, a locality is considered as an urban area when its population is over 10'000 people. Other countries have more accurate ways of classifying their population. **Germany** distinguishes between 'densely', 'moderately' and 'sparsely' populated areas. In **Finland**, a group of buildings with at least 200 residents, and with less than 200 meters distance between buildings, are considered as urban areas, whereas in **the Netherlands**, areas with more than 1,000 registered addresses per square-kilometre are considered 'urban'. Some countries also have an intermediate category, such as **Switzerland and the Netherlands**. The OECD proposes a typology based on 3 categories: 1) predominantly urban; 2) intermediate; 3) rural. Based on this classification, data collected in the context of the ENERGISE project show that some countries are predominantly urban like the **United Kingdom (75%), the Netherlands (74%) and Switzerland (61%).** Moreover, save for **Ireland** which is characterized by a high proportion of rural regions (60%), all countries analysed in relation to ELLs are mostly composed of urban or intermediate regions: **the Netherlands (1%), the United Kingdom (3%) and Switzerland** (3%) are associated with the smallest rural population.

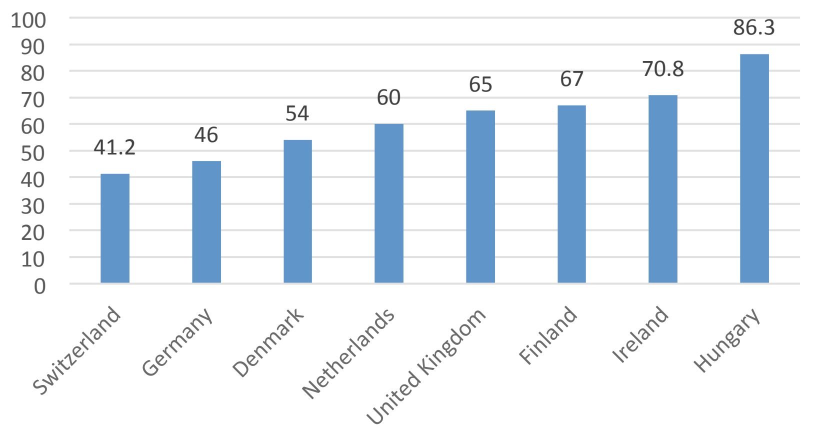
Figure 3. Urban - rural distribution (OECD)



Source: OECD, 2017; National Summary Briefs

Dwelling tenure will also determine households' opportunities to reduce energy demand. Deliverable 3.1 highlights the extensive literature on the **tenant-landlord relations** associated to energy use problematics, pointing out dilemmas such as 'the fact that landlords lack incentives to invest in energy renovations for buildings where the benefits would accrue to tenants or, from the perspective of the tenant, the savings in energy use cannot offset the rent increase due to the renovation' (Laakso and Heiskanen, 2017: 12). In this context**, Germany and Switzerland** are the two only countries under study where the share of rental buildings is higher than the one of ownership (Switzerland has a percentage of 41.2% of owned dwellings and Germany 46%). **Denmark** follows with a share of owned dwellings a little higher than rental dwellings (54%); **the Netherlands** (60%), **the United Kingdom** (65%) and **Finland** (67%) are above 60%; and finally, after **Ireland** (70.8%), **Hungary** has by far the highest share of owned dwellings (86,3%).

Figure 4: Share of owned dwellings (%)



Source: synthesis based on ENERGISE National Summary Briefs

PART 4: MATERIAL SYSTEMS AND ARRANGEMENTS

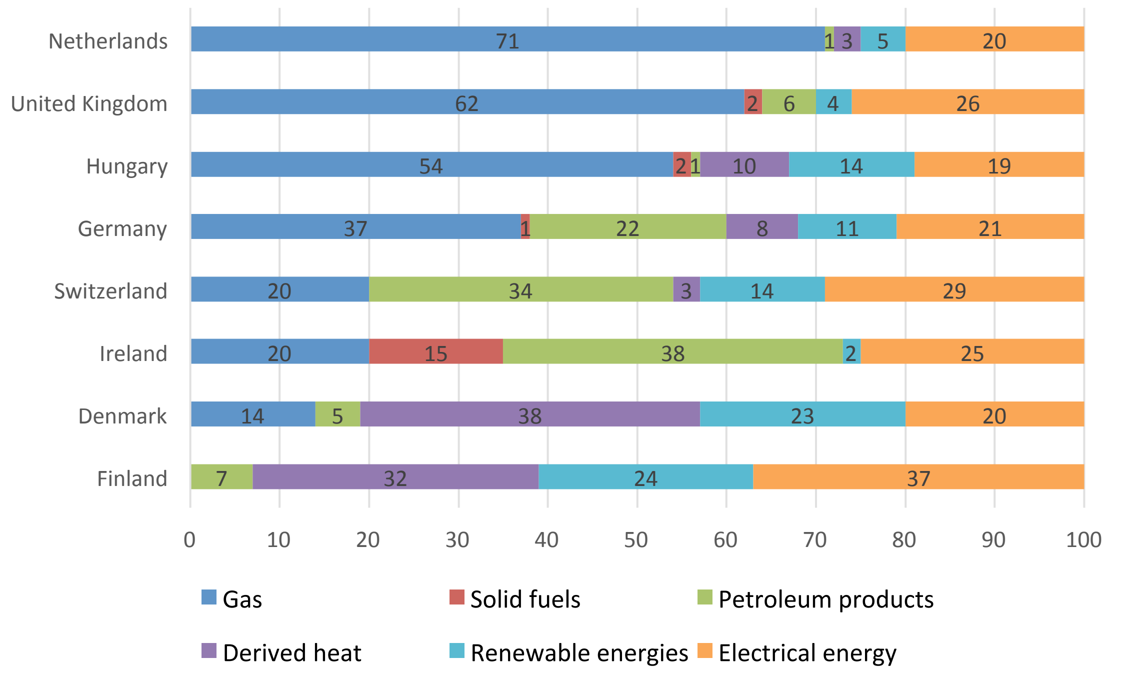
4.1 FINAL ENERGY CONSUMPTION

In Stephenson et al. (2010, 2015), and as expressed in Deliverable 1.2, household energy use reflects social and material conditions outside the home, including social norms and national policies (developed in parts 2 and 3 below) and material arrangements, such as house characteristics (e.g. age of a building and state of its insulation), heating systems (e.g. individual heating vs district heating), existing infrastructures (e.g. accessibility of renewable energy supply), technologies (e.g. smart grid), and energy sources (e.g. fossil vs. solar).

As a starting point, and building on D2.5 National Summary Briefs and D3.1 Good practice report: capturing cross-cultural interventions, it is important to set the context of energy usage by understanding current patterns of residential final energy consumption across the eight countries involved in ENERGISE Living Lab (ELL) rollout. These indicators of energy sources per country can be placed in relation to the European Commission's Renewable Energy Directive, which requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020; and 37% renewables in final energy consumption by 2030. The figure below presents the share of fuels in the final energy consumption in the residential sector, drawing from the ENERGISE National Summary Briefs.

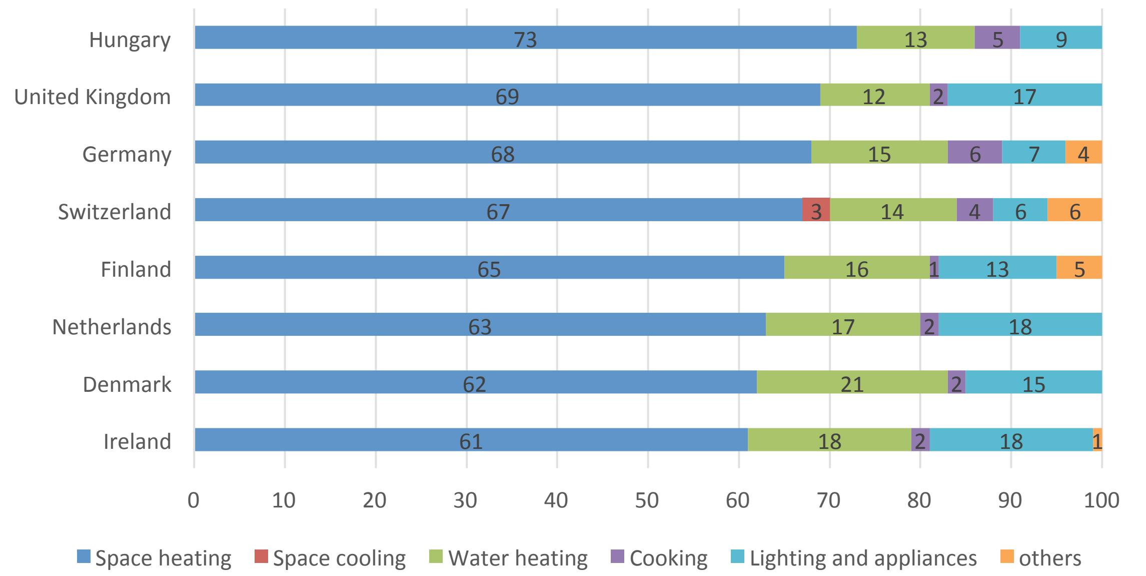
For space heating, petroleum products are used mainly by **Ireland** (38%), **Switzerland** (34%) and **Germany** (22%). Countries with the highest proportion of renewable energy usage for space heating are **Finland** (24%) and **Denmark** (23%). **The Netherlands** has only a 5% share of renewables, however the country projects to increase to 12.4% by 2020 and by 16.7% in 2016. The **United Kingdom**, with a current share of 4%, has announced that it would provide at least 15% of its energy from renewable energy sources by 2020. Gas is predominantly used by the **Netherlands** (71%), the **United Kingdom** (62%) and **Hungary** (54%), while electrical energy is a resource mobilized in a rather equilibrated way among the countries under study, from 19% (**Hungary**) to 29% (**Switzerland**).

Figure 5: Share of fuels in the final energy consumption in the resident sector, 2015 (%)



Source: synthesis based on ENERGISE National Summary Briefs

Figure 6: Residential final energy consumption by type of end-use, 2015 (%)



Source: synthesis based on ENERGISE National Summary Briefs

As illustrated in the figure above, space heating clearly represents the most significant form of household energy usage, followed by water heating. Due to the climatic conditions related to these countries (as detailed in section 4.4), air conditioning systems are almost inexistent – **Switzerland** is the only country that use these devices in a noteworthy way (3%) – but could become more frequent in the context of climate changes and hotter summers.

As documented in D3.4, laundry does not stand out as a significant consumption category in relation to energy usage, yet the focus on laundry practices in ENERGISE reflects ways of washing and drying clothes which can be 'sticky' or difficult to change, because they are held together by social norms and collective conventions around hygiene and cleanliness that have developed over time. Further, considering laundry and heating together shows the ways in which "these sets of practices (related to laundry and heating) are intermingled in daily life through collective arrangements on a household level as well as through perceptions of comfort and cleanliness" (D3.4: p. 9). D5.1 further develops the complexity of final energy consumption around heating and laundry, thus confirming the focus on these two domains for the ELL rollout.

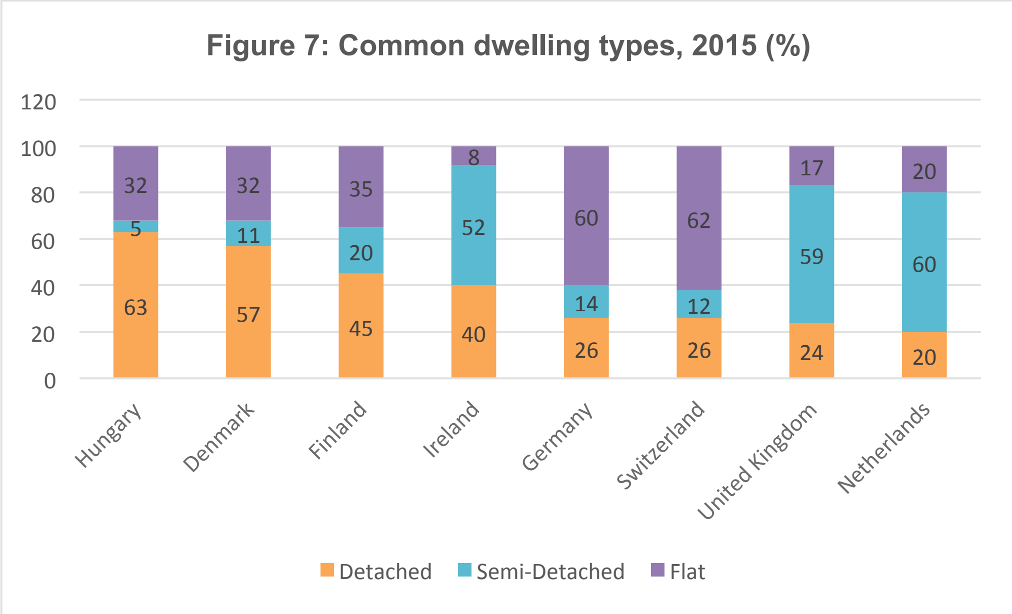
4.2 BUILDING TYPE AND CONFIGURATION OF HEATING/ WASHING SYSTEMS

As stated in Deliverable 3.1, material conditions play a key role in the configuration and performances of practices: 'This is particularly the case concerning heating practices, where people in parts of Europe suffer from poorly insulated buildings and relatively high costs of heating' (D3.1: 25). Regarding **house characteristics**, the **type, age and state of**

dwellings will determine energy use, especially in terms of investment needed to increase energy efficiency. Such characteristics are linked to socioeconomic factors: for example, in the era of the capitalist economy and the consumerist society, the size and shape of houses have evolved to be bigger, containing more screen windows. The materials used for the construction of houses are also different. For example concrete has replaced more traditional materials such as wood and clay. Moreover, the historical development of countries and towns will also influence energy use. The necessity for renovation is for instance greater in countries where the building stock is older. In a comparison of different countries in Europe, Bartiaux et al. (2014) showed that energy renovation did not form a unified practice in any of the countries, but rather a bundle of somewhat disjointed practices. As stated in Deliverable 3.1, in old and poorly maintained buildings, the practices that are likely to save energy can be quite different from those in new and highly automated buildings. In considering the eight countries under study, **Ireland** has the lowest share of buildings built before 1980 (less than 50%), followed by **Hungary, the Netherlands, Finland** (between 60% to 65%), the **United Kingdom, Germany and Denmark** (more than 70%)[6]. Indeed, the **United Kingdom** housing stock is one of the oldest compared to other European countries. Many houses date from the Victorian era and have poor insulation, implying additional energy consumption to maintain a certain level of comfort. However, as the older housing stock is gradually being replaced with a newer one, more energy efficient homes are being developed: houses built prior to 1918 represented 25% of the housing stock in 1970, compared to 16% in 2014.

The **size and type of the dwelling** are also important factors determining energy use. On one hand, larger dwellings consume more energy, but on another hand, multiple rooms offer the opportunity for regulating temperatures when rooms are not used. In our research context, **Hungary, the United Kingdom and Finland** have the smallest average size of residential dwellings (less than 80 square-meters), followed by **Germany** and the **Netherlands** (80-100 square-meters). **Denmark and Ireland** have the largest average size with more than 100 square-meters.[7] **Hungary** is an interesting case as it is characterized by a large amount of old detached houses: around 63% of the population (6.5 million people) live in this type of dwellings, generally implying individual heating systems and lower rated insulation. In **Hungary**, households living in detached houses often use a mix of fuels for heating (e.g. natural gas and wood) and even household waste (despite legal restrictions). **Ireland** also has a significant population living in detached houses (40% for the general population, although rising to over 80% in rural areas) and only a small amount in flats (8%). Furthermore, household size in **Ireland** is the second highest in Europe at 2.7 persons per dwelling (SEAI, 2018). The proportion of flats is also very low (17%) in the **United Kingdom**, partly due to the importance of the respect for privacy and independence, as well as the ‘pride in ownership’.

[6] No data was available for Switzerland in D3.1
[7] No data was available for Switzerland in D3.1



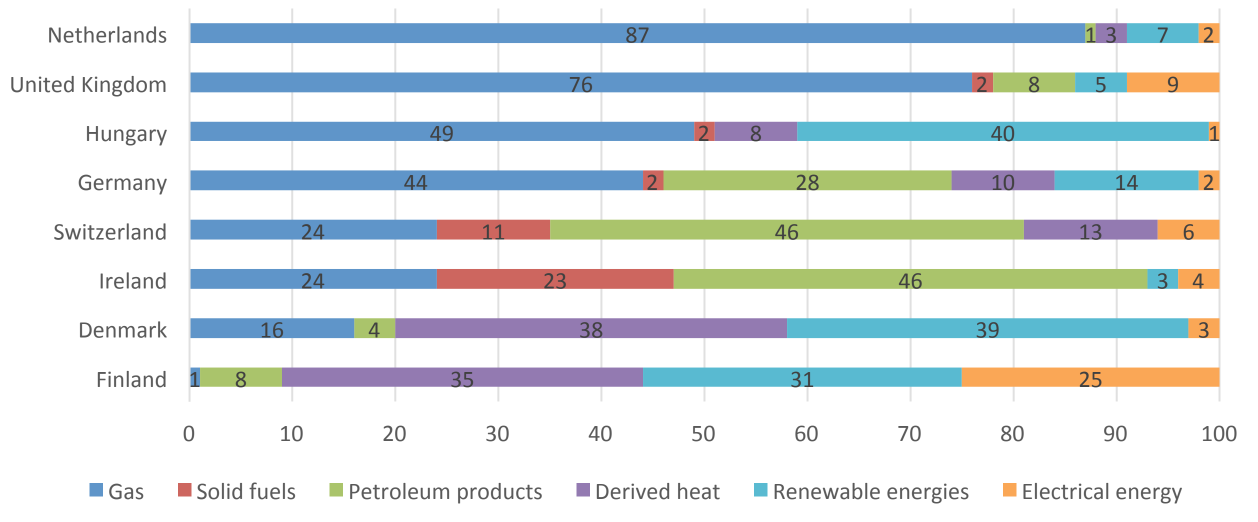
Source: synthesis based on ENERGISE National Summary Briefs

4.3 ENERGY NETWORKS AND SYSTEMS

Deliverable 3.1. also stresses the importance of **heating systems and sources** as material conditions influencing household practices related to energy use, adding that these elements differ widely across Europe. Indeed, various **sources** of energy for heating are predominantly used depending on the countries. One issue with calculating the share of fuels in final energy consumption has to do with definitions of energy sources, and the temporality of the assessment. For example, what is considered as a “renewable” resource in one context may not be in another (e.g. hydraulic).

In **the Netherlands and the United Kingdom**, households heat space in a large majority with natural gas (87% for the **Netherlands** and 76% for the **United Kingdom**). This is also the case, but with a lesser extent, for **Hungary** (49%) and **Germany** (44%). Renewable energies are still sparsely used in average in the domain of space heating, with **Hungary** using renewables the most (40%; note that wood is currently classified as a renewable form of energy), followed by **Denmark** (39%) and **Finland** (31%). The other countries situate themselves between 14% (**Germany**) and 0% (**Switzerland**). Petroleum products are used in a very contrasted manner depending on the countries: it represents almost half of the fuels for **Switzerland** (46%) and **Ireland** (46%), as well as 28% for **Germany**. Other countries rely far less on petroleum products: between 8% (the **United Kingdom**) and 1% (**the Netherlands**). Derived heat is used mostly in **Denmark** (38%) and **Finland** (35%), but very scarcely in other countries: from 13% (**Switzerland**) to 0% (**the United Kingdom**). Finally, solid fuels and electrical energy are the less used, the first being used significantly only by **Ireland** (23%) and the latest by **Finland** (25%).

Figure 8: Share of fuels in final energy consumption - resident space heating, 2015 (%)



Source: synthesis based on ENERGISE National Summary Briefs
Note: this figure relies on national definitions of renewable energy sources.

In terms of **energy systems**, while district heating is widespread in **Denmark** (65%), it is almost inexistent in the **United Kingdom and Ireland** (1%). **Finland** has a relatively important number of households connected to district heating in urban areas (15% in built detached homes and 90% in buildings), but the other countries under study present a rather low amount of heat produced this way: **Hungary** (12%), **Germany** (8%), **Switzerland** (4%) and the **Netherlands** (4%). However, some countries are expecting district heating to play a more important role the upcoming years. The **Netherlands** is planning a shift to district heating, while the National District-heating Development Plan (NDhDP), based on the expansion of the district heating infrastructure, is currently under finalization in **Hungary**. In **Finland**, smart district heating systems are also under development.

In the recent years, the development of **'smart systems' and 'smart cities'** has increased to become a global phenomenon. Smart technologies have been progressively integrated in governments agendas and considered as a priority area for research. Moreover, smart meters are starting to be installed in homes all over the world towards the goal of improving household energy efficiency. Smart technologies can be used to act directly on energy consumption through management of the needed parameters, for instance a smart thermostat for self-regulating homes or self-managing washing machines. The development of **smart systems and technologies is at different stages in Europe**, and the eight countries in focus for ELL implementation present a good illustration of this diversity. Northern European countries seem to be the most advanced, already operating smart systems in relation to energy distribution, while other countries are only in a prospective stage, building and implementing strategies. Since 2010, smart energy systems gained momentum in **Denmark and Finland**, with the latter providing most of its electricity consumers with automatic meter reading installations. Both countries invested significantly in smart grid and smart energy research. **Finland** is already developing smart products (e.g. Internet of things, building automation, smart controls) for the export market and has around 20 cities piloting smart technologies. In the **United Kingdom and the Netherlands**, national governments committed to ensuring smart meters for all households by 2020, and smart metering is also part of the 2050 Energy Strategy of **Switzerland**. **Germany** is significantly upgrading its electricity grid, integrating smart technologies, and developing the concept of smart cities in major cities like Berlin, Munich, Mannheim and Hamburg. **Ireland** identified smart cities and smart systems as priority for research in 2012. Only **Hungary** has at this point no central governmental strategy dedicated to the development of smart systems; nevertheless, smart cities have received attention among policy-makers, and several Hungarian cities have started to develop their smart city strategies.

The number and the ownership of **energy suppliers,** from private to state-owned, are also elements that may influence household practices in relation to energy usage. State regulations related to energy distribution generally seek to protect consumers' interests and act primarily on the energy bill (adapting the cost of energy between supply and demand for example), which can also shape household energy-usage. For example, regulations to offer low electricity prices based on renewable energy sources might shape the consumer environmental sensibility. The scale of the production and distribution (municipal, regional, national) will influence the number of suppliers (from one national supplier, to multiple regional or local ones). In the countries under study, most of the energy companies are public or private-public; their markets, however, vary between municipal and national. **Hungary, Ireland, the Netherlands** have a single national system (with parts of the grid operated at a regional level in some cases). In **Hungary**, electricity, natural gas and district heating are provided on the national energy markets: there is a state owned public utility company sharing this market with other private companies. Since 2000, **Ireland**'s electricity markets have been open to competition: The Electricity Supply Board's (ESB) market share went from operating 95% of the installed generation capacity in **Ireland** to 51% in 2015, yet ESB still owns the vast majority of the infrastructure – other companies must pay them to operate the power grid.

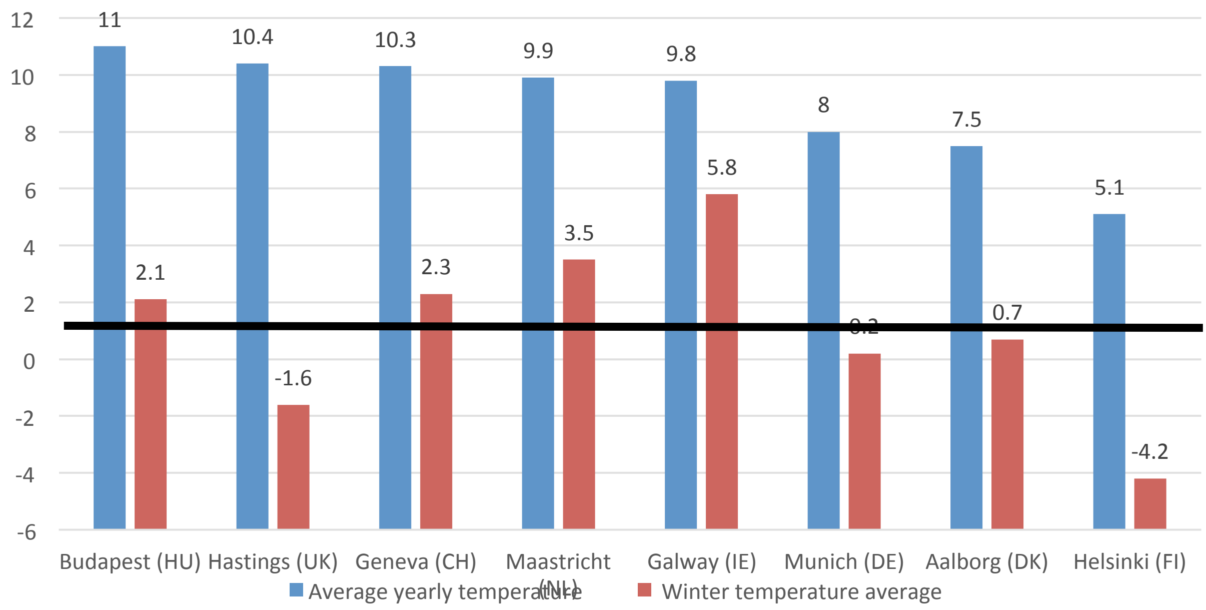
In Great Britain, the electricity system is divided into a national high-voltage transmission network and several regionals, lower-voltage distribution networks. The system is operated by single public system Operator (National Grid), who also owns and operates four of the eight regional gas distribution networks. The British system that exists throughout Scotland, England and Wales does not extend out to Northern Ireland. In Northern Ireland, the electricity transmission network and the distribution network are owned and operated by Northern Ireland Electricity Networks. The Dutch state owned 'Transmission System Operator', owns and operates the high voltage transmission grid at the national level in the **Netherlands**, but other parts of the grid (lower voltages until 230V - 400V) are owned and operated by regional energy companies. **Switzerland's and Finland's** energy systems are also mostly public, but they are operated at the level of municipalities. In **Switzerland**, energy companies for electricity and gas are generally municipality owned, or at least they must be accountable to the municipalities (private companies exist but are marginal). In **Finland**, electricity distribution grids were originally developed by municipalities or local industries. From 1995 to 1997, electricity markets were liberalized and since, approximately 120 companies produce electricity for the retail market but many of them are still owned by municipalities. **Germany and Denmark** are mostly characterized by private operated systems, although some energy cooperatives also exist in Denmark (parts of the system are still owned by consumers or municipalities in Denmark, but pressure on local budgets may lead to further privatization). In the three countries where district heating is developed – **Denmark, Finland and Hungary** – suppliers are usually municipal monopolies (over 50 operators in Hungary and more than 100 in Finland), therefore prices can vary significantly within their borders.

4.4 CLIMATIC AND WEATHER CONDITIONS

Climatic conditions will also have an influence on how energy-using practices play out, especially in terms of heating and cooling, but also in relation to the option for drying clothes outdoors. The countries analysed here are mostly on the Northern part of Europe; **Switzerland and Hungary** are the most southern countries, and **Finland** is situated at the northern extremity of the continent. In general, the selected countries are characterized by a temperate climate (**Denmark, Switzerland, Hungary, most of Germany**) and a maritime climate or temperate maritime climate (**the Netherlands, United Kingdom, Ireland, the Northern part of Germany**), and cold climate (**Finland**). The categorization of climates changes according to the sources and the description methods, and moreover, these climates are far from being homogenous in the whole national territory. In Switzerland, the temperature significantly depends on altitude, with high variation from Artic to Mediterranean types of climate. It is also important to mention that climate change will have a significant impact on the Swiss climate: local climatic warming in the Alpine arc is twice as important as the global average. **Hungary** is characterized by an erratic climate, as the country is situated in between three climatic zones: oceanic, continental and Mediterranean. Finally, **Finland** is the coldest country, with an annual average temperature of 2ºC (a little more than 5ºC in Helsinki on the South Coast and about 0ºC in Sodankylä in Lapland). Furthermore, this Nordic country is associated with a great variability in the availability of sunlight over the year: during winter solstice, the sun is up for less than 6 hours in Helsinki, and during summer solstice, for almost 19 hours. Thus, with a focus on countries situated in Central and Northern Europe, the main implication for household energy use is related to home heating. In the cities where the ELLs were rolled out, average yearly temperatures range between 5.1 ºC (Helsinki, FI) and 10.4 ºC (Hastings, UK). In those seasonal climates, winter is of course a determinant period due to the increase of heating practices. Helsinki (-4.2 ºC) has again the coldest average winter temperature, while Galway (IE) has the warmest (5.8 ºC).

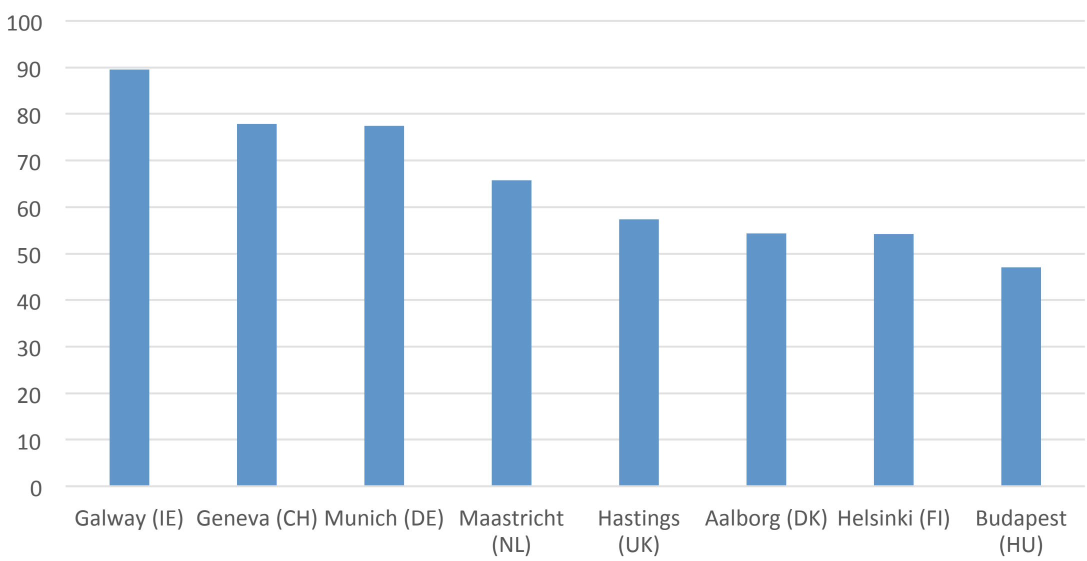
Humidity also influences the way people heat themselves and use energy. Most of the countries in this study are characterized by a relatively high level of rainfalls. **Switzerland, Ireland and the United Kingdom** get the most rain: Switzerland is enjoying cold, cloudy and rainy or snowy weather in winter, but only occasional showers in summer, while **Ireland** and the **United Kingdom** are characterized by abundant rainfall year-round. As mentioned in Deliverable 3.1, on average, practices related to heating, cooling and domestic hot water constitute 85%, and heating alone about 78%, of household energy usage in Europe. Galway (IE) sees the most rain (89.6 mm) and Budapest the least (47 mm).

Figure 9: Average temperatures (ºC)



Source: climate-data.org (2018) ('winter average temperatures' are based on month average temperature from December to March included.)

Figure 10: Average monthly precipitation (mm)

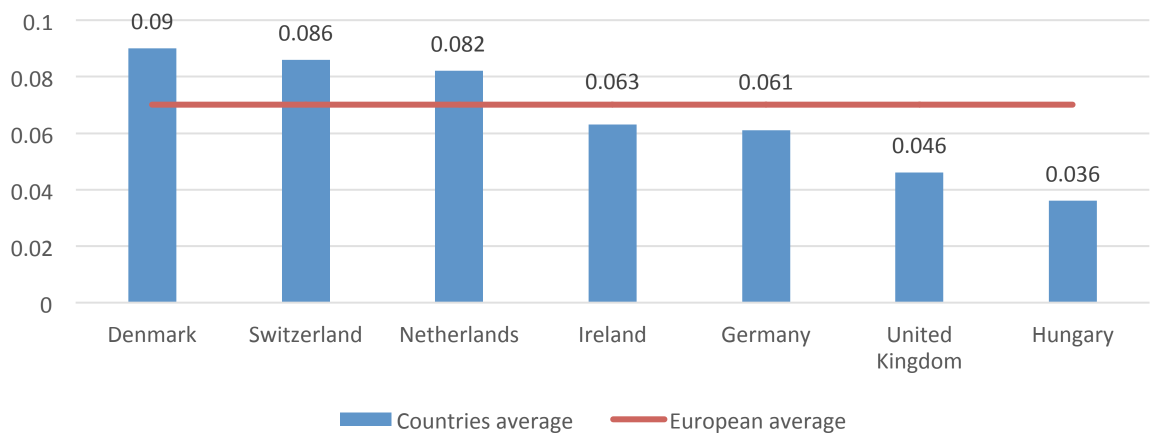


Source: climate-data.org (2018)

4.5 COST OF ELECTRICITY AND HEATING

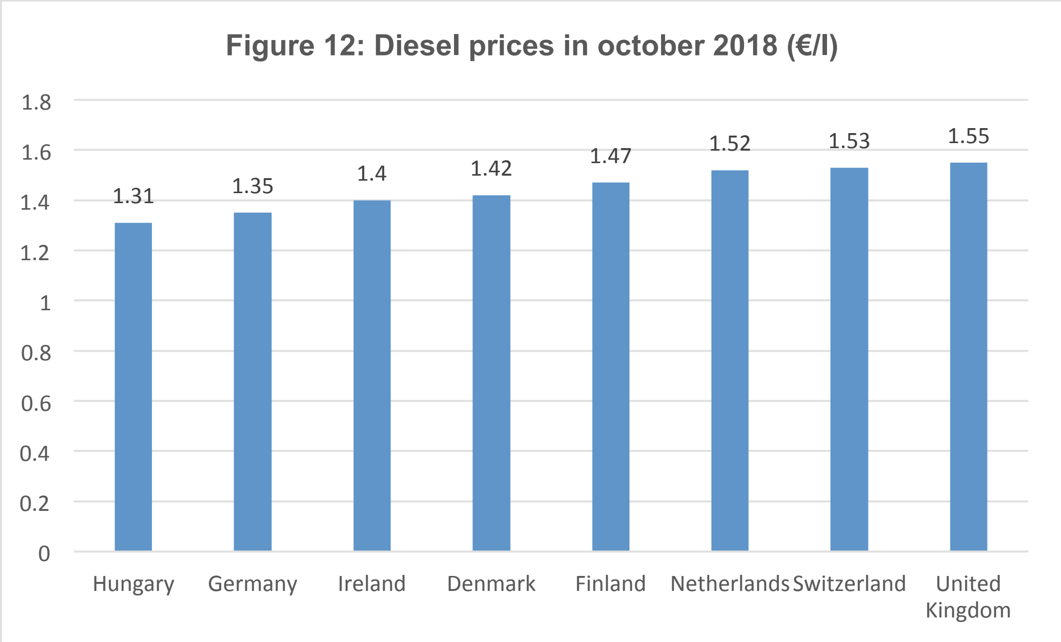
The elements presented above will have an influence on household energy bills. Indeed, according to the Eurostat website, the **price of energy** in Europe depends on a mix of conditions. The geopolitical situation, the national energy mix, import diversification, network costs, environmental protection costs, weather conditions, or levels of excise and taxation are all elements influencing on the energy bill of households. In 2017, the electricity prices for household consumers average was 20 cents of Euro per kWh in the European Union (21 in the European area). Natural gas for household consumers was of 6 cents per kWh (7 in the European area). The figure below presents **natural gas** prices for household consumers in 2017 in the countries under study. Data for **Finland** is not available, as this resource is rarely used. The highest prices are in **Denmark** (prices vary within the country) and **Switzerland**. In **Denmark**, natural gas is relatively widespread. After the 1970s oil crises, this country known as 'land of oil' shifted first to coal, and then progressively to integrated natural gas a principal resource. The lowest prices are in **Hungary** and in the **United Kingdom**. For the former, the Hungarian government has an explicit aim to keep household energy prices low. For the latter, gas prices have been increasing since the early 2000's in the UK, due to upward pressure on prices in Europe and the decline of UK Continental Shelf gas production, decreasing since 2014.

Figure 11: Natural gas prices for household consumers (€/kWh)



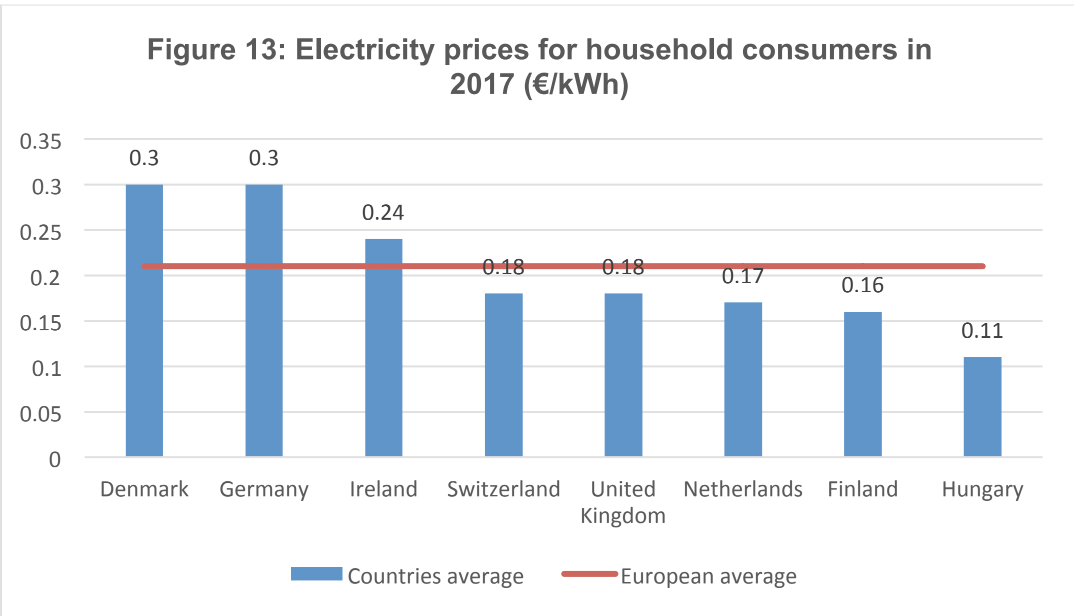
Source: Eurostat (first semester of 2018)

D2.5 Country Reports represent in various ways **oil** prices for household consumers. The figure below shows the price of diesel during October 2018. The **United Kingdom** and **Switzerland** are the most expensive countries in this domain, and **Hungary**, as with natural gas, is the country with the lowest prices.



Source: Fuel-prices-Europe (November 2018)

The **cost of electricity** may vary depending on the type of consumer (e.g. household, business, industry), the time of consumption (where day or night rates apply) and the type of the band (kWh capacity). The figure below presents electricity prices for consumers during the second semester of 2017 according to Eurostat[8]. In **Germany and Denmark**, where systems are mostly operated by private energy companies, the prices are the highest with more than 30 cents per kWh. **Ireland** is also over the European average of 22 cents. In the **United Kingdom**, prices have generally been on a rising trend as imported gas has become an important part of the country energy mix.

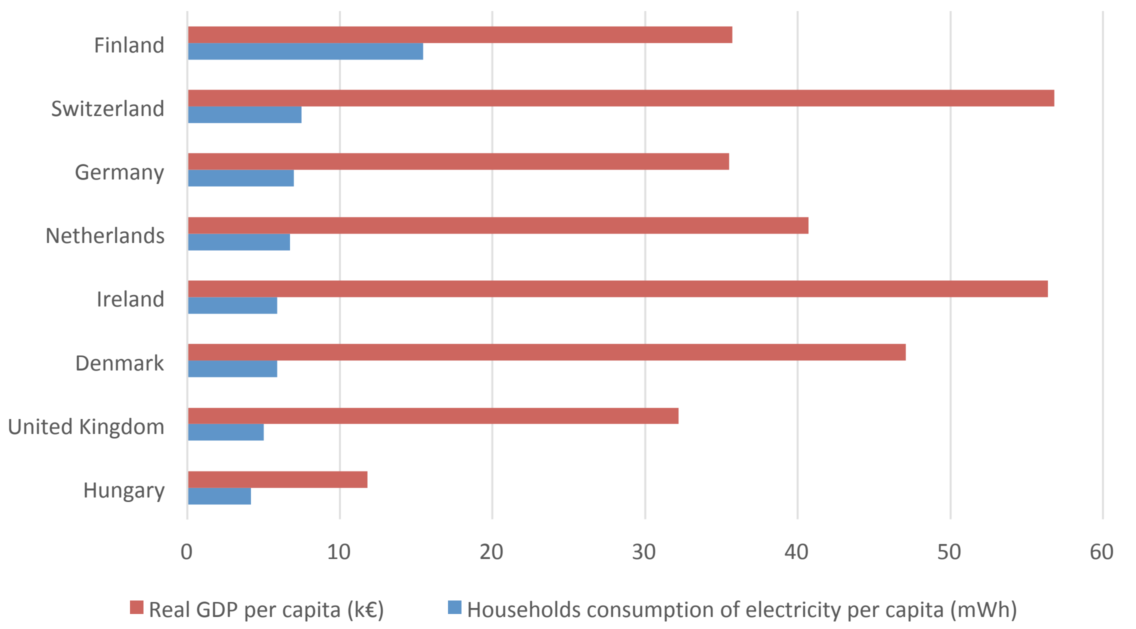


Source: Eurostat (first semester of 2018)

[8] Except for Switzerland where the price is based on D2.5 Country Reports

If we compare the prices of some of the energy sources above (natural gas, diesel and electricity), **Hungary** has the lowest range of prices in every category, which seems logical since the country is also the one with the lowest GDP per capita. Yet, beside this constant, there are some significant differences between the ranking of these countries, depending on the resource in question. These variations are of course related to the living standards of these various states, but also to the availability of the resource within their boundaries or the price it costs to import it. For instance, **Switzerland** is characterized by high prices when it comes to diesel or natural gas – since there are no gas and oil sources in the country – however, the prices of electricity are in the lower range, a situation that could be explained by the important hydroelectric resources present in this mountainous region. In contrast, electricity costs more in **Germany** than almost anywhere else in Europe, a situation associated with the country's attempt to transition from fossil fuels and nuclear energy to more renewable energy sources. This transition is importantly funded by high taxes on energy companies, as in the case of **Denmark**, which is also among the most expensive countries in terms of household electricity.

Figure 14: Real GDP and households electricity consumption



Source: International Energy Agency (2016) and the World Bank (2018)

Fuel subsidies also have a role to play on the cost of energy, as do social subsidies indirectly – in that they can provide support for people in need. Framing household's energy practices by suggesting that sustainable behaviours can be financially beneficial is seen to increase acceptance and adoption of sustainable consumption practices. **Denmark** had a tradition of offering various subsidies, for instance for the installation of solar panels and the replacement of oil burners with heat pumps. Moreover, many subsidies were given in buildings construction and renovation for thermal insulation and double-glazing. However, the Danish right-wing political government tends to currently remove subsidies to households and concentrate on energy savings in business, implying cuts in subsidies to home-renovations. In the **Netherlands,** the national government offers subsidies for heat pumps, biomass, wood pellet or solar thermal heating systems for households, and since 2017, also to municipalities, provinces and public bodies. While there are currently no more subsides for solar panels, energy cooperatives can still profit from tax exemption schemes. The Dutch cooperative sector is undergoing remarkable developments in this sector. In 2017, 100 new solar cooperatives have been established, beneficing of a national tax exemption scheme, and leading to an increase of 53% compared to 2016. In **Germany,** the government also supports energy efficiency of the housing stock: The Federal Development Bank finances the construction of energy-efficient buildings and provides subsidies for energy-related refurbishment. Since 2011, the **UK** government provides a set of financial incentives to encourage the deployment of renewable energies. Important bill reductions for households are also offered to increase the use of smart metering and technology for monitoring energy consumption. **Hungary** provides soft loans for energy efficiency improvements, both for the household and the SME sectors. Furthermore, refurbishment of buildings has gained attention lately: small financial support has been available, even though they have been recently stopped due to general budget cuts.

Several specific campaigns targeting household energy practices have also been promoted this last decade, often based on financial mechanisms. The **German** government's largest current campaign is the *'Deutschland macht's effizient'* initiative focusing primarily on energy efficiency by offering information, consultations and financial incentives in the form of grant aid for households, companies and municipalities who undertake to improve their energy efficiency. In the **Netherlands,** the 'energy efficiency you do now' programme provides cheap loans for energy efficiency renovations to private home owners and associations of apartment owners. Finally, the **Hungarian** government has recently launched the programme 'Modern Cities' that also provides funding for energy-related developments.

The price of energy can influence consumers but is not sufficient in itself to explain energy usage. The cost of energy must be placed in relation to revenues and other household expenditures. The **United Kingdom and Hungary** are facing particularly important challenges in terms of price and access to energy; it is estimated that fuel poverty affects over 15% of British households (approximately 4 million) and 21% of the Hungarian population (Fülöp and Lehoczki-Krsjak, 2014) On the contrary, **Switzerland**, with a relatively high buying power and low prices of electricity, (compared to healthcare costs for example) uses an important amount of electric heating. In **Germany**, with higher prices of electricity, a lower amount of expensive electric heating is used. More generally, the figure below shows that **Finland** (and to a lesser extent **Switzerland**), with relatively low prices in terms of household electricity, is by far the country with the highest household electricity consumption. In this Nordic state, concerns about electricity costs are thus limited to people with direct electric heating, mostly outside the large cities.

4.6 SMART TECHNOLOGIES IN THE HOME

Whether used to regulate a building's indoor thermal climate, provide time-sensitive information on energy supply and demand, or anticipate a household's needs in relation to the different domains of everyday life, smart technologies are often touted as a solution towards improved energy usage, along with the promise of providing modern, comfortable homes with a year-long consistent indoor temperature (Wilhite, 2017). However, the smart home does not always deliver the expected energy savings: several authors link smart technologies to the notion of performance gap (Gram-Hanssen and Georg 2017; Shove, 2003; Wilhite, 2017), whereby anticipated energy savings are not achieved because of the actual building usage (Gram-Hanssen and Georg, 2018). In addition, smart systems have been criticized in the literature because they can affect the perceived control on the thermal environment, for example, with more satisfaction when users feel they can control energy systems directly (Karjalainen, 2009). For Wilhite, smart technologies are ‘doomed to fail’ if they don't take the users’ preferences and thermal management knowledge, if they don’t give the users a real ‘active engagement’ (2017: 69). While researchers and practitioners remain optimistic about the opportunities provided by smart homes, Costanza et al.’s study “suggests that no computational model or smart agent can fully cover the complexity and spontaneity of everyday routines” (2014: 821). They conclude by suggesting that: “A particular balance that will need to be struck is between the grid’s need for fixed and optimal energy demand and users’ desire for flexible and convenient energy consumption” (ibid).

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