ENCHANT
Energy Efficiency through behaviour Change Transition Strategies

ENERGY EFFICIENCY THROUGH BEHAVIOUR CHANGE TRANSITION STRATEGIES

Literature review on energy-related behavioural interventions

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ABSTRACT

This report is an internal working document for the ENCHANT project and describes the research activities relayed to project task T2.1 and analyses previous studies, research projects and practical interventions where psychological science and behavioral insights have been applied to stimulate behavioural change in the domain of energy choices and sustainable lifestyles in general. This document reviews published studies, systematic reviews, and meta-analyses useful to provide a synthesis of this literature body. Our purpose was to identify and discuss the good and bad practices that might affect the efficacy and the success of practical interventions aimed at steering the behaviours of individuals, groups and communities in the direction of a sustainable energy transition, as well as the major contextual boundary conditions that are linked to more or less successful practices. The report is also an input to the design of the ensuing ENCHANT WP2 tasks and to WP3 AND WP4 activities.

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1. Introduction

1.1 Executive summary

This document reports on the activities related to the Task 2.1 included in the Work Package #2 of the H2020 EU-funded research project titled "ENCHANT" (G.A. N. 957115). As stated in the ENCHANT proposal, the Climate Pact that the new European Commission is driving forward is setting explicit and ambitious goals for deeply decarbonizing European lifestyles and economies.

Within this context, the objective of ENCHANT WP 2 is to "Identify key factors affecting intervention impact on energy behaviour". Our first endeavour here was thus to conduct a review of existing behavioural interventions, drawing on established findings from previous studies, research projects and practical interventions where psychological science and behavioural insights have been applied to the domain of energy choices and sustainable lifestyles in general. Along with this literature review, we also provide a short overview of the existing sustainable energy policies and initiatives in five different key countries of the ENCHANT project (Austria, Italy, Norway, Romania and Turkey).

Many studies identified different typologies of practical interventions in the energy conservation domain, based on established psychological science and theory, and on research protocols that can be assessed, adapted, implemented and replicated. The effect of different behavioural interventions on electricity consumption has been studied since the 1970s, with several reviews and analyses showing how interventions implemented in this field are often characterized by variable patterns of success and outcomes.

In particular, we focused here on seven different typologies of behavioural interventions to promote more sustainable energy choices at different individual, group or community levels, which are:

1. Feedback on own consumption
2. Social norms
3. Information including simplification
4. Monetary incentives
5. Commitment
6. Competition
7. Collective vs. individual framing

For each of these seven typologies, we provide a brief review of the main scientific results achieved so far and of the main gaps that still need to be filled to advance our knowledge. Because of the limits of many studies in this area, which are often based on small-scale pilots, an open issue for ENCHANT is to ascertain which intervention tools (either alone or combination with others) can be most effective in different contexts. As we show in this report, there is no "silver bullet" approach: each intervention types have both strengths and weaknesses, although some interventions seem to be more promising than others. Furthermore, researchers and practitioners need also to pay attention to the possible unintended side effects or risks of behavioural interventions, such as avoidance, motivation crowding out, reactance, or negative emotions.

To find the best approach, interventions thus need to be thoroughly pre-tested prior to their large-scale roll out, which is one of the main practical goals that will be pursued in the remaining of the ENCHANT project.

1.2 Report scope

The aim of this document is to report on the activities related to the Task 2.1 included in the Work Package 2 of the H2020 EU-funded research project titled "ENCHANT" (G.A. N. 957115). As stated in the DOW, the main aim of the ENCHANT project is to help foster energy efficiency behaviour in current European society, by assessing a large-scale rollout of interventions informed by social, psychological and behavioural science. ENCHANT's overall objective is to affect energy behaviour in a more sustainable direction in European citizens and households under real-life conditions, thereby supporting international, national, regional, and local policies targeting the sustainable energy transition in Europe. To help authorities, organisations, public decision-makers and energy providers/suppliers in driving the process of a global sustainability transition, and to increase the impact, acceptance, and effectiveness of ambitious public policies in the energy domain, it is now conventionally accepted at the scientific and policy levels that behavioural change in real-life situations can be promoted and steered through behavioural insights that are capable to be easily understood and assimilated by the general public. Some also argue that energy-related behavioural interventions could be comparatively cheaper than structural interventions that require high upfront costs and can be highly risky in the mid-long-term, so that their the cost-impact ratio can be quite significant.

From a general point of view, it is usually assumed that the ability to improve energy-related behaviour is linked to the behavioural choices of users and to the specific conditions that facilitate people's willingness to accept sustainable energy policies and energy system changes. It is therefore important to consider the social and psychological factors driving a successful implementation of an energy transition process at the individual, community, and organizational level (e.g., Dumitru et al., 2016; Ruepert et al., 2018; Sarrica et al., 2014; 2016b; 2018).

Recently, Steg and colleagues proposed an overarching framework to understand the human dimensions of the sustainable energy transition (Abrahamse et al., 2005, Steg, 2008; Steg, Perlaviciute & van der Werff, 2015). Steg et al. (2015) argued that an integrated approach is essential in order to obtain a better understanding of the socio-psychological factors on the basis of sustainable energy behaviours, as well as the acceptability of distinctive energy policies and energy system changes. This integrated approach is the result of an in-depth review of the contribution of social and environmental psychology. These authors highlight the role of three main factors on the adoption of sustainable energy behaviours, such as *knowledge*, *motivations*, and *contextual factors*. In addition, they point out the importance of real-life contexts interventions, and try to identify the main characteristics of specific interventions aimed at promoting a sustainable energy transition.

Talking about *knowledge*, it is long known in psychological science that knowledge, per se, might not be enough to promote behavioural change. However, empirical evidence shows for example that people often have limited knowledge of the causes and consequences of climate change; furthermore, they often disregard the impact of human behaviour on global environmental modifications. According to this general framework, for example, the inadequate or incorrect information on the characteristics of different types of alternative energy sources and their effects on the environment can influence the evaluation of the pros and cons of energy alternatives that are available to the public. The limited influence of the knowledge factor has also been related to personal and collective motivations. In order for people to adopt more sustainable energy behaviours and engage in actions aimed at environmental sustainability, individual and group motivation needs to be supported. People also need to feel able to engage in sustainable energy behaviours by perceiving that the individual costs of their behaviours are relatively minor in relation to the benefits that can be obtained. Costs and benefits involve instrumental, affective, and social consequences of individual or collective choices related to sustainable energy use. Individual and collective motivational factors are also associated to the relation between people's self-identities and the promotion of pro-environmental behaviours. Indeed, many authors argued about the identity dimension of pro-environmental and sustainable energy choices (e.g., Fritsche et al., 2018), and various studies recently reported how people who engage in sustainable energy behaviours strengthen their image as pro-environmental individuals (e.g., Carrus et al., 2019b; Masson et al., 2017). In relation to this, it should also be noted that costly or uncommon pro-environmental behaviours seem to have a greater influence on a person's self-perception as an individual interested and involved in environmental sustainability issues.

Among the *motivational* factors, Steg et al. (2015) also put the accent on the role that values have on evaluations, beliefs, and actions and in general on the way in which people consider and evaluate the individual and collective consequences of their sustainable energy behaviours. In fact, although adequately informed about the environmental and social problems caused by their behaviour, about energy problems and about energy savings strategies, people might not necessarily translate such knowledge and awareness baggage into actual and coherent behavioural choices. An alternative to the traditional information-based approach is thus represented by the social influence approach, which is increasingly used to encourage pro-environmental behaviour change (e.g., Schultz et al., 2015). Strategies such as the block leaders' approach, commitments, or socially comparative feedback, may act more effectively on individuals' perception and the evaluation of the pros and cons of sustainable energy behaviour.

An energy transition process also depends on how *contextual factors* promote or hinder the adoption of sustainable energy behaviours. Contextual factors refer to environmental, social, political and economic constraints that may influence individual and collective decision-making processes, by defining costs and benefits and thus influencing motivations. In terms of public acceptability of interventions and changes in energy systems, it is also important to consider the role of local contexts or territorial characteristics where the opinions of citizens may take shape, also on the basis of previous life experiences. Hence, it is important to take into account the quality of the trust relationship between the community and local institutions or the perception of being involved in a transparent decision-making process (e.g., Sarrica et al., 2018b).

Reviewing which types of interventions are most effective for promoting a successful energy transition process, empirical evidence suggests that people might not be sufficiently motivated to act sustainably unless certain personal benefits are involved. External incentives (e.g., financial or subsidies and tax discounts, governments' regulations, or rules) have been so far among the most applied "structural" strategies to facilitate sustainable energy choices (we use the term "structural" here to designate "hard" monetary measures, such as taxes or incentives, as opposed to "soft" psychological solutions, such as social norms, knowledge or motivation). However, previous research points to the unstable effect of incentives for consistent sustainable energy choices. In particular, the positive effects of financial incentives to promote ecological behaviour often fades as soon as incentives are removed. If such kinds of structural policy strategies appear to have an unstable effect in determining long-term behavioural changes, it is important to understand which strategies are more capable to strengthen the intrinsic motivation to engage in sustainable energy behaviours.

Considering the current scientific debate on the human dimensions of sustainable energy transition process, summarized in the above paragraphs, it is arguable that this process will imply fundamental and large-scale changes in human perceptions, preferences, and behaviour. Therefore, it is essential to understand how to motivate and enable people to actively contribute to a sustainable energy transition, not only from the perspective of the single individual or consumer, but also from the wider perspective of institutions, collective bodies, and formal social units (e.g., Tiberio et al., 2020).

As stated in the ENCHANT proposal, the Climate Pact that the new European Commission is driving forward is setting explicit and ambitious goals for deeply decarbonizing European lifestyles and economies (see for example, https://ec.europa.eu/clima/policies/strategies/2050_en). To reach these goals, any step that might help the sustainable energy transition and contribute for the global aim of reducing the carbon emissions related to energy production, as well as for reducing energy demand in daily life settings, need to be fully exploited. In the ENCHANT project, we focus specifically on private energy consumption, at the individual and households' levels. Following commonly accepted estimates, like Eurostat (see for example https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_consumption_in_households#Energy_products_used_in_the_residential_sector), private households are responsible for 27% of all primary energy use, not including energy embedded in products and services consumed by households. This makes energy efficiency improvements in households an important target for interventions, at a broad societal level.

As a first step to pursue such an overall aim, the objective of WP 2 is to "Identify key factors affecting intervention impact on energy behaviour". To reach such a goal, our first endeavour is to "analyse the existing literature" (T2.1) in the domain of social and behavioural science, in order to conduct a comprehensive review of existing behavioural interventions, drawing on established findings from previous studies, research projects and practical interventions where psychological science and behavioural insights have been, with different degrees of success and different short-term and long-term outcomes, applied to stimulate behavioural change in the domain of energy choices and sustainable lifestyles in general.

Therefore, in line with the overall stated goals of ENCHANT, in the early phases of the project (and of WP2 in particular), we analysed published studies, systematic reviews and meta-analyses, that were identified as useful to provide a synthesis of this literature body. In reviewing this broad corpus of studies, our purpose is also to identify and discuss the good and bad practices that might affect the efficacy and the success of practical interventions aimed at steering the behaviours of individuals, groups, and communities in the direction of a sustainable energy transition, as well as the major contextual boundary conditions that are linked to more or less successful practices.

While recognizing the relevant progress and achievements that social and behavioural science has made in developing interventions tools and programmes aimed at improving private energy efficiency in real life settings, it must also be acknowledged that a great deal of studies in this area are based on small-scale pilot studies. How to reach a measurable effect on the European scale, the applicability of such programs in real-life, cost-efficient, and practical settings is still an open issue. Thus, in ENCHANT, one of the most important questions to answer is which intervention tools (or which combinations of these) can be most effectively implemented, by which societal actor, in which cultural context.

The remaining of this report, thus, reviews and systematises the existing theoretical models, empirical data, and best practices information about the implementation of behavioural and psychological interventions aiming to steer and change human behaviours in relation to sustainable energy choices. We will identify and review existing knowledge about psychological, social, and contextual drivers of energy choices and sustainable energy lifestyles in the European society, as well as how these factors can be more effectively addressed in practical interventions that have been, or may be, implemented and scaled up. We will provide an overview of what has been identified as most commonly used science-based behavioural intervention techniques to promote the sustainable energy transition among the general public.

Before presenting a summary of our literature review, in the next paragraph we will also briefly present an overview of the current situation that characterizes the existing sustainable energy policies and initiatives in five different key countries of the ENCHANT project, Austria, Italy, Norway, Romania and Turkey.

1.3 General context of energy-related interventions in key ENCHANT countries

Austria

Austria's national climate and energy strategy focuses on reaching the three core energy policy goals of the European Union as agreed in the Paris Agreement and more recently the Clean Energy for all Europeans legislation. Currently, the implementation of this package of regulations and directives is an ongoing process in Austria, planned to be completed in 2021. It aims at providing the political and regulatory framework necessary to reach Austria's ambitious 2030 goals. These are a reduction of GHG emissions in the non-ETS sectors of 36% (compared to 2005 levels), a share of renewable energy in gross final energy consumption of 46-50% and to generate 100% of electricity consumption from renewables. Concerning energy efficiency, the goal is to improve primary energy intensity by 25-30% compared to 2015 levels (BMNT, 2019). Today, Austria's overall energy consumption is split between the transport sector, which accounts for 36% of the national final energy demand, followed by industry with a share of 27%, the residential sector with a share of 25%, the service sector with 10% and agriculture with a 2% share (Statistik Austria, 2020). Meeting the GHG reduction, renewables, and energy efficiency goals is built on a strategy that targets all of these sectors, which is challenging as Austria's gross final energy consumption has increased by nearly 3% since 2015. Most recent data (comparison of 2019 and 2018) show that energy consumption in transport and the residential sector both increased by 2% and energy use in the services sector increased by 3%. Only in the industrial sector, a reduction of demand by 2% was realized. Looking at the composition of the total final energy consumption, no significant changes of the share of renewables and electricity is observed, while coal-based energy sources, natural gas and district heating increased by 1% each. Also, the use of petroleum products increased by +2% (Statistik Austria, 2020).

When it comes to the share of renewables in the energy mix, Austria has nearly reached its goals laid down in the Renewable Energy Directive (2009/28/EC) of 34% of renewables in gross final energy consumption, with a current share of 33.4% in 2018, translating into an increase of 11% as compared to 2005. In the transport sector, road transport accounts for 86% of the sector's total consumption and demand has constantly and significantly increased in the past decades. Since 1990, final energy demand has nearly doubled; since 2015, the increase amounts to 8%. This development is driven by a doubling of the demand for road transport and a near tripling of demand for air transport since 1990 (Statistik Austria, 2020). Consequently, the transport sector is a key aspect in Austria's national climate and energy strategy and three flagship projects are prioritized in this sector:

1) increase the efficiency of goods transport logistics;
2) strengthen public rail transport;
3) impose a comprehensive e-mobility plan.

To facilitate these projects, a bundle of measures is to be implemented, ranging from increasing the share of renewables in the fuel sector to a reform of the tax regime to provide price incentives for vehicles with low CO_2-emissions. Public rail transport is to be expanded, especially between the capitals of Austria's nine federal states, and the trans-European goods transports is to be facilitated by finalizing several key tunnel projects to allow better transport links. Further measures focus on local and regional public transport services, including cycling and walking masterplans, as well as on fostering e-mobility (vehicles and bikes) by providing subsidies, tax benefits and a nationwide charging infrastructure (BMNT, 2019). In comparison to the transport sector, the final energy demand of the residential sector has increased at a much slower pace and is currently 15% above the 1990 values and 1% above the 2015 value.

The energy mix in the residential sector shows that biogenic energy sources are in the lead with 24%, followed by natural gas (22%), electricity (22%), oil (15%), district heating (12%), renewables with 4% and coal (<1%) (Statistik Austria, 2020).

In the current national climate and energy strategy, several planned flagship projects target the residential sector. First among them is the thermal renovation of buildings, which has been a key policy goal in the past decades. In Austria, about 50% of all buildings (residential and others) were constructed before 1970 and many of them have a significant energy savings potential by either being fully or partly renovated (Statistik Austria, 2020a). Related to the thermal quality of existing buildings and the living quality in newly built buildings is the heating technology used. Here, the flagship project focuses on supporting renewable heating solutions by providing funding for the replacement of old, fossil-fuel based systems and subsidies for heating systems in new buildings. Thirdly, Austria aims at significantly increasing electricity generation from renewable sources, most notably from photovoltaic plants. The Austrian government set a goal of equipping 1 million roofs with photovoltaics and proposed several measures to facilitate this goal, from reducing bureaucratic hurdles to simplifying grid access for small PV plants (Bundeskanzleramt, 2020).

In addition to what is reported above, it is also important to emphasize that Austria’s national Climate and Energy plan acknowledged the need for education and awareness raising measures and aims at implementing related activities in school curricula and training activities (BMNT, 2019).

Finally, it is useful to mention energy efficiency policy in Austria. The Energy Efficiency Directive (EU/2018/2002), which is part of the "Clean Energy for All Europeans'' legislative package, was implemented in Austria, amongst others, with the Energieeffizienzgesetz (EEffG, Energy Efficiency Law). This law demands stringent energy savings that are to be achieved by a combination of strategic measures set by the government (regulations, subsidies, taxation, etc) and an Energy efficiency obligation scheme (in accordance with Article 7 of the Energy Efficiency Directive). In Austria, the obligated parties responsible for fulfilling these savings are energy distributors and they must set energy efficiency measures that lead to a yearly reduction of 0.6% of their overall energy sales of the previous year. The most recent monitoring report shows that 30% of all energy savings were achieved by energy taxes, followed by measures related to heating and warm water preparation technologies (22%), individual measures (13%) as well as measures related to the renovation of buildings (13%). Further categories include mobility measures (11%), more efficient electricity generation (5%) and lighting (4%). Current predictions show that these measures will allow Austria to reach the 2020 target of cumulated energy savings of 310 PJ (Monitoringstelle, 2019).

Italy

Energy efficiency plays a key role in Italy's energy transition path. During the year 2017, energy efficiency policies have been strengthened by facilitating the measures that have the best cost-effectiveness ratio in order to achieve the goal of 30% energy savings by 2030, compared to the expected consumption at that date. The energy demand is fairly stable and Italy's consumption levels are comparable to the first half of the 1990s, but with a different mix of energy sources. In 2016, fossil fuels covered about the 80% of primary energy demand compared to 94% in 1990, with an increasingly important contribution of natural gas in place of oil. The share of renewable sources is constantly growing: 16.8% in 2016, of which one third was solid biomass, followed by geothermal energy with 20.8% and hydroelectricity with 14.9% (in 1990 both covered over the 40% of renewable sources). The contribution of electricity also increased (2,1%) (Federci et al., 2020).

In 2016, the energy consumption of the residential sector was lower than the previous year. Increases in the consumption of natural gas and heat were seen, while there was a decrease in the consumption of electricity and wood. Other renewable sources grew by 5.3%, especially solar thermal, even if at present they only contribute marginally to the energy mix. Natural gas is the main source of energy: in 2016 it met more than 53% of the energy consumption in the sector, followed by wood and electricity.

In 2016, energy consumption of the transport sector was lower compared to 2015, continuing the decreasing trend that started in 2007 (with the exception of 2014). The main mode of transport is road transport (especially for freight), which accounted for about the 85% of the total sector use. In 2016, energy consumption decreased as compared to 2015, confirming the negative trend in recent years. In the period 2000-2016 the sectors that most contributed to the improvement of energy efficiency were industry and the residential sector. The former achieved the greatest increase, amounting to 20.7%. For the transport sector, the National Energy Strategy plan underlines the need to reduce the use of private mobility through measures aimed at encouraging a shift towards smart mobility and local public transport.

The residential sector achieved an energy efficiency gain of 10.7%, lower than the previous decade due to changes associated with living comfort. Finally, the transport sector has experienced the greatest difficulty in achieving energy efficiency gains, because freight transport is almost exclusively done on the road. Although railways, shipping and air navigation have seen significant gains in energy efficiency in recent years, they represent only the 15% of total transport to date.

To stimulate energy efficiency investments and achieve national energy savings targets, Italy adopts energy savings obligations - tradable certificates for energy savings such as white certificate and tax reliefs. A white certificate is an instrument issued by an authority or an authorised body providing a guarantee that a certain amount of energy savings has been achieved. Each certificate is a unique and traceable commodity that carries a property right over a certain amount of additional savings and guarantees that the benefit of these savings has not been accounted for elsewhere.

According to 9th Energy Efficiency Report released in 2020 by ENEA (The Italian National Agency for New Technologies, Energy and Sustainable Economic Development; www.enea.it), the Integrated National Plan for Energy and Climate (PNIEC), prepared in implementation of the Regulation (EU) 2018/1999, is a fundamental tool that marks the beginning of an important change in the energy and environmental policies of Italy towards the decarbonisation.

The general goal is to reach and overcome the EU objectives in terms of energy efficiency and security, use of renewable sources (RES), single energy market and competitiveness. More specific aims declared by the Agency refer to: acceleration of the decarbonisation process in the energy sector, considering 2030 as an intermediate stage and 2050 as a point of arrival, promotion of renewable energy consumption, involving the citizen and the enterprises in the energetic transformation process, promotion of the evolution of the energy system, in particularly in the electricity sector, based mainly on renewable sources, promotion of the electrification of consumption, particularly in the civil sector and in the transport sector, accompanying the evolution of the energy system with research and innovation activities, and continuing the system integration process of national energy in that of the Union.

The Plan is structured on 5 lines of intervention that will develop in an integrated way: decarbonisation (including renewables), energy efficiency, energy security, development of the internal energy market, and research, innovation, and competitiveness.

Italy intends to pursue an indicative target of reduction in consumption by 2030 equal to 43% of primary energy and 39.7% of the final energy compared to the referred scenario of 2007. For the absolute level of energy consumption up to 2030, Italy pursues a target of 125.1 Mtoe (Million Tonnes of Oil Equivalent) of primary energy and 103.8 Mtoe of final energy (Report INECP, 2019).

In particular, the residential sector contributes for 3.3 Mtoe at this contraction, while the tertiary sector reduces the projections of own consumption of 2.4 Mtoe, thanks to interventions of building requalification and installation of heat pumps, as well as a strong efficiency of end-use devices and with a commitment to gradual elimination of heating oil.

Another important contribution comes from the transport sector which, thanks to the displacement of private passenger mobility towards collective mobility and/or smart mobility, to a shift of freight transport from road to rail, and to increased levels of efficiency in private vehicles efficiency, manages to contribute approximately for 2.6 Mtoe to the gap between the two scenarios, by 2030.

The industrial sector would achieve a reduction in consumption of about 1.0 Mtoe, but not for this is to be considered a sector with few opportunities for intervention. With 0.935 Mtoe cumulated each year, it will reach a total of 51.4 Mtoe of final energy savings attributable to active measures or to measure that will be activated from 2021 to 2030.

Relevant data contained in the 2020 "9th Annual Report on Energy Efficiency" by ENEA, show that over €42 billion were invested in energy requalification interventions; in particular €3.5 billion in 2019, with an overall saving of approximately 17,700(?) GWh/year (Gigawatt hours per year), of which slightly over 1,250 GWh/year in 2019. This is the economic assessment of 13 years of so- called "eco-bonus" initiatives, a mechanism to incentivize energy efficiency in end uses introduced in 2007.

The data on the 2019 eco-bonus shows that last year, Italian families conducted over 395,000 energy efficiency refurbishing projects, mainly to replace windows (1.3 billion euros), install condensing boilers and heat pumps for winter heating (about 1 billion euros), insulating floors and walls (over 650 million euros), for deep renovation of buildings (231 million euro) and solar shading (133 million euros). Also, in 2019, around 600,000 projects were conducted with the "home bonus" (50% deduction for energy-improvement interventions in private houses) with an overall saving exceeding 840 GWh / year. These investments are quite significant if one considers that in Europe the building stock accounts for about 40% of total energy consumption and 36% of greenhouse gas emissions. Furthermore, thanks to this tax deduction and other incentives, in 2019, 250 million euros were saved in the national energy bill and over 2.9 million tons in CO_2 emissions.

As far as technological innovation is concerned, significant progress has been made in recent years: new buildings tend to consume about half the energy consumed by buildings built at the end of the 90s; however, it is estimated that by 2050, 75% of buildings will still be under-efficient. If the European Union wants to achieve its objectives of carbon neutrality, energy efficiency and renewable sources, the annual renewal rate of the building stock will have to double the current range between 0.4 and 1.2% in several Member States. This paradigm shift intersects with the trends in housing needs post COVID-19, which entail an actual redesign of spaces inside homes and workplaces, in the parallel pursuit of energy efficiency and environmental sustainability goals and of better health and well-being conditions for contemporary living. The potential increase in energy consumption at the level of households, due to the increased home-working related to the COVID-19 emergency is also an aspect that could be underlined here.

Norway

Hydropower accounts for most of Norwegian electricity supplies, and the resource base for production therefore depends heavily on precipitation. Norway's hydropower plants account for 96% of total installed capacity, and reservoir capacity corresponds to 70% of annual Norwegian electricity consumption. In 2018, the installed capacity of the Norwegian power supply system was 33,755 MW, and normal annual production was 141 TWh.

The Norwegian power system is closely integrated with the other Nordic systems, both in physical terms and through market integration. The Nordic market is in turn integrated with the rest of Europe through cross-border interconnectors. Integration with other countries' power systems, a well-developed power grid and the characteristics of hydropower production make Norway's power supply system flexible, reducing vulnerability to fluctuations in production between seasons and years (Energy Facts Norway, 2019).

The Norwegian Water Resources and Energy Directorate, (NVE; www.nve.no/english), has as its mandate to ensure an integrated and environmentally sound management of

Norway's water resources, as well as to promote efficient energy markets, cost-effective energy systems and contribute to efficient energy use. NVE bears an overall responsibility for maintaining national power supplies.

Everyone has access to reasonably priced electricity in Norway, which has led to electricity being used for energy-intensive production, as well as for heating buildings and water. Because such a large proportion of electricity is produced from renewable sources, greenhouse gas emissions associated with stationary energy use are low in Norway. However, Norway also uses considerable amounts of fossil fuels, particularly for transport, construction, and agricultural machinery.

While the level of electricity production varies with water inflow and wind conditions, consumption is affected by prices and fluctuates with temperature. The underlying situation in the Norwegian power supply system can be illustrated by comparing Norwegian production capacity in a normal year with electricity consumption corrected for temperature. Energy use is highest in the manufacturing and transport sectors, followed by services and households. Average electricity consumption in Norwegian dwellings is very high compared to the rest of Europe, with a slight decrease from 2000 to 2017 (Odyssee-Mure, 2020). Looking at the average energy consumption per dwelling, the numbers are still high, but lower than some countries. In addition, overall consumption has decreased noticeably from 2000 to 2017.

Norway's population has risen by 1 million inhabitants since 1990, to 5.3 million in 2020, and strong economic growth has resulted in a doubling of GDP since 1990. Both production of and demand for goods and services that use energy are growing steadily. However, final energy consumption has risen by only 16%, implying that the Norwegian economy is becoming gradually less energy-intensive (Energy Facts Norway, 2019).

Creating a sustainable energy system that is environmentally and climate-friendly, efficient, secure and facilitates value creation on the way to a low-emission society depends on facilitating policies. Laws and licensing regulations, research and development, market-based solutions, and grid regulations all rely on conditions in the market. The power market in Norway was deregulated in 1991, and subsequently integrated with the Swedish, Finnish and Danish market as one of the first common, transnational, power markets. The market is now a fundamental element in the Norwegian power supply (Bye and Hope, 2005).

Norway also takes part in the EU Emission Trading System (ETS), which also influences electricity prices in Norway through its efforts to raise the cost of fossil electricity production.

ENOVA (www.enova.no/om-enova) is a state-owned enterprise with a budget of between two and three billion NOK annually (ca. 200-300 millions EUR), with a mandate to create lasting changes in the supply and demand for efficient and renewable energy and climate solutions for companies as well as households. ENOVA is supposed to support the development and spread of energy- and climate-friendly solutions that the market alone does not produce.

In addition, energy requirements for buildings, energy labelling of buildings for sale or rent, guarantees of origin, electricity certificates, and similar initiatives are political instruments targeting energy consumption. These measures are developed to take into account considerations such as good resource management, security of supply, environment, value creation, efficient production, transfer and use of energy, as well as public ownership of water resources.

Romania

Romania is a country with a diverse primary energy mix with 27% natural gas, 32.6% crude oil, 15% coal, 15% hydropower, solar and nuclear energy together in 2019 (Draft Strategy 2019). Based on a prediction model applied to the 2016 situation, it was assumed that by applying a balanced set of interventions, by 2030 the following trend will take place: a reduction of gas in the national fuel mix, a slight growth of crude oil and a much higher growth of coal, combined with an increase of both renewable and nuclear energy. This pattern might seem unusual in comparison to other countries. However, this is mainly due to the transport sector. As it is assumed to increase in consumption during the coming years, Romania has a slower policy towards electric transition. A serious transition will only happen after 2030. The current estimate on the mix is for 2030. Despite being considered to be the transition fuel, gas will go down due to reduced household consumption, given market liberalization and refurbishing programmes in view. Renewables are also expected to increase mainly due to wind power (MEEMA, 2019; Figure 1 Appendix B).

From a final energy consumption perspective, Romania's domestic sector is the main energy consumer, followed by industry, transport, and other economic sectors. The energy consumption of a household is determined by two main types of needs: heating (and cooking) and just marginally by cooling, lighting and electricity required to power domestic appliances. In Romania 47% of households use solid fuel, mainly wood (95%), 33% heat up with natural gas, 17% are apartments which are supplied from district heating. A minority heats up with either liquid fuel or electricity. Wood is mainly used in rural areas (80% of rural households) (MEEMA, 2019).

In the long run, and based on the current state of affairs, the residential consumption is expected to slightly decrease, possibly based on the increase in energy efficiency in buildings, and increased use of more efficient household appliances given the rise in welfare and the application of appliance scrapping programmes. Higher household income will also give rise to an increased migration from gas and other fossil fuel appliances to electrical equipment. The reduction of heating and cooling-based consumption is only achievable by means of the transposition of the currently under-implemented EU legislation on building quality, and of the energy price mechanisms due to energy market liberalisation, which will call for higher energy savings. More far-reaching decarbonisation programs will involve greater efforts to increase the energy efficiency of the household sector, with implicitly better consumption results. However, this narrative will be influenced by the Romanian legislative inflexibility and by the evolution of Romanian consumers' real purchasing power (Sinea et al, 2018). Despite efforts to improve energy efficiency in 2015 energy intensity was still 75% higher than the average European scores mainly due to industry. A prospective analysis based on the current state of affairs indicates a 30% reduction in energy intensity by 2030 to a level of still 65% higher than the European average (MEEMA, 2019; Figure 2 and 3 in Appendix B).

Referring to progressive and prospective application of energy efficiency improvement measures, initially, before joining the EU (beginning with the year 2000), the most relevant energy efficiency programmes in Romania were related to the obligations under the Energy Charter Treaty, and they consisted of obligations for energy producers, operators, transporters, and important energy consumers to implement energy efficient technologies, especially RES. Further obligations were related to conformity assessments on these technologies, reporting to authorities on energy efficiency and consumption at various time intervals, depending on the level of energy consumed. Energy balance sheets, energy efficiency programmes and the appointment of certified energy managers with the aim of overviewing energy efficiency were compulsory for large consumers. Medium-large transport companies had to monitor their fuel consumption, whereas public administrations had to implement measures for an efficient use of heating/cooling, acquire devices to measure consumption, use energy efficient materials and elaborate energy balance sheets every five-years for buildings with floor areas over 1000 sqm (Parlamentul Românei, 2000).

At a later stage, with the accession to the EU, energy efficiency legislation started implementing EU standards. In 2008, green energy certificates and mandatory quotas were introduced, mainly with an impact in industry and transport, whereas the frequency of data published on energy consumption was increased and made public. Various facilities were introduced for energy efficient consumers and implementers of new technologies: access to competitive loans, tax exemptions, access to infrastructure to new investment projects, etc. (Guvernul României, 2008).

In 2014, the elaboration of a national strategy on the renovation of residential and commercial buildings was legislated imposing an annual renovation pace of 3% for public buildings and energy efficiency in public procurement. Energy auditors started to be trained, standards for buildings and vehicles were issued, the system of energy labelling of products was rolled out, and more strict regulations of end-users were developed. A roll-out of individual meters took place especially in multifamily buildings, whereas legislation provided for free billing which was based on real consumption. The department for energy efficiency was made responsible with consumer education and with issuing policy instruments that would improve energy consumption (financial incentives, access to financial, grants or subsidies, pilot projects, information campaigns, etc.) (Guvernul României, 2014). In 2016, energy audits were made compulsory for economic operators and smart metering was increasingly regulated (including the concept of prosumers). Smart metering rollout was provided for, in areas where it was financially and technically possible (Parlamentul României, 2016).

Having had various strategic approaches to energy before, it was in 2016 that Romania issued the most consistent draft for a national energy strategy. It is important to note that the draft energy strategy, despite being issued at a regular pace, and widely embraced institutionally and politically, has never been adopted, mainly due to political reasons.

Additionally, a guiding instrument for energy policy is the National Energy and Climate Plan (NECP).

In the national energy strategy, energy efficiency was being recognised as the most important source of energy, due to its high climate and energy security impact. The most important need of improvement was identified to be in industry (through high investment technological change), however, changes here are expected to take place at a slower pace due to high investments needs. Faster potential improvement is identified mainly in buildings (residential and non-residential). Transport is also spotted to be an important source of energy-efficiency improvement (MEEMA, 2019). As a part of the NECP, Romania avoids implementing compulsory energy efficiency schemes due to their high economic costs and opts for "alternative policies". These alternative policies (described below, with a number of examples on implemented programmes) aim at over 40% reduction in final energy consumption and 45% reduction in primary energy consumption (NECP, 2020).

In the residential sector, where the heating activity is recognised to be the main consumer, the purchasing power of the population and some cultural aspects related to energy consumption behaviour are recognised to be important factors, given the fact that, for instance, more than 50% of the households are being partially heated in winter. Improvements in the housing sector are exclusively related to retrofitting and updating of heating technology, and the connection of various localities to gas distribution networks, the installation of gas boilers and heat pumps or the use of more efficient biomass solutions as opposed to the less efficient wood ovens, which are widespread. The change is however expected to happen at a slower pace. The adoption of new eco-design technologies is expected to result in reduced consumption in cooking, heating, lightning, and the use of household appliances. The strategy presumed that energy price increases due to market liberalisation and wood market regulation may induce an improvement of energy efficiency in residential buildings. In order to improve energy efficiency, the national draft energy strategy of 2019, recommends as a financial means the increased absorption of dedicated European funds. Various funds were used in urban centers to purchase energy efficient (including electric) public transportation vehicles, and improve the standards of existing ones (MEEMA, 2019).

Based on these assumptions, various refurbishment programmes have been adopted over time (2006-2018), with various financing schemes (national-local-individual contributions). These were mainly oriented towards socialist-era blocks of flats in urban areas (while prioritising those that had the greatest energy efficiency improvement potential), with an increasingly integrated urban development perspective. Funding was primarily directed towards administrative units that had local strategies for CO_2 reduction and sustainability action plans (ANRE, 2019). In 2019, Romania energy efficiency-related refurbishments have only been performed on 5% of apartment buildings in total (MEEMA, 2019). With regard to household amenities, a national scrapping programme was launched in 2018, applied through retailers. The aim was to allow citizens to replace used electrical and electronic appliances with more energy efficient ones. Based on the programme, citizens can purchase more efficient equipment by handing over used equipment, in exchange for vouchers. Labelling is generally applied to consumer goods. With regard to the mobility of consumers from the lease efficient wood technologies to the more efficient gas systems, the government enacted a programme in 2020 to extend the existing gas network and waived connection fees for all consumers (ANRE, 2019).

Non-residential buildings interventions were mainly focused on administrative buildings, which involved the inventory of government buildings with their consumption data attached and various criteria on rehabilitation quota, nearly zero energy buildings (NZEB) conditionality on new buildings and the energy efficiency criteria in public procurement. Public schools were rehabilitated under various financing programmes. All the above programmes were run under some combination of EU funding, or Swiss funding and national, local public sources. They were extended to include the extension and modernisation of public urban lightning in various urban centres (ANRE, 2019).

With a future prospective, the NECP identifies further actions aimed at energy efficiency improvement in the buildings sector: Inventory and evaluation of the building stock and the development of associated databases, the continuation of thermal insulation programmes with a special focus on energy poor households, the implementation of educational and energy consumption advice programmes, the increase role of NGOs and individual public leadership in generating energy efficiency, increased access to sustainability loans, more widely implementation of the prosumer concept, the regulation of the renting and real estate market with energy efficiency conditions, minimum standards for buildings and heating, ventilation and air conditioning (HVAC) renovation, energy system digitalisation and demand-response system, implementation of energy audits in the tertiary sector, etc. (NECP, 2020).

In the transport sector, the strategy focuses on the implementation of electromobility according to a phased development approach, passing through an initial transitional module of hybrid urban mobility with reduced electric capacity, to a second one focusing on the implementation of plug-in cars. The final and more important phase will focus on the implementation of pure electric mobility, in parallel with decreasing technological costs and improved emission standards of electricity production. 60% of cars are supposed to be electric powered by 2050, with the rest incorporating some electric propulsion (MEEMA, 2019). A wide application of an automobile scrapping programme, generically called "Rabla" (meaning "old car"), which was destined to cars older than 8 years, started being applied in 2017. A scrapping premium programme provided a voucher for the purchase of a new car based on certain emissions criteria. The programme was improved subsequently with increased incentives to encourage scrapping. From a more integrated urban perspective, transport was targeted through various local projects focused on urban regeneration aimed at improving non-motorised traffic (pedestrian and cyclist), urban reforestation and division between various modes of transport (ANRE, 2019). With a future perspective, the NECP identifies further actions aimed at energy efficiency improvement in the transportation sector, such as: continuation of the car fleet renewal programmes, electromobility, modernisation of public infrastructure including railways and the implementation of TEN-T, the implementation of digitalised and intelligent traffic and multimodal transportation (NECP, 2020).

In the industry sector, various initiatives are foreseen, such as: a wider implementation of decarbonation audits, deployment of new technologies and digitalisation, minimum standards for industrial processes where absent, and a wider and increased implementation of the concept of circular economy (NECP, 2020).

Turkey

Energy efficiency and savings, energy supply security, energy dependency, environmental protection and combat of climate change are fundamental components of Turkey's national strategy and energy policy for 2023. Currently, Turkey has an energy intensive economy. Total final energy consumption by sector in Turkey shows that industry has the largest share with 31.7 percent in 2018, followed by the transport sector with 27.1 percent, the residential sector with 20 percent, the commercial sector with 12.1 percent, the agriculture/forestry sector with 4.3 percent and the remaining in other sectors including fishing and non-energy use (IEA, 2020). Considering Turkey's primary energy consumption, oil has the largest share in 2019 with 31%, followed by coal with 26%, natural gas with 24%, hydropower with 12.2 percent and renewables with 6.3 percent (BP, 2020). Turkey's annual primary energy consumption reached 6.49 exajoules, increasing by 3.2% in 2019 compared to the previous year. Similarly, electricity generation increased by 1.2% to 308.5 TWh. The base scenario, as defined by the Turkish Ministry of Energy and Natural Resources, implies that annual electricity consumption is expected to increase by 4.3%, reaching 375.8 TWh in 2023 (Republic of Turkey Ministry of Energy and Natural Resources, 2020a). As of 2019, coal has the largest share in Turkey's electricity generation mix. In 2019, 37.1% of Turkey's electricity generation is obtained from coal, 29.8% from hydropower, 18.8% from natural gas, and 15 percent from other renewables (BP, 2020). The installed electricity generation capacity of the country reached 90.720 MW at the end of 2019. The breakdown of the installed capacity by resources is as follows: 31.4% hydropower, 28.6% natural gas, 22.4% coal, 8.1% wind, 6.2% solar energy, 1.6% geothermal, and 1.7% other resources (Republic of Turkey Ministry of Energy and Natural Resources, 2020a).

As an energy intensive economy and a country dependent on fuel imports, energy efficiency is considered as one of the key remedies in Turkey's national energy strategy. It is also a significant component of the projected sustainable energy transition in the country. Turkey aims to decrease energy intensity (energy consumed per national income) by at least 20% until 2023 compared to the energy intensity rates in 2011. To this end, Turkey's first energy efficiency action plan, which is the National Energy Efficiency Action Plan (2017-2023), entered into force in 2018. With the implementation of 55 actions planned in 6 different sectors, it is expected that a cumulative 23.9 Mtoe energy will be saved until 2023, along with a projected investment of 10.9 billion USD (YEGM, 2018). This saving corresponds to 14% reduction in Turkey's estimated primary energy consumption in 2023. The savings are further expected to reach 30.2 billion USD by 2033. The policies of Turkey's Ministry of Energy and Natural Resources for energy efficiency, energy savings, and environmental protection include national and international training programs (e.g. energy manager training programs and social project training programs), authorization and empowering of stakeholders (e.g. energy efficiency consultancy companies, universities and trade associations), measurement, monitoring and audit, energy efficiency supports and incentives (e.g. Efficiency Improvement Projects and Voluntary Agreements), promotion and awareness campaigns, national and international projects, planning and coordination of energy efficiency activities, and monitoring and training activities for Greenhouse Gas Emissions (Republic of Turkey Ministry of Energy and Natural Resources, 2020b).

Turkey's National Energy Efficiency Action Plan (NEEAP) aims to make the highest contribution to national prosperity, while utilizing energy and natural resources in the most efficient and environmental-friendly manner. In this sense, the Action Plan includes policies and projections in five different fields: buildings and services, industry and technology, energy, transport, and agriculture.

The buildings sector in Turkey has experienced a strong growth rate in recent years. The end-user energy consumption in Turkey was 19.5 Mtoe in 2000. Within a decade, this figure increased by 66%, going up to 32.4 Mtoe. The average annual increase for energy demand in the buildings sector is around 4.4%, and the sector's share in end-use energy consumption reached 32.8%, which exceeds the share of the industry (YEGM, 2018). As a response to rapidly rising energy demand of the buildings sector, specific targets were set for boosting energy efficiency and decreasing the energy consumption of the building sector in Turkey. Accordingly, the Climate Change Action Plan 2011-2023 provides several goals regarding energy efficiency and the share of renewable energy in electricity consumption (Republic of Turkey Ministry of Environment and Urbanization, 2011). Under the Action Plan, Energy Efficiency Strategy defines the relevant actions as follows: "introduce maximum energy requirements for buildings and limits for maximum emissions", "impose administrative sanctions on those which emit carbon dioxide at quantities above the legally defined limits", "reduce building energy demand and carbon emissions" and "scale up sustainable, environment-friendly buildings that use renewable energy resources" (YEGM, 2018). To achieve these goals, public and private sectors act cooperatively to improve buildings-based energy efficiency. The Regulation on Energy Performance for Buildings, as part of these strategies, necessitates obtaining at least C class Energy Performance Certificates in new buildings.

Energy costs constitute one of the heaviest burdens on enterprises and industry in Turkey. Therefore, improvement of energy efficiency, reduction of energy consumption, and acceleration of technological developments are of great importance for the industry. The Energy Efficiency Law provides requirements for industrial enterprises to implement energy efficiency audits and establish an organized management structure for energy (Republic of Turkey Ministry of Energy and Natural Resources, 2007). Besides, the investments for energy efficiency projects are expected to save energy by at least 20% translating into a simple payback period of 5 years or shorter. On the other hand, the Energy Efficiency Strategy aims to decrease energy densities at rates not to be less than 10% annually. To this end, measures and investments that promote energy efficiency play a key role.

Energy efficiency is also quite significant for the energy and transportation sectors of Turkey. Particularly, energy efficiency in the energy sector aims to reduce Turkey's total losses in transmission and distribution grids to 8%, which is above the OECD average (YEGM, 2018). In this sense, the Tenth Development Plan and National Energy Efficiency Action Plan introduce relevant actions to improve the sustainability of the energy sector and provide momentum for transformation into an energy-efficient sector in Turkey. Similarly, factors such as the growth of the transportation sector, increasing road transport related mainly to petroleum, energy supply security concerns as well as environmental, air and noise pollution in the environment, require a transformation in Turkey's transport sector. The share of the transportation sector in total final energy consumption was around 25% in 2018. For this reason, energy efficiency in Turkey's transportation sector is seen as essential. Road transport accounts for nearly 92% of the energy consumption in the transportation sector. Along this line, the Transport and Communications Strategy Goal 2023 has several targets such as increasing the share of railroad transport in freight transport beyond 15%, and in passenger transport beyond 10%, thereby reducing the share of road transport in freight transportation below 60%, and in passenger transportation below 72% by the end of 2023. These steps are expected to result in reduction of fossil fuel consumption, prevention of congestion-related fuel consumption in urban transport, and reduction of CO_2 emissions (Republic of Turkey Ministry of Energy and Natural Resources, 2019). Sustainable transportation principles, use of alternative fuels, implementation of clean car technologies as emphasized by National Intelligent Transport Systems Strategy (2014-2023) of the Ministry of Transport, Maritime Affairs and Communications also contribute to these objectives.

The National Energy Efficiency Action Plan also prioritizes energy efficiency improvements in Turkey's agriculture sector with principles and actions such as encouraging replacement of the old technology tractors and harvesters with energy-efficient alternatives, shifting to energy efficient irrigation methods, promoting renewable energy resources in agricultural production, utilizing the biomass potential, and supporting energy efficiency in the fisheries sector (YEGM, 2018).

2. Field experiments on energy-related behaviours: a review

2.1. Introduction

As shown by the brief overviews on current existing sustainable energy policies and initiatives across Europe, many countries involved in ENCHANT have set ambitious and comprehensive goals in the energy domain for the next decades, also in response to EU directives and policies. To reach these goals, it is crucial to obtain the participation and compliance of individuals and communities.

So far, we have restated the importance of considering and identifying the psycho-social dimensions that drive the promotion of sustainable behaviour in the field of energy saving. However, although the implementation of strategies and projects aimed at changing the behaviour of the final energy consumer is an urgent need in contemporary societies, the discontinuous and not immediate verifiability in the field of the results of these programs does not yet allow a solid measurability of the effects and the success of people's behavioural changes. Consequently, in the face of an ecological conscience that has firmly become part of the public opinion and significant investments in the field of environmental sustainability, important difficulties are still observed in strategically orienting individual motivations and behaviours, and in promoting their settling in daily practices that have a permanent and measurable impact on people's energy consumption behaviour. It is possible to state that in the field of energy saving, the provision at a social level of suitable infrastructures for the achievement of a certain behaviour or the development of incentive policies are interlinked with the intentions of people towards sustainability issues that, in turn, we have seen them be influenced by attitudes, social and affective factors and by habits established in the context of energy consumption.

Therefore, the study of the psycho-social dimensions linked to sustainable energy saving behaviours in real-life conditions, becomes a priority. In the same way, it is a priority on the one hand to support international, national, regional, and local policies in the process towards a global sustainability transition and on the other hand, to increase the impact, acceptance and effectiveness of ambitious public policies that currently share the assumption that behavioural change in many energy-saving domains can be promoted and steered through behavioural insights. Consequently, field experiments on energy-related behaviours have become a vibrant area of research in the social sciences, especially psychology (Schultz et al., 2007; Steinhorst et al., 2015; Leoniak & Cwalina, 2019) and economics (Allcott, 2011; Allcott & Rogers, 2014). Their growing popularity can be attributed to the fact that well-designed field experiments combine the methodological advantages of traditional lab experiments with the possibility to study people in their natural setting while they make naturally occurring choices, as opposed to the more artificial setting of the laboratory (Harrison & List, 2004).

A first step in this direction is to start from the analysis of existing data and research-based knowledge, to streamline and optimize the application of behavioural interventions in the field of energy saving. A number of researchers have investigated how pro-environmental behaviour patterns can be encouraged, suggesting different typologies of practical interventions based on established and verified psychological science and theory, and on research protocols that can be assessed, adapted, implemented and replicated.

The effect of different behavioural interventions on electricity consumption has been studied by researchers since the 1970s, and as such, several reviews and analyses have been undertaken whose results confirm how interventions aimed at encouraging pro-environmental behaviours have been widely implemented, but often with different degrees of success, diffusion and outcomes.

Delmas et al. (2013) conducted one of the first studies that quantify the potential of information-based strategies for energy conservation, and also provided insights into the relative effectiveness of different strategies for the design of energy saving programs. These authors analysed 59 studies published between 1975 and 2012 and compared the impact that different types of information strategies, such as savings tips, energy audits, different forms of energy use feedback, and monetary strategies, have on energy use in residential settings. Their meta-analysis is focused on experiments trying to lower overall consumption levels (energy conservation) as opposed to shifting usage in time from periods of high demand to off-peak periods (load shifting). Results from controlled experimental studies included in this meta-analysis show that strategies based on individualized audits/consulting and real-time feedbacks are comparatively more effective for conservation behaviour than strategies that provide historical or peer comparison energy feedback and pecuniary feedback. The authors also point out just how pecuniary feedback tends to lead to a relative increase in energy usage rather than induce conservation. An important suggestion that the authors offer is to consider the greater effectiveness of information delivered in person than information provided through other media such as mail or e-mail.

Abrahamse and Steg (2013) systematically reviewed 29 studies published between 1976 and 2016, focusing on social influence approaches used to encourage resource conservation and to promote change in people's pro-environmental behaviour. Through a meta-analytic approach, they analyse the effectiveness of six social influence approaches (social norms in information and feedback provision, block leaders and social networks, public commitment making, modelling, social comparison in feedback provision, and feedback provision about group performance), often used to encourage resource conservation. The authors conclude that interventions based on face-to-face interaction and social networks, such as block leaders, public commitment and modelling appeared to be most effective at reducing energy consumption compared to social norms. They find also that the use of a social influence approach is appropriate for groups where social interactions are more prevalent, such as employees and students.

Karlin et al. (2015) review 42 feedback studies from 1976 to 2010 and conclude that the feedback is an effective strategy for promoting energy conservation behaviour. Their results also show that feedback is most effective when it is combined with other behavioural interventions, such as goal-setting or external incentive interventions. In addition to that, effectiveness emerges when feedback provides goal-based comparisons, when it is given via a computer, and when it is given in either short-term or long-term, compared to medium-term.

In 2018, Andor and Fels performed a systematic review of the behavioural interventions reported in 44 studies from 1978 to 2017. Studies analysed the effect of social confrontations, engagement devices, goal setting and labelling on energy usage. In their meta-analysis, the authors include randomized controlled field trials that allow the identification of the causal relationship between the intervention and the outcome of interest. The authors conclude that social comparison strategies are the most effective in reducing energy consumption compared to engagement devices and goal setting. Furthermore, some crucial points are highlighted for future studies that lie in evaluating the causal effect of the intervention with an adequate methodology and a sufficiently powered sample, that enables the identification of even small effects with statistical precision.

The authors also recommend researchers to refrain from combining too many different incentives: in fact, evidence of the pure effect of a given intervention should be obtained before potentially starting to reinforce this effect with additional incentives. The long-term effects of the behavioural intervention should then be analysed and, by documenting the costs of the intervention, allow a cost-benefit analysis on the effectiveness of the treatment and its effectiveness compared to more traditional policy tools, such as taxes or bans.

More recently, Nisa et al. (2019) attempt to overcome some limitations of previous meta-analyses. From the authors' point of view, such limitations include estimating behavioural effects from self-reported beliefs, attitudes, or intentions, as well as combining estimates from observational and experimental study designs. These lead to problems regarding the assessment of the impact of interventions and guidelines and lead scholars and policy makers to erroneously use the available results as a basis for important predictions on the strategies for promoting and disseminating pro-environmental behaviours linked to energy consumption. Nisa and colleagues attempt to overcome these limitations by performing a large-scale meta-analysis strictly based on randomized controlled field trials, measuring actual changes in behaviour. Among the behaviours essential to mitigate climate change, the authors take account of domestic and individual behaviours, including the consumption of energy in the home. Through a meta-analysis of 83 randomized controlled trials, the authors conclude that the real challenge for researchers is to investigate voluntary behavioural changes in households and individuals. The results of this meta-analysis show that behavioural interventions promote climate change mitigation to a very small degree, while the intervention lasts with no evidence of sustained positive effects once the intervention ends. In general, household mitigation behaviours show a low behavioural plasticity. The intervention with the highest potential is based on nudges, a strategy that has been tested in a limited number of behaviours. Overall, the results of the meta-analysis by Nisa and colleagues underline that behavioural interventions, while no less effective than alternative strategies such as financial incentives or regulations, could certainly have stronger effects when used in combination with alternative strategies.

Bergquist et al. (2019) analyse 74 studies from 1982 to 2019 focusing on independent field-experiments aimed to assess the overall effect size of social norms in promoting pro-environmental behaviours. The authors conclude that there is clear empirical evidence that social norms-based interventions are a successful means to promote pro-environmental behavioural change. The authors conclude that there is clear empirical evidence that social norms-based interventions are effective means to promote pro-environmental behavioural change. The results also highlight that the influence of social norms is stronger when communicated implicitly (e.g., through the provision of environmental cues that signal the norm of reducing energy consumption, such as implied descriptive norms and situational norms)[6] compared to when communicated explicitly (e.g., through direct computerized messages). In addition, social norms are more influential in individualistic countries compared to collectivistic countries (contrary to the author's expectations) and in student samples compared to non-student samples.

Buckley (2020), in a recent meta-analysis, reviews 52 experimental studies published between 2005 and 2019, on the effect of three incentives' categories (monetary, informational and behavioural) and on the characteristics of experimental design on consumption of electricity in residential contexts. As Andor and colleagues (2018) stated a few years earlier, the results of this meta-analysis also underline some methodological gaps and the need for greater rigor in the implementation and reporting of the effects of incentives and behavioural interventions in the field of energy saving. Key findings indicate the validity of individual, real-time feedback and personalized advice on how to save electricity as incentives to promote energy-saving behaviours. Less effective are the feedback on the cost of electricity and general energy saving tips which lead to relative increases in consumption. Based on the results of the meta-analysis, the authors also offer guidelines for the implementation of interventions in favour of energy saving. From their point of view, it is important to provide families with detailed information on their energy consumption; in fact, it has been seen that if awareness of one's own consumption increases, families are inclined to reduce their consumption. In the same way, it would be appropriate to offer personalized consultancy services to the families as suggested also by Delmas et al. (2013). In general, generic advice on how to save electricity is less effective, and it actually seems to have the undesirable effect of increasing consumption.

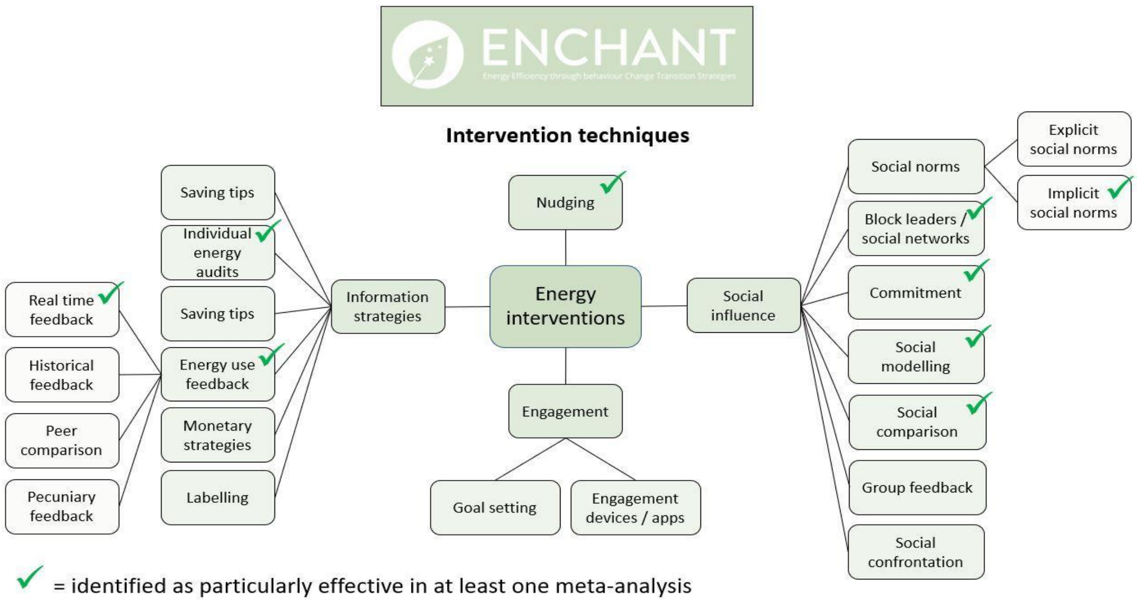


Figure A shows a summary of the technical interventions with particular reference to those interventions that in the literature are identified as particularly effective in at least one field experiment.

[6] This is the case of experiments showing that people may be more likely to turn off lights or computers when they find these already turned off.

To sum up, in this section we started from the importance that the psycho-social dimensions play in promoting sustainable behaviour in the field of energy saving, realizing that today there are still many obstacles and shortcomings in currently available knowledge, from a methodological, political, social and cultural nature. However, it remains imperative to continue to design and implement intense public policies to promote the behavioural change of the final energy consumer. On the basis of this approach, several authors, experts, and social scientists have begun to explore the methodological barriers and apparently negligible characteristics of interventions that once implemented in real life contexts can have substantial effects on individual behaviours. Research literature reports various reviews and insights on this topic, in which researchers such as social and environmental psychologists have tried to classify the effectiveness of the various strategies tested to promote virtuous behaviours in the field of energy saving, and the possible obstacles that can represent barriers to their success. On the basis of the results currently available in the literature, it is possible to state that there is a need to devise creative solutions, which should lead in the first place to fill some methodological gaps. It is important to identify to what extent a particular intervention — and that intervention alone — contributes to behavioural change, and how to implement behavioural change strategies measurable and lasting over time, as illustrated by the examples provided in figure A.

In the next sections, we provide a comprehensive review of a wide range of existing behavioural intervention typologies, drawing on established findings from previous projects and studies where psychological science and behavioural insights have been more or less successfully applied to stimulate behavioural change in the domain of energy choices and sustainable lifestyles in general.

In particular, following up the brief state-of-the art review that we highlighted in the ENCHANT project proposal, we will focus in this report on seven different typologies of behavioural interventions that can be (and has been) used to promote more sustainable energy choices at different individual, group or community levels, which are:

1. Feedback on own consumption
2. Social norms
3. Information including Simplification
4. Monetary incentives
5. Commitment
6. Competition
7. Collective vs. individual framing

For each of these seven typologies we will provide a brief review of the main scientific results achieved so far and of the main gaps that still need to be filled to advance future research and interventions. Table 1 below provides an overview of the main outcomes that emerged, for each of the seven intervention typologies, from the above referred comprehensive meta-analyses and systematic reviews.

Table 1: overview of the main conclusions of the Meta-analyses and systematic reviews for each of the seven interventions typologies. The number of + and - signs indicates the efficacy (or inefficacy) of the intervention types, as emerged across the studies. Empty cells indicate not tested strategies in the respective study.

Intervention types	Comprehensive Studies						
	Delmas et al. (2013)	Abrahamse & Steg (2013)	Karlin et al. (2015)	Andor & Fels (2018)	Nisa et al. (2019)	Bergquist et al. (2019)	Buckley (2020)
Feedback on consumption	+++	++	++				++
Social norms	+	+		++	+	++	+
Information	++			+++	+		++
Monetary incentives							++
Commitment		+++		++	++		
Competition							
Collect. vs. Indiv. framing							

2.2.Feedback on own consumption

A common element of many interventions is that they also provide feedback on the target's own energy consumption (see Delmas et al., 2013). For example, in Allcott (2011), Ayres et al. (2013) and Costa & Kahn (2013), feedback on own consumption is accompanied by social norm feedback and energy saving tips, leading to a decreased in energy consumption by 1% to 2%, potentially saving 110 million kWh per year if feedback is provided to all of the utility's customers.

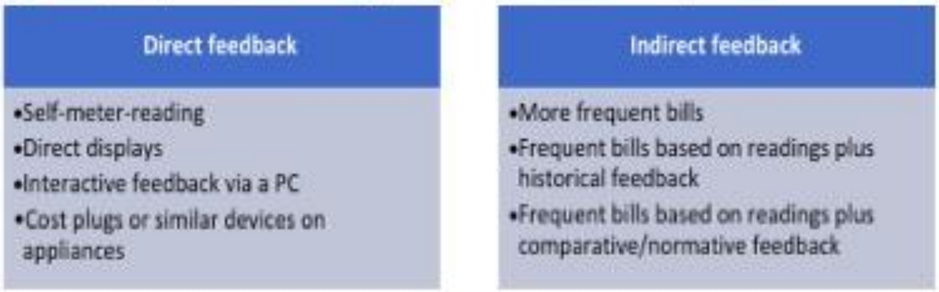
BOX 1: Hands-on example of a Feedback on own consumption

According to the definition in the oxford English dictionary adopted from Darby (2006), feedback is represented by information about the result of a process or action that can be used in modification or control of a process or system, especially by noting the difference between a desired and an actual result (pp. 7).

Feedback on own consumption interventions promotes personal knowledge about use of energy. people may take in the information about energy consumption, change their behaviour and gain understanding of the effect of the behavioural change by interpreting the received feedback.

Figure 1, taken from Darby (2006, pp. 14), illustrates this.

Figure 2, adopted from Darby (2006) shows some examples of feedback's categories.



The combination between these three types of interventions appears to effectively encourage behaviour change regarding energy consumption also in the study by Bekker et al. (2010) on electricity consumption in a university residential hall. Similarly, Dolan and Metcalfe

(2013) showed that biannual feedback with a comparison to neighbours' consumption triggers energy conservation of around 4%, while the combination of this intervention with tips to save energy increases the effect to almost 11%. Providing residents with personalized feedback about their water consumption, coupled with normative information about similar households in their neighbourhood proved to be effective in reducing residential water consumption, especially for residents with low personal norms (Schultz et al., 2016). Lokhorst et al. (2015) similarly augment their individual feedback condition with social norm information. Mack et al. (2019) combine individual feedback with several other intervention modules (e.g., energy saving tips, social norms, and commitment). Asensio and Delmas (2015) combine individual feedback for example with social norm feedback and information about energy production's environmental and health effects. Some research in workplace settings has demonstrated the positive effect of comparative feedback on reducing energy consumption. Gulbinas and Taylor (2014), in a study designed to understand the impact of feedback in a commercial office setting (where both comparative and individual feedback was used), found those who received individual feedback engaged less with the feedback and saved less energy than the comparative group. Mulville et al. (2017) demonstrated that on average in the commercial office setting, energy savings of 18.8% are possible, with savings of 28% for the comparative feedback group, 18% for the basic feedback group and 10% for the individual and basic feedback group.

As a general rule, when feedback on own consumption is bundled with other intervention elements in this way, it is difficult to isolate the effect of feedback alone without appropriate control conditions. In addition, as noted by Bergquist et al. (2019) in their meta-analysis on pro-environmental behaviours promotion, financial and individual feedback has shown to be less influential than feedback based on social norms (Schultz et al., 2015, 2016). Those field experimental studies that were able to isolate the effect of feedback on own consumption only show modest, often non-significant treatment effects. Harries et al. (2013) and Schultz et al. (2015), for instance, report no statistically significant changes in terms of electricity consumption as a result of feedback provision (for comparable results from a field experiment on water conservation see Fielding et al., 2013). Gleerup et al. (2010) studied SMS cell phone and e-mail messaging to alert consumers when usage levels are exceptionally high and find that these approaches reduced consumption by about 3%. Matsukawa (2005) estimated the effect of feedback information on residential energy usage in Japan. In the experiment, households had a continuous-display, electricity use monitoring device installed at their residence. Findings showed a reduced energy usage by 1%. Aggregating the results of previous studies, a meta-analysis by Karlin et al. (2015) found a small positive effect of feedback on energy conservation, on average. Delmas et al. (2013) similarly found a small average effect of feedback in their meta-analysis, but more importantly, results from their full meta-regression model (controlling for different relevant attributes of each intervention) show no statistically significant effect of providing individual feedback on energy conservation. Other studies pointed out the limited effect over time of providing feedback on own consumption. Wemyss et al. (2019) in their study on household electricity savings in Switzerland concluded that providing feedback on individual electricity use was not enough to maintain the positive short-term impacts one year after the end of the intervention. In the same line, Hargreaves et al. (2013) reported that the long-term effect of a feedback-based energy saving intervention was little. Instead, encouraging long-term effects on electricity savings were shown in a socially embedded energy efficiency program in the Netherlands (Staats et al., 2004). Anderson et al. (2017) also found a positive effect on the durability of energy behaviour change, when normative feedback messages were continued over time. Jessoe and Rapson (2014) report an effect of providing real time feedback in terms of consumers becoming more responsive to electricity price increases (by reducing their usage). This latter result underscores the importance of designing policy instruments that combine mutually reinforcing elements (like feedback and incentives), which is an approach taken in the proposed project. See also Abrahamse et al. (2005) and Fischer (2008) surveying much of the older literature on energy consumption and the role of feedback.

In this project, we will put the notion that feedback elements should be routinely included as part of other interventions to the test. We suspect that some interventions (e.g., norm-based interventions) may sometimes benefit from withholding explicit feedback on own consumption. On the one hand, learning that one consumes less energy than others may lead the former "energy-savers" to increase their future consumption (a boomerang effect, see e.g., Schultz et al., 2007). Boomerang effects can be avoided when feedback on own consumption (or norm feedback) is not provided to the segment of energy-savers (see Ayres et al., 2013 for a similar argument). More generally, a number of studies indicate that one's own past pro-environmental behaviour can influence future engagement in related behaviours (Truelove et al., 2014; Maki et al., 2019). This suggests that feedback on own energy consumption can in some cases decrease, rather than increase, one's motivation to conserve energy in the future.

2.3.Social norms

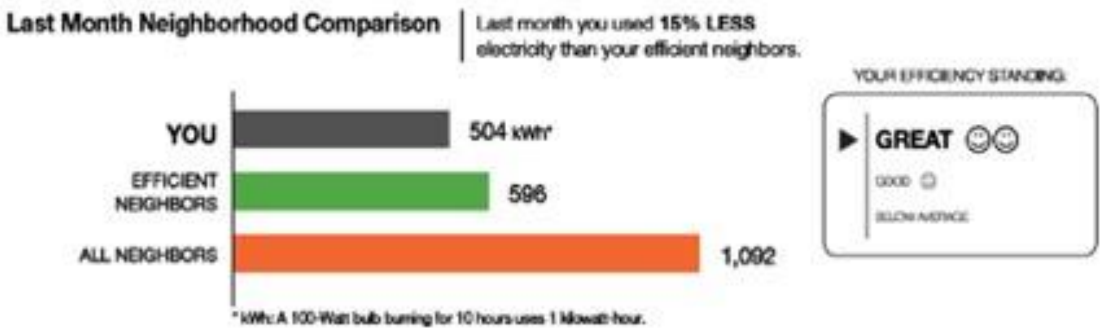
Social norm feedback is an extremely popular type of intervention, employed in dozens of previous field experiments on energy conservation (e.g., Schultz et al., 2007, 2015; Nolan et al., 2008; Allcott, 2011b; Ayres et al., 2013; Leoniak & Cwalina, 2019). An advantage of norm-based interventions is that they are easily scalable (e.g., Allcott, 2011b; Bator et al., 2014). Behavioral effects, however, are typically only modest in magnitude (Delmas et al., 2013; Buckley, 2020). We suspect this may be partly due to the intervention treatment interacting with baseline behaviour levels (Schultz et al., 2007, 2016) and other factors like electricity prices (Sudarshan, 2017), decision observability (Vesely & Klöckner, 2018), participants' issue involvement (Göckeritz et al., 2010), group identification (De Dominicis et al., 2019) or political orientation (Costa & Kahn, 2013). We therefore discuss possible boundary conditions and moderators of social norm intervention effects below. Are social norm interventions robustly effective in promoting energy-related behaviours in field settings? Table A1 in the Appendix A summarizes some of the key sources to help answer this question.[7] While we encourage the reader to review the detailed presentation of existing research available in Table A1, to give a sense of the magnitude of social norm effects on energy conservation and eco-friendly technology adoption, we provide a more condensed summary of those findings in what follows.

BOX 2: Hands-on example of a Social norm intervention

Social norm interventions are typically based on providing participants with information about the behaviour of other people (e.g., how much energy other households of similar size consume) and/or about others' approval or disapproval of specific behaviours (e.g., that your colleagues approve of commuting to work by means other than the car).

Figure 1, taken from Allcott (2011b, p. 1084), illustrates this. The graph on the left side compares the target household's consumption (grey bar) to average and efficient neighbours (orange and green bar, respectively). The graphic on the right side conveys social approval by saying "great" and accompanying this with smiley faces.

Figure 1: Example of a social norm message



Previous social norm field experiments mostly achieved small and often statistically insignificant reductions in energy consumption (e.g., Delmas et al., 2013; Jachimowicz et al., 2018; Buckley, 2020). However, larger effects were occasionally observed (e.g., Bator et al., 2019; Brülisauer et al., 2020). Careful targeting of normative interventions to the most suitable target populations could be one way of improving the efficacy of social norm interventions.Below we outline several such possibilities.

[7] The Appendix A is an integral part of this report, offering an extensive summary of the literature such that is not available elsewhere. We, however, decided to place it at the end of the main text to aid readability. Brief recaps are provided in relevant sections of the main text.

Research overall suggests varying degrees of efficacy of social norm approaches when it comes to eco-friendly technology adoption. Several studies suggest the possibility of fairly substantial effects (e.g., Graziano & Gillingham, 2015; Barth et al., 2016; Wolske et al., 2017). However, with the exception of Bollinger et al. (2020b) and partly Holladay et al. (2019), no field experimental studies leveraging social norms for the purposes of boosting eco-friendly technology adoption have been conducted. A number of observational field studies that support the existence of small (Bollinger & Gillingham, 2012; Rode & Weber, 2016) to large (Graziano & Gillingham, 2015; Inhoffen et al., 2019) norm effects also exist. However, the majority of available evidence relies on self-reports, and the promising results obtained in this way need to be corroborated in field settings to strengthen their policy relevance (cf. Levitt and List, 2007; Kormos and Gifford, 2014).

We next provide an overview of possible boundary conditions and moderators (MacKinnon, 2011; Hayes, 2013) of social norm intervention effects that have been proposed and tested in the literature. We should underline that the evidence base concerning factors modulating the effectiveness of social norms is rather slim at this point. The findings presented here should generally be regarded as tentative prior to several rounds of successful replication (see Maniadis et al., 2014; Allcott, 2015).

Understanding the factors moderating the effects of social norm (and other) interventions is not only theoretically interesting, but also highly relevant from an applied perspective. To give a simple example: Let us say a field trial shows that an intervention has a small overall effect on energy conservation. This can mean different things depending on the presence (or not) of influential moderators. Let us first assume there are no variables moderating the intervention's effect. This means that the intervention has a small effect on all its targets across the board. In a second scenario, let us assume that there is a variable strongly moderating the intervention's effect – say, young people do not respond to the intervention at all but older people respond to it strongly. In this second scenario, it would make sense for the policy maker to only target subgroups responsive to the treatment in any subsequent wide deployment of the intervention program. For related discussion see, e.g., Wenzel (2004), Hine et al. (2016), Vesely and Klöckner (2018).

Based on an analysis of the existing literature, we identified the following moderators of social norm effects:

(a) Baseline behaviour levels. Participants with higher energy consumption at baseline tend to be more responsive to social norm information (e.g., Allcott, 2011b; Ayres et al., 2013; Ferraro & Price, 2013; Byrne et al., 2018; Andor et al., 2020b; Brülisauer et al., 2020; but see Schultz et al., 2015; Henry et al., 2019). This is especially true when high pre-treatment users also endorse pro-environmental values (Bonan et al., 2019). For a novel strategy on how to frame social comparison messages addressed to low and high pre-treatment users see Brent et al. (2020).[8]

(b) Group identification. People who identify themselves with a reference group are more likely to adhere to that reference group's norms. For evidence from an energy conservation field experiment see De Dominicis et al. (2019). Dixon et al. (2015), on the other hand, found no evidence for a moderating effect of group identification in their survey on energy conservation in the workplace. Thus, while the notion of an interaction between group norms and group identification is relatively uncontroversial in other domains (Terry and Hogg, 1996; Terry et al., 1999; Fielding et al., 2008; White et al., 2009; Masson and Fritsche, 2014; Bertoldo and Castro, 2016; Liu et al., 2019), support for this hypothesis in the context of performing energy-related behaviours is tenuous at this point.

(c) Proximity of the norm source. Existing research indicates that proximity of the norm source (the reference group) matters for norm-compliance in the context of energy and resource conservation (Goldstein et al., 2008; Loock et al., 2012; Shen et al., 2016) and eco-friendly technology adoption (Barth et al., 2016; Bollinger et al., 2020a). At least up to a point, greater proximity of the reference group seems to be associated with its greater normative influence. Among the reasons for a greater influence of (relatively) proximal reference groups could be that people are more aware of them (Bollinger et al., 2020a), that the conduct of these groups provides cues that seem more pertinent to the decision maker's own situation (Goldstein et al., 2008; Passafaro et al., 2019) or that the decision maker identifies with these groups (Agerström et al., 2016).

(d) Personal norms. Participants holding strong personal pro-environmental norms are less susceptible to social norms conveyed via interventions (Schultz et al., 2016; but see Wan et al., 2017).

(e) Issue involvement. Somewhat similar to the previous case, participants exhibiting greater personal involvement in conservation issues are less responsive to social norms (Göckeritz et al., 2010; see also Lapinski et al., 2017).

[8] The messages can be framed either in terms of comparing absolute consumption levels (as in most existing campaigns) or in terms of comparing consumption reductions over some period (a strategy that can outperform traditional norm campaigns when targeting households with small consumption reductions relative to their peer group). The main contribution of this approach therefore lies in its ability to put increased social pressure on households already consuming little energy at baseline. As Brent et al. acknowledge, welfare implications for consumers targeted in this way need to be carefully assessed (to give an obvious example, one should not communicate norms that could make people fail to adequately heat their homes, see e.g., Howden-Chapman et al., 2012).

(f) Environmental concern. Environmental concern does not seem to reliably predict how people respond to normative peer influence (Moons & De Pelsmacker, 2012, 2015).

(g) Innovativeness. Innovative individuals do not seem to differ from others in their willingness to align their behaviour with perceived normative expectations of their peers (Moons & De Pelsmacker, 2015; Lundheim et al., in press).

(h) Decision observability. People can become more norm compliant when their decisions are publicly observable – see Vesely and Klöckner (2018) for a study on donations to environmental organizations. However, this effect was not confirmed in the context of investments to renewable energy (Vesely et al., 2020). More broadly, Nemati and Penn (2020) report more pronounced effects on electricity conservation of information-based interventions (which included but were not limited to norm-based interventions) when behaviour was publicly observable.

(i) Behaviour difficulty and other costs. Sudarshan (2017) report that an intervention utilizing normative feedback leads to reduced consumption of cheap grid electricity but failed to bring down consumption of more expensive electricity generated from a backup diesel source. Thus, when prices were high, there appeared to be no room left for norms to motivate energy conservation. Andersson and von Borgstede (2010), on the other hand, found that while perceived social norms influenced both low- and high-cost waste recycling behaviours in households, normative influences were more pronounced in case of high-cost recycling. In another study on household recycling, however, Hage et al. (2009) found no evidence for an interaction between perceived social norms and a proxy for behaviour difficulty, namely the access to nearby waste collection points. Taken together, these findings suggest that both when behaviour costs are high and when they are low, normative influences can be sometimes relatively ineffective compared to situations associated with intermediate behavioural costs. More research in this area is needed, especially in the context of energy-related decisions.[9]

(j) Cultural context. Analyses reported by Bergquist et al. (2019) suggest that people in individualistic countries (e.g., many European countries) may be more responsive to pro-environmental social norms than people in collectivistic countries (e.g., many Asian countries, see Hofstede et al., 2010). However, this finding should be interpreted with caution, as it is based on a meta-analysis across studies with different designs, the design differences not being accounted for when the role of individualism-collectivism has been examined. A

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[9] Also the broader literature studying the interplay of behavior costs and attitudinal variables like environmental concern and personal norms does not present an unambiguous, unified picture (see Guagnano et al., 1995; Diekmann & Preisendörfer, 2003; Kaiser & Schultz, 2009; Best & Kneip, 2011; Keuschnigg & Kratz, 2018; Taube et al., 2018; Farjam et al., 2019; Keizer et al., 2019; Kaiser et al., 2020; Neumann & Mehlkop, 2020).

counterexample can be found in a questionnaire study by Eom et al. (2016), where social norms predicted intention to purchase eco-friendly products in participants recruited from a country scoring high on collectivism (Japan) but not in participants from a highly individualistic country (the U.S.). For other studies illustrating the complex ways in which culture and pro-environmental normative influences interact see, e.g., Onwezen et al. (2014), Pettifor et al. (2017a, 2017b), and Mintz et al. (2019), and for a broader reflection concerning the study of cultural differences in environmental psychology see Tam and Milfont (2020). Cultural differences (broadly speaking) exist within nations as well – some suggestive evidence on how these can impact the effectiveness of norm-based interventions is provided by Gillingham and Tsvetanov (2018) who detected a substantially greater effect of their intervention, designed to promote the uptake of home energy audits, in rural compared to urban areas (but see Loock et al., 2012 reporting comparable norm effects in urban and rural areas).

(k) Political preferences. In countries such as the USA, perceived social norms appear to shape the personal moral obligation to engage in energy conservation and efficiency behaviours among those with a liberal political orientation, but not among those with a conservative political orientation (Arpan et al., 2013). Costa and Kahn (2013) report heterogeneous treatment effects that can be traced back to participants' political ideology, with liberals responding more strongly to energy conservation norms than conservatives. No differences in intervention effects related to the political ideology of the intervention's targets were, however, found in Gillingham & Tsvetanov (2018). Using municipality-level data from Germany, Inhoffen et al. (2019) detected weaker peer effects on solar panel installations in municipalities with larger Green party vote shares (this result should be interpreted as suggestive due to the spatial data aggregation).

2.4.Information including Simplification

As in the case of individual feedback (section 2.2) many different interventions involve informational elements, e.g. energy saving tips (see Delmas et al., 2013). This typically means that isolating the effect of information provision from other types of interventions is not possible. In Allcott (2011), Ayres et al. (2013) and Costa & Kahn (2013), for example, energy saving tips are presented as one element of an intervention also involving individual and social norm feedback. Ghesla et al. (2019) combine information regarding tips on saving electricity with goal setting and with the introduction of negative or positive externalities. Lokhorst et al. (2015) and Mack et al. (2019) use electricity saving tips to augment other intervention strategies like feedback and commitment. Nolan et al. (2008) found that consumers who received descriptive normative messages used significantly less energy in the short-term compared to householders who only received energy saving 'tips'.

BOX 3: Hands-on example of Information including Simplification

Information strategies are based on the principle that more and easier information about the environmental impact of own activities will encourage people to assume an energy conservation behaviour.

Some examples of information strategies provide participants with ***energy savings tips***, conduct ***home energy audits***, use of ***message framing*** (a technique of manipulating the receiver's perceptions of the outcomes of behaviours in terms of its benefits/gains or costs/losses). These types of information strategies on energy use can play a fundamental role in training people in new behaviours to lower their energy consumption.

Some examples of information strategies are provided below in the table below.

Energy Savings Tips	Home Energy Audits	Message Framing
• "To reduce energy consumption in your home, you do not necessarily need to go out and purchase energy efficient products. Energy conservation can be as simple as turning off lights or appliances when you do not need them." • "Traditional incandescent light bulbs consume an excessive amount of electricity and must be replaced more often than their energy efficient alternatives. • "Windows are significant source of energy waste - they can add up to 10-25% of your total heating bill. To prevent heat loss through your windows, you can replace single-pane windows with double-pane products instead.	• A home energy audit, also known as a home energy assessment, can help you understand the whole picture of your home's energy use. • An audit can help you determine how much energy your home uses, where your home is losing energy, and which problem areas and fixes you should prioritize to make your home more efficient and comfortable. • A home energy audit should be your first step before making energy-saving home improvements, as well as before adding a renewable energy system to your home.	• Example of **gain frame**: *"if you recycle, you conserve natural resources"* • Example of **loss frame**: *"if you do not recycle, the environment will deteriorate."* • Both messages advocate the behavior of recycling; however, first one emphasizes the benefits of adopting the behavior whereas the other focuses on the costs of not adopting the behavior

"The implicit assumption behind the use of information strategies to reduce energy usage is that these strategies will result in a higher level of knowledge and therefore enable participants to change their behaviour" (Delmas, 2013, pp 732).

Different studies combined the provision of information with framing. Cheng et al. (2011) explored the ways in which message framing can be applied to environmentally sustainable behaviours related to energy efficiency or conservation to enhance the effectiveness of social marketing campaigns, concluding that proper segmentation of the population should be carried out before designing messages with frame or threat factors. Along the same lines, Pelletier and Sharp (2008), in their literature review on persuasive communication and pro-environmental behaviours, propose that (a) tailoring messages according to proposed processes underlying behaviour change could be useful (i.e., being aware of a problem, deciding what to do, initiating, and implementing a behaviour); and (b) framing these messages to serve intrinsic goals (i.e., health, well-being) as opposed to extrinsic goals (i.e., make or save money, comfort) could make them more effective by progressively increasing the level of self-determined motivation of the targeted population and, as a result, facilitating behaviour change and the integration of a new behaviour in one's lifestyle.

Despite these limitations inherent in the study design of previous studies, there is some research attesting to the role information and knowledge play in energy-related and other sustainability decisions. Barth et al. (2016) report that perceived knowledge about electric vehicles was positively linked to electric vehicle acceptance.

Asensio and Delmas (2015) show in their field experiment that providing information specifically about energy production's impacts on the environment and on public health boosted energy conservation efforts compared to a treatment where participants were informed about monetary savings associated with energy conservation. In contrast, in their field experiment Schultz et al. (2015) found no effect (on energy consumption) of an informational video about climate change and the ecological effects of electricity consumption. Importantly, results from the full meta-regression model in Delmas et al. (2013) showed no statistically significant effect of providing energy saving tips on subsequent energy conservation. However, a significant positive effect of home energy audits (in which provision of individualized energy-related information is a major component) was observed. Regarding this latter evidence, Maibach et al. (2008), reviewing household energy conservation interventions, pointed out that the provision of tailored or customized recommendations — based on home energy audits — has been shown in many studies to reduce energy use anywhere between 4% to 21%. Tailored information regarding energy conservation proved to be successful also among households in a military installation (McMakin et al., 2002). Abrahamse et al. (2005), in their review of intervention studies aimed at household energy conservation, concluded that information tends to result in higher knowledge levels, but not necessarily in behavioural changes or energy savings. Mass media campaigns tend to result in an increase in attitudes or knowledge, but there is no clear evidence that this results in reductions of energy use. In a pre-post design, Schmalfuß et al. (2017) show that a one-day test drive experience with an electric vehicle positively affected people's evaluations of vehicle attributes, their attitudes towards electric vehicles, and (marginally significantly) purchase intentions as well. The latter result is contrary to Skippon et al. (2016), who found a decrease in purchase intentions following a 36-hour electric vehicle test drive. We conjecture that some of the changes reported in these two studies may have occurred via increasing participants' knowledge about the technology (for related research see Jensen et al., 2013, 2014; Bühler et al., 2014). In a different problem domain, Bolderdijk et al. (2013a) demonstrate that provision of information about negative consequences of bottled water increases pro-environmental intentions and policy acceptance, but only for people endorsing pro-environmental values at baseline. Fielding et al. (2013), but not Schultz et al. (2016), show a positive effect of providing water saving tips on water conservation in their field experiments. In an online study in which each participant was randomly exposed to a subset of a large battery of sixty climate change-related messages, Hine et al. (2016) found that messages providing specific adaptation advice were successful in fostering climate change adaptation intentions. Moreover, providing advice was equally effective when targeting audiences with different levels of concern, worry and knowledge about climate change. Feldman and Hart (2018) found no differences in how information about climate change consequences versus information on actions that can be taken to mitigate climate change (e.g., power plant emissions regulation and investment in renewable energy sources) affected support for climate change mitigation policies. However, liberals, moderates and conservatives differed in how they emotionally processed the information.

Until recently, there has been a scarcity of research systematically evaluating the potential causal effects of energy-related education programs (Boudet et al., 2016). One exception is Cornelius et al. (2014), who in their randomized controlled trial with high school students applied a five-lesson energy-related education program featuring elements of for example modelling, goal setting, and learning about climate change, and reported positive effects on subsequent energy saving behaviours. Boudet et al. (2016) similarly found positive effects on energy conservation of a five-lesson energy-related education program offered to Girl Scouts, involving for example elements of behaviour rehearsal, commitment and monitoring. Education can be also used to influence antecedents of energy-related behaviours, such as climate change concern and knowledge (Flora et al., 2014; Lawson et al., 2019). We suspect that interaction effects may often be at play in determining the effect of information and knowledge on subsequent behaviour (consistent with evidence reported in Bolderdijk et al., 2013a; Asensio and Delmas, 2015; Feldman and Hart, 2018; but see Hine et al., 2016). In addition, as reported in a recent meta-analysis by Bergquist et al. (2019), in general, educational information has very little effect on behaviour (e.g., Osbaldiston and Schott, 2012), while environmental- or health-based information has been shown to be more effective than financial information (e.g., Asensio and Delmas, 2015).

Regarding the contents and the way in which information on energy consumption and other pro environmental behaviours is provided, as reported by Frederiks et al. (2015), simply providing large amounts of information, procedural instructions and other educational material may fail to produce long-term behavioural changes, particularly if such information is highly complex, delivered in isolation (i.e. without reference to social norms, goals, feedback, rewards, etc.), or if people already have the requisite knowledge needed to act accordingly. Rather than delivering information-intensive campaigns and complicated consumer education programmes, behavioural strategies should instead focus on communicating simple messages that the average consumer can quickly and easily understand. Indeed, laboratory experiments and field studies have found that having more choices is not necessarily more desirable, appealing or intrinsically motivating, and people may even perform better in limited-choice contexts (Greifeneder et al., 2010; Scheibehenne et al., 2010).

2.5.Monetary incentives

It is a standard assumption in economics (including major behavioural economics models like Andreoni, 1989 and Krupka and Weber, 2013) that incentives and costs shape and constrain people's decisions. It is therefore not surprising that people can be sometimes motivated by financial considerations also in the context of energy-related behaviours, including hybrid and battery electric vehicle adoption (Hardman et al., 2017; Lévay et al., 2017; Hardman, 2019; Münzel et al., 2019), installation of residential solar panels (Kwan, 2012;

Dharshing, 2017; Bollinger et al., 2020b), preferences for green electricity (Ek and Söderholm, 2008; Welsch and Kühling, 2009; Neumann and Mehlkop, 2020), and electricity consumption (Faruqui and Sergici, 2010, 2011; Mizobuchi and Takeuchi, 2013; Steinhorst at al., 2015; but see Delmas et al., 2013; Jessoe et al., 2014; Asensio and Delmas, 2015; Sudarshan, 2017; Buckley, 2020).

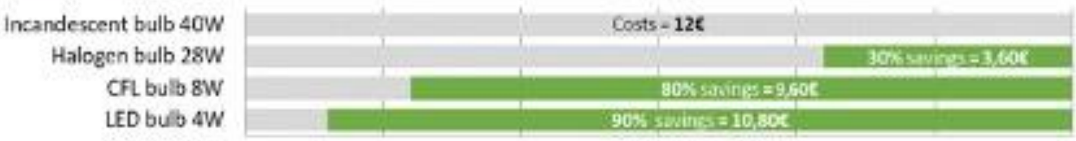
Before evaluating the main and interaction effects of incentive-based interventions, we would like to discuss some interesting open questions concerning their usefulness, taking a broader theoretical perspective. These considerations (such as the possibility of incentive effects fading after incentives are discontinued or the possibility of motivation crowding out) should be kept in mind when looking at the effect of incentives on energy-related behaviours.

BOX 4: Hands-on example of an Monetary incentive-based intervention

There are various ways of harnessing monetary incentives in order to promote energy conservation and eco-friendly technology adoption. Two main classes of these approaches exist:. It is possible to change the financial cost of different behaviours directly, for instance by subsidizing eco-friendly technology adoption. For an overview of different demand-side monetary policies used to promote the uptake of electric vehicles in Europe in recent years, for example, see Münzel et al. (2019).

It is also possible to simply draw participants' attention to existing costs of different consumption options. Figure 2, adapted from Rodemeier & Löschel (2020, p. 37), illustrates this approach. The figure displays projected annual expenditures associated with using different types of light bulbs (showing costs and savings per bulb).

Figure 1: Example of an incentive-based intervention



Even when incentives have the desired effect initially, research in a number of domains, including energy conservation and eco-friendly technology adoption, suggests that the effects may quickly dissipate once incentives are withdrawn (Thøgersen and Møller, 2008; Royer et al., 2015; Delaney and Jacobson, 2016; Braito et al., 2017; Dharshing, 2017; Ito et al., 2018; Azarova et al., 2020; Kaiser et al., 2020). However, a meta-analysis by Maki et al. (2016) suggests that incentive-based interventions promoting pro-environmental behaviour may retain their initial positive effect also when the incentive is no longer in place.

Many authors argue that incentives partially crowd out intrinsic motivation and pro-social motives (i.e., decrease the influence of these motives on people's decisions, see Deci, 1971; Frey and Oberholzer-Gee, 1997; Deci et al., 1999; Gneezy and Rustichini, 2000a, 2000b; but see Steinhorst and Klöckner, 2018; Kaiser et al., 2020; West et al., 2020). Thus, if the mere provision of incentives crowds out intrinsic motivation and pro-sociality to some extent, incentives need to be powerful enough in order for their net effect on the desired outcome to be positive. This may render the use of incentives impractical in economic terms (others have pointed out that incentives need to be powerful enough to shift choices related to energy use, see, e.g., Delmas et al., 2013).

Another question concerns the relative suitability of positive motivation (e.g., subsidies and discounts) versus negative motivation (e.g., taxes and fines). As far as behavioural outcomes go, the use of negative motivation may be somewhat more effective (Balliet et al., 2011; Hossain and List, 2012; Hong et al., 2015). Research on public acceptance of sustainability policies, however, indicates that the more heavy-handed "push" measures (taxes and fines falling into this category) are typically less acceptable than softer "pull" measures like subsidies and rebates (Schuitema et al., 2011; de Groot and Schuitema, 2012; Tobler et al., 2012; Rhodes et al., 2017; Mahmoodi et al., 2018; Keizer et al., 2019).

A final question concerns the relative suitability of incentive-based interventions compared to other, non-price interventions. Previous experimental work for example indicates that incentive-based interventions targeting energy-related behaviors may sometimes be less effective than interventions making environmental and health benefits of energy conservation salient (Bolderdijk et al., 2013; Asensio and Delmas, 2015, 2016; Schwartz et al., 2015; Xu et al., 2015; Chen et al. 2017), even though the evidence is inconclusive, with several studies also reporting mixed findings and null results (Dogan et al., 2014; Spence et al., 2014; Steinhorst et al., 2015; Steinhorst and Klöckner, 2018; Brandsma and Blasch, 2019). In sum, any benefits of using incentive-based interventions need to be carefully weighed against their potential drawbacks.

Below we provide a condensed overview of incentive effects reported in previous research on energy conservation and eco-friendly technology adoption. A more detailed presentation of the evidence can be found in Table A2 in the Appendix A.

Incentive-based interventions typically achieve small or statistically insignificant reductions in energy use (see, e.g., Delmas et al., 2013; List et al., 2017; Buckley, 2020). However, larger effects were also observed (Faruqui and Sergici, 2010; Ito et al., 2018; Burkhardt et al., 2019). We discuss a number of factors contributing to the interventions' success or failure below.

Concerning eco-friendly technology adoption, most field experiments found no effect of pecuniary strategies (e.g., Allcott and Sweeney, 2017; Gillingham and Bollinger, in press). Interestingly, large effects have been found in a few cases (see Allcott and Taubinsky, 2015; Bollinger et al., 2020b) and some non-experimental studies also suggest a substantial potential of monetary instruments (e.g., Gallagher and Muehlegger, 2011; Münzel et al., 2019).

To sum up, incentives seem to represent a potentially powerful policy instrument. However, the possibility that an incentive-based strategy will be entirely unsuccessful is also large. Thus, there is a need for continued examination of the types of incentive-based strategies that fare best and of the specific contexts and recipient characteristics that may improve their performance. For example, providing cash incentives rather than providing information on prospective savings may be more effective in some cases (Allcott and Taubinsky, 2015; Rodemeier and Löschel, 2020).

Also, for incentive interventions it is important to take into account the factors that modulate their effectiveness. Apart from studies exploring the role of socio-demographic moderators, existing research in the energy-behaviour domain is largely silent on this important issue. Given the paucity of available data, we should therefore once again underline that findings presented here should be regarded as tentative prior to several rounds of successful replication (see Maniadis et al., 2014; Allcott, 2015). Our analysis of existing literature uncovered the following moderators of incentive effects in the energy domain:

(a) Socio-demographic characteristics. Numerous studies[10] provide evidence that socio-demographic characteristics, including age, gender, education, income, home ownership, and parental status, help determine people's responsiveness to incentives and prices. Findings are, however, often mixed, or inconclusive. For example, lower-income consumers sometimes appear to be more responsive to incentives and energy and technology prices (Reiss and White, 2005; Alberini et al., 2011; Allcott, 2011a; Ito, 2015; DeShazo et al., 2017; Houde, 2018; Charlier and Kahouli, 2019; Lundgren and Schultzberg, 2019; Schmitz and Madlener, 2020), but other studies disconfirm or qualify this link (Nesbakken, 1999; Alberini et al., 2019; Faruqui et al., 2013; Moshiri, 2015; Zhang, 2015; Schulte and Heindl, 2017; Hansen, 2018; Prest, 2020). Inconsistent findings could be partly due to methodological differences across studies. Alternatively, income effects on price elasticity of demand in the energy domain could be context dependent.

(b) Political preferences and environmental concern. Schwartz et al. (2015) and Xu et al. (2015) report that the relative effectiveness of monetary vs. environmental appeals depends on the target audience's political preferences (and environmental concern, in Xu et al., 2015).

(c) Personal norms. Steinhorst and Matthies (2016) found that people with strong (as opposed to people with weak) pro-environmental personal norms may respond better to

[10] See e.g. Nesbakken (1999), Reiss & White (2005), Rehdanz (2007), Meier & Rehdanz (2010), Alberini et al. (2011, 2019), Allcott (2011a), Mills & Schleich (2012), Asensio & Delmas (2015), Ito (2015), Moshiri (2015), Yang & Zhao (2015), Zhang (2015), Bjerkan et al. (2016), Zhang et al. (2016), Wichman et al. (2016), DeShazo et al. (2017), Schulte & Heindl (2017), Hansen (2018), Houde (2018), Ščasný et al. (2018), Silva et al. (2018), Sovacool et al. (2018, 2019), Charlier & Kahouli (2019), Kormos et al. (2019), Lundgren & Schultzberg (2019), Bollinger et al. (2020b), Deryugina et al. (2020), Jenn et al. (2020), Rodemeier & Löschel (2020), Schmitz & Madlener (2020), Stojanovski et al. (2020), and Wolske (2020).

information about the negative environmental impacts of energy consumption than to information about monetary savings associated with energy conservation (for related evidence concerning the role of personal norms and values in the context of paper conservation appeals see van den Broek et al., 2017).

(d) Environmental identity. DellaValle and Zubaryeva (2019) indicate that individuals scoring high on pro-environmental identity may be more responsive to incentive-based interventions promoting the uptake of eco-friendly technology.

(e) Time preferences. Response to potential future cost-savings from eco-friendly technology adoption appears to be steeper for individuals who are more willing to delay consumption (DellaValle and Zubaryeva, 2019).

(f) Context effects. The influence of incentives on energy-related behaviours may depend on the context determined by other intervention elements, for example information provision (Hayes and Cone, 1977; Sexton et al. 1989; Ashraf et al., 2013; Krause et al., 2013; Jenn et al., 2018; Palmer et al., 2018; Rodemeier and Löschel, 2020), feedback on own consumption (Hayes & Cone, 1977; Jessoe and Rapson, 2014; Martin & Rivers, 2018; Prest, 2020), and norms (Dolan and Metcalfe, 2015; Sudarshan, 2017; see also Rezvani et al., 2018; Brent and Wichman, 2020).

2.6.Commitment

Commitment strategies have been, more or less successfully, used to encourage energy-related and other sustainable behaviours, including unplugging electrical appliances when not in use (van der Werff et al., 2019), electricity conservation (Pallak and Cummings, 1976; Loock et al., 2013), water conservation (Jaeger and Schultz, 2017), travel mode choice (Matthies et al.,2006), and towel reuse during hotel stays (Baca-Motes et al., 2013; Terrier and Marfaing, 2015). Meta-analyses of experimental studies by Abrahamse and Steg (2013) and Lokhorst et al. (2013) indicate that commitment tends to have a positive effect on pro-environmental behavior (for a more detailed overview of relevant evidence see the next section). It is of note that commitment strategies are often used to foster other types of desirable conduct, such as behaviours related to health and financial responsibility (Ashraf et al., 2006; Royer et al., 2015; Sadoff and Samek, 2019; Samek, 2019).

Interestingly, most research in psychology focuses on non-binding commitments that, if broken, do not induce any material losses, but presumably only losses in terms of damaged self- or social image as a consistent and responsible individual (cf. Kantola et al., 1984; Thøgersen, 2004). In this report we focus on non-binding commitments only.

As we document in more detail in Table A3 in the Appendix A, the effectiveness of commitment and goal setting strategies employed in previous field experimental studies on energy conservation has been very limited (e.g., Lokhorst et al., 2015; van der Werff et al., 2019; Andor et al., 2020a). The results are slightly more encouraging for pro-environmental behaviour more generally (Lokhorst et al., 2013; Nisa et al., 2019). One approach could therefore be to increase the salience of the environmental impact of intense energy consumption when asking participants to commit to energy conservation goals.

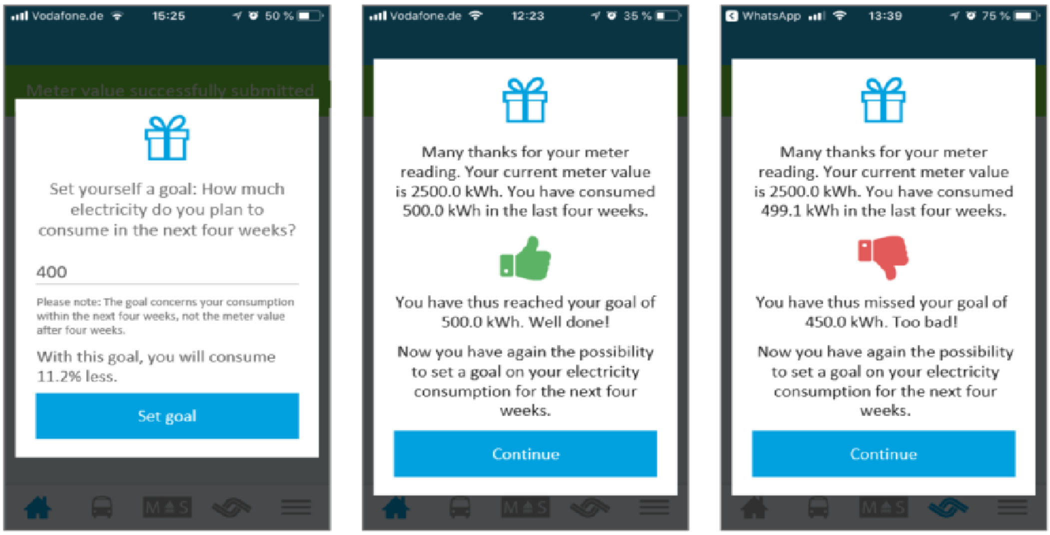
The evidence concerning possible boundary conditions and moderators of the effect of commitment on energy-related behaviours is extremely limited. Broadly speaking, the following factors may moderate the success of commitment interventions:

BOX 5: Hands-on example of a Commitment

In commitment-based interventions, participants are asked to commit to future behaviours or goals (such as reducing one's energy consumption by a certain percentage in the next year).

Figure 3 (taken from Löschel et al., 2020, p. 6) shows a phone app screen on which participants can set their energy conservation goal (see the leftmost part of the figure). After the commitment period elapses, participants are notified whether they reached their goals or not (see the middle and the right side of Figure 3).

Figure 1: Example of a commitment intervention



(a) Personal pro-environmental norms. Matthies et al. (2006) demonstrate that the efficacy of commitment-based strategies is enhanced when the committing individuals hold strong personal norms in favour of the target behaviour.

(b) Values. People holding strong "egoistic" values appear to be more responsive to commitment opportunities, and people with strong "biospheric" values are sometimes less responsive (Brandsma & Blasch, 2019).

(c) Public commitment. Commitments made in public appear to be more effective than private commitments (Pallak & Cummings, 1976; see also Epton et al., 2017).

(d) Behaviour difficulty. Van der Werff et al. (2019) report that commitment can be used as a lever to motivate difficult energy-saving behaviours, but not easy behaviours.

2.7.Competition

A number of "competition" campaigns designed to promote energy conservation bundle competition incentives with other strategies (e.g., feedback, norms, energy saving tips, commitment, and prompts), making it impossible to separate the effect of competition itself from the effect of these other elements (e.g., McClelland and Cook, 1980; Senbel et al., 2014; Petersen et al., 2015; Sintov et al., 2016).

BOX 6: Hands-on example of a Competition

Competition has become an increasingly popular strategy to engage people not only in energy conservation behaviour, but also in increasing awareness, understanding and knowledge of the connection between behaviour change and energy use (Vine, 2016).

Figure 1, adapted from Vine (2016) shows the structure of an intervention or strategies based on competitions. In order to stimulate change in thought and behaviour in terms of short and long-term reductions in energy use, a competition have to follow four steps:

These studies tend to show positive effects of "competition" campaigns on energy conservation. For instance, Sintov et al. (2016) evaluated the impact of a competition-based intervention combining high resolution electricity feedback, incentives, information, and prompts on college dormitory residents' energy consumption. Electricity use among all suites was approximately 6.4% lower during the competition period compared to baseline, a significant reduction: in three weeks, dormitory residents saved 3,158 kWh of electricity compared to baseline – the equivalent of more than 3,470 pounds of carbon dioxide emissions. Additionally, participants reported engaging in various pro-environmental behaviours significantly more frequently during the competition relative to baseline. However, a study by Schultz, Kohn, and Musto (2016) which used essentially the same basic processes in sorority houses over two years, achieved only moderate reductions. Senbel et al. (2014) analysed a competition between students to reduce energy consumption from a baseline level. They found that competition was successful in achieving both short-term and medium-term energy reductions when compared to control groups of the same year that did not receive the intervention. However, points and prizes primarily functioned as an initial incentive and then other experiences dominated through the act of participation: students tended to join the competition because multiple pathways of participation were available to them and were motivated by the actions and stories of their friends, not paying attention to the actions or competition scores of strangers. More rigorous tests of the actual unique causal effects of competition are required, as illustrated by Alberts et al. (2016), who demonstrate that adding a competition element to a social norm and individual feedback-based campaign can in fact lead to less energy saving (for related evidence from an online study see Bergquist et al., 2017). Vine and Jones (2016) in their review of much of the relevant literature, concluded that competition appeared to be effective at changing behaviour and reducing energy use, although the persistence of the energy savings or practices (habits) is unknown.

Wemyss et al. (2018) transferred the competitive approach into a gamified environment to test the effectiveness of competition and collaboration on engaging people to change their household electricity-use habits. A mobile app was developed to provide electricity meter feedback in two gamified environments: the participants are assigned to either a collaborative team where citizens in the same city try to reach a fixed amount of energy saving, or a competitive team which tries to save the most electricity in comparison to another city. The results showed that both gamified structures (competitive and collaborative) showed significant positive impacts compared to the control group, both in terms of electricity savings and reported electricity use, however, no significant difference is found between the two gamified structures. Adopting a similar gamified intervention, Gustafsson et al. (2009) developed and tested an app to promote energy efficiency behaviours among teenagers in which participants could cooperate within the family or compete via duels with other players between the correspondent avatars. Electric consumption data on the test group of players shows tentative indications for a persistent post-game effect compared to the control group. Findings also show a statistically significant positive change in the players' attitudes toward saving energy compared to the same group and a negative effect on the players' attitudes toward environmental questions in general, which the authors explained as a case of cognitive dissonance. Despite these first results, the study of gaming interventions addressing energy efficiency behaviour is an emerging field of research, and further studies are needed to clarify the effectiveness of competition also in a gamified environment (Morganti et al. 2017).

As we outline below, theory suggests that indiscriminate, non-targeted application of competition incentives is likely suboptimal. Previous research in various domains, including for example education, the labour market, and sports, suggests that different people may respond very differently to competition incentives, depending for example on their ability, confidence, risk aversion, distributional preferences, or gender (Gneezy et al., 2003; Niederle and Vesterlund, 2007; Bartling et al., 2009; Cotton et al., 2013; Preece and Stoddard, 2015; De Paola et al., 2018). Related to this, competition incentives may potentially crowd-out intrinsic motivation and pro-social motives in some people. Bergquist et al. (2017) found that contest-based interventions promoting energy-saving behaviour may be used when aiming to promote intensive but short-term engagement, but it also seemed to discourage feelings of pro-environmental obligation. All this means that only some people will likely be motivated to conserve more energy, whereas others will withdraw effort under competition. The fact, for instance, that women sometimes prefer not to compete (Niederle and Vesterlund, 2007; Markussen et al., 2013; Preece and Stoddard, 2015) could conceivably mean that they experience undue psychological pressure under competition.

2.8.Framing

Framing engagement in energy-related sustainable behaviours as either an individual problem or a collective problem is bound to make certain attributes of the decision (e.g., individual vs. social costs) and certain characteristics of the decision-maker and the collective (e.g., self-efficacy vs. group efficacy) salient in the decision-maker's mind. The salient factors will subsequently gain greater importance when deciding whether or not to engage in the sustainable behaviour at hand (Cialdini et al., 1990). There is much evidence on a variety of framing effects (e.g., Dufewnberg et al., 2011; Bager and Mundaca, 2017; Carrus et al., 2019a; Chang et al., 2019; Masson et al., 2019). Bager and Mundaca (2017) investigated the potential impact of loss aversion on electricity use via a non-price intervention for a group of smart meter users. The hypothesis was that framing electricity use as a salient, financial loss would have had more impact on behaviour than if energy savings were perceived as a gain. The results showed that reductions were higher when salient, loss-framed information was provided. The analysis used two baselines, and the differential effects revealed that the provision of loss-framed, salient information reduced daily demand by 7 to 11%, compared to unframed information. Reductions in standby consumption were more pronounced, with a differential effect of 16 to 25%.

The systematic review by Andor and Fels (2018) on energy conservation behaviour showed that framing is often combined with social comparison, and also with goal setting/commitment. Regarding the combination between framing and social norms, Ferraro et al. (2011) examined how different norm-based strategies influence long-run patterns of residential water use. A natural field experiment was implemented that randomized households into four treatments: a control group, a group that received technical advice, a group that received both technical advice and an appeal to prosocial preferences, and a group that received both technical advice and an appeal to prosocial preferences that included a social comparison (information framed in a negative way emphasizing how many people do not engage in the targeted behaviour). Post-treatment residential water demand over a 2year period was examined. The results showed that while appeals to prosocial preferences and social comparisons affected short-term patterns of water use, only messages augmented with social comparisons had a lasting impact on water demand.

BOX 7: Hands-on example of Framing

Framing a problem within a specific concept (e.g., framing energy reduction in terms of CO2) influences the individual choice between a series of alternatives and guides individuals to draw different conclusions from the same set of information, depending on how it is presented and the relative salience of its elements (Spence et al., 2014).

Consequently environmental framing is useful in engaging people with energy saving behaviour. This happens because priming a concept or idea can lead to the activation of that idea (e.g., it is necessary to reduce energy consumption to help fight climate change) and related ideas and to subsequent changes in behaviour (e.g., perform the desired energy saving behaviour).

Framing environmental action can be also be conceptualized as an individual or a collective endeavour. As a collective endeavour, it should help to overcome barriers to personal action that rest on personal helplessness. For instance, defining the production and use of green energy as a collective project of the ingroup rather than as personal attitudes and individual decisions, may instigate personal actions that people perceive as joining in a collective effort (e.g., we can save energy, we use green technology). "Joining in" means that people may not only experience a sense of group membership and coherence with ingroup norms and goals, but also act on a collective level of their self, which might be more effective for bringing about relevant changes than the personal self (Carrus et al., 2019a)

In another study, Hahn et al. (2016) used social comparisons and loss-framed messages to get consumers to purchase drought-resistant plants and reduce water use. The results showed that by themselves, social comparisons and loss framing have no significant impact on the number of rebate requests; when combined, however, they lead to a 36% increase in requests. Only loss framing led to a significant increase in the purchase of drought-resistant plants, and only the social comparison reduced water consumption. On the other hand, Tiefenbeck et al. (2013) reported the side effect of a framing intervention combined with feedback and social comparison. They distributed weekly water consumption feedback flyers containing a social appeal to contribute one's share to the mutual goal of energy conservation, a social comparison with the most efficient 10% of users and energy saving tips. After seven weeks, the treatment group showed a significant reduction in water consumption of 6% but at the same time, the electricity consumption increased by 5.6% compared to the control group.

Regarding the combination between individual/collective framing and goal setting, Abrahmase et al. (2007) aimed at encouraging households to reduce their direct and indirect energy use providing individual or group goals and feedback. The first experimental group was provided a combination of tailored information, individual goal setting (5%), and feedback about personal consumption. The second experimental group received the same combination but in addition they received a group goal of 5% as well as group feedback about average and total energy savings of all participants. After 5 months, households exposed to the combination of interventions saved 5.1%, while households in the control group used 0.7% more energy. The above-mentioned results highlighted the importance of testing different combinations of instruments, particularly when policymakers have multiple goals and the relationship between instruments and goals is uncertain.

It is an important open question whether individual-based interventions designed to foster energy-related sustainable behaviours are more, or less, effective than collective-based interventions. Theory suggests that both types of factors matter, including for example personal identity and self-efficacy on the one hand and group identity and collective efficacy on the other hand (see e.g., van Zomeren et al., 2010; Klöckner, 2013; van der Werff et al., 2013; Jugert et al., 2016; Fritsche et al., 2018; Vesely et al., 2019). For instance, van der Werff et al. (2013) tested the influence of a private commitment strategy, in which people pledge to change their behaviour, on energy saving behaviour. The authors found that the private commitment only influenced energy saving behaviour when the behaviour was perceived to be relatively effortful. In this case, the private commitment strengthened people's personal norm to engage in the behaviour, since they felt more morally obliged to engage in the behaviour they committed to. In turn, a stronger personal norm was positively related to energy saving behaviour. Injunctive norms and environmental self-identity did not explain why making a private commitment changed energy saving behaviour if the behaviour is perceived to be relatively effortful.

To sum up the wide range of existing behavioural intervention typologies analysed in this report, and the various strengths associated to these different intervention typologies that we reviewed so far, the following figure (B) might help.

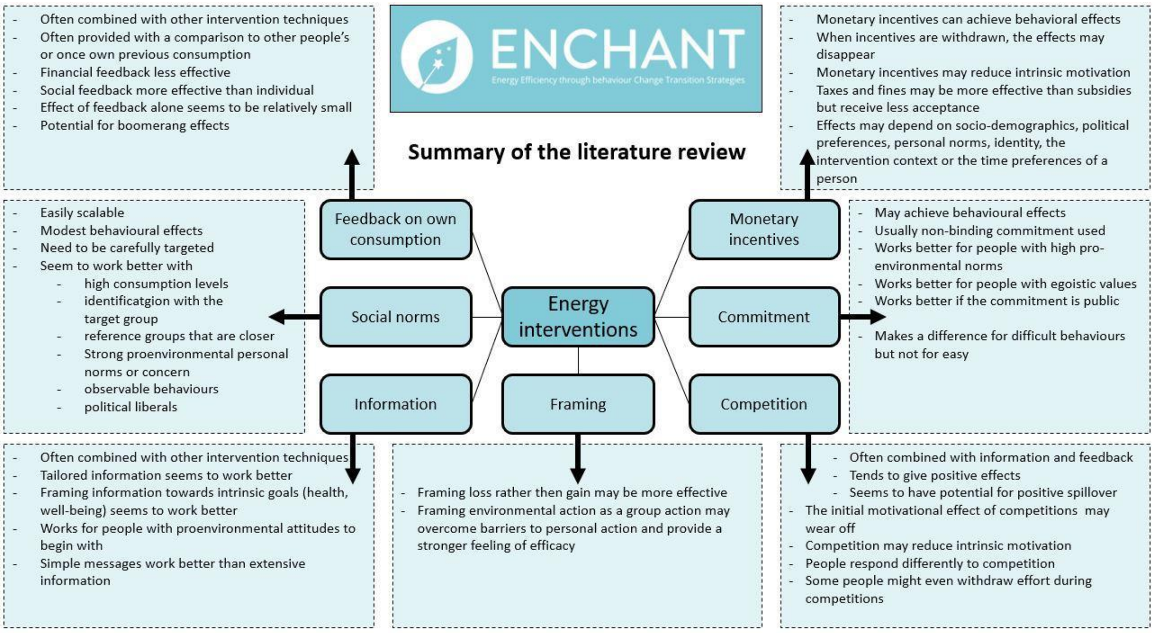


Figure B– summary of a comprehensive review from paragraph 2.2 to paragraph 2.8

2.9. Limitations of existing research and future directions

This section analysed the current state of knowledge in the research field of behavioural interventions that have been implemented in the realm of energy policy in order to reduce energy consumption (e.g., providing feedback to consumers), increase investment in energy efficiency (e.g., information with framing related to energy efficiency), and encourage energy-related and other sustainable behaviours (e.g., commitment strategies).

Taking into account the generally recognized state of the art, in this paragraph we discuss issues in the research and practices – inherent in each behavioural intervention described above – and how those issues can be addressed, and we focus on positioning these issues as a starting point for future research endeavours as well as for theoretical advancement.

Feedback on own consumption

One major limitation of the current literature deals with the **isolation of variables within intervention conditions**. Moderator analysis in meta-analysis is essentially correlational (Karlin et al., 2015); given that most of the studies were conducted with a random assignment to the different levels of the moderators, from a strictly formal point of view causation cannot be easily inferred in many instances. Also, treatment conditions were often confounded (e.g., goal-setting and incentives), preventing study authors from determining which strategy was responsible for treatment effects. To correct for this, **factorial designs are recommended to test more precise research hypotheses and to isolate treatment conditions.**

In addition, the way in which feedback information is presented to users can have an impact on the way in which it is perceived and interpreted, and a subsequent impact on motivation and action. However, there has been limited work investigating responses to different types of feedback displays, beyond energy measurement and comparison messages (Ford and Karlin, 2013): the successful design of energy feedback technologies can greatly benefit from users' evaluation of the designs that are used most often in practice, so that feedback design can take into account principles drawn from both cognitive and social psychology.

All the previous studies collected data on energy use (i.e., kWh savings) for measuring the effectiveness of feedback, but few included additional measures of potential individual-level moderators of feedback effectiveness. In particular, **contextual barriers** (e.g., home and appliance ownership, financial resources, home location, house size, and relevant cultural constraints) **may impede people from engaging in a behaviour regardless of attitudes or motivation** (Stern, 2011). Additionally, consumers may have other personal considerations with regard to energy use that are more self-relevant than conservation (e.g., comfort, security). **Understanding these motivations and constraints is vital to the successful use of feedback for energy conservation**.

Finally, most studies measured behaviour during or immediately after the intervention took place; **future research may collect data for a longer period of time, to examine the long-term effects of feedback as an intervention strategy**.

Social norms

Considering the limitations of the research carried out so far on the role of **social norm** on energy conservation, previous field experiments focused primarily on low-cost curtailment behaviours, notably on encouraging people to curtail their energy consumption at home and in public spaces (e.g., Allcott, 2011b; Bator et al., 2014; Leoniak and Cwalina, 2019) and on other simple low-cost, low-involvement actions like towel reuse (Goldstein et al., 2008; Schultz et al., 2008), tyre pressure checks (Yeomans and Herberich, 2014) and leaving the windows closed when the heating is on (Ornaghi et al., 2018). Even though a portion of energy use reductions achieved in energy conservation campaigns such as described in Allcott (2011b) seems to stem from energy-efficiency investments rather than solely from a change in habits (Brandon et al., 2017), **promoting household energy-efficiency and eco-friendly investments also more directly would be useful**.

In fact, with the exception of Bollinger et al. (2020b)[11] we are not aware of any previous field experiments using norm-based interventions to motivate high-cost investment decisions in the energy domain, such as buying electric cars or installing solar panels.[12] This contrasts with an abundance of correlational studies on related topics (e.g., Korcaj et al., 2015; Barth et

[11] To encourage adoption of residential solar panels, Bollinger et al. (2020b) applied an intervention combining messages highlighting social identity ("My own town can be a state leader in solar energy") and social norms ("All of my friends and neighbors are doing it too"). Results from a related survey experiment are reported in DellaValle & Zubaryeva (2019). See Table A1 in the Appendix for more details.

[12] To further confirm this, we checked that no such studies were included in recent meta-analyses by Bergquist et al. (2019) and Nisa et al. (2019).

al., 2016; Shi et al., 2017; Wolske et al., 2017, 2018; Noppers et al., 2019). **Future field experimental research should devote increased attention to a wider variety of energy-related choices, comprising both curtailment and investment. Motivating such a broader range of also high-cost and/or high-involvement behaviours is key for achieving ambitious climate change mitigation goals** (Dietz et al., 2009; Stern et al., 2016; Bjelle et al., 2018; Ivanova et al., 2020).

Future research should also focus on **the replication of promising findings on factors which modulate the effects of social norm interventions**. As noted in section 2.3, social norm interventions can be particularly effective for example when targeting intensive energy users or people with strong ties to their (norm) reference group. However, initially promising findings need to be replicated and tested in field conditions (Levitt and List, 2007; Maniadis et al., 2014; Allcott, 2015; Camerer et al., 2016).

A further limitation of earlier studies is that the possible impact of interventions on their targets' **emotional well-being has been largely overlooked.** Interventions are typically solely evaluated in terms of their effects on the targeted behaviour and sometimes in terms of their cost-effectiveness (e.g., Allcott, 2011b; Allcott and Rogers, 2014; Ito, 2015; Andor et al., 2020b). Evidence on how social norm interventions designed to foster sustainable energy-related behaviour affect their targets' emotional well-being is sparse and inconclusive. A number of studies suggest that social norm interventions can induce negative emotional states, for example anger (Aronson and O'Leary, 1982-83; Allcott, 2011b; Ayres et al., 2013; Sussman and Gifford, 2012; Costa and Kahn, 2013; Bergquist and Nilsson, 2016), other studies suggest a positive effect on emotions (Delmas and Lessem, 2014; Vesely et al., 2020), and some studies detect no discernible effects or report mixed findings (Toner et al., 2014; Allcott and Kessler, 2019; Leoniak and Cwalina, 2019). It is vital to **ensure that people's emotions do not take a negative hit as a result of an intervention as companies and policy makers care about their customers and constituents.** Such considerations are similarly vital in terms of promoting subsequent sustainable behaviors (cf. Carrus et al., 2008; van Zomeren et al., 2010; Feldman and Hart, 2018; Hahnel and Brosch, 2018). In particular, Masson et al. (2017) and Carrus et al. (2019) specifically support the existence of a strong link between emotions and energy-related behaviors and intentions in their meta-analysis of previous research on this topic.

A final point to consider is that **many social norm interventions employed in field experiments on energy conservation combined information on social norms with additional treatment elements**. For example, in Allcott (2011b), Ayres et al. (2013), Costa and Kahn (2013) and many other studies, social norm information is augmented with feedback on own consumption and with energy saving tips. Bator et al. (2019) and Mack et al. (2019) combine social norm information with several other intervention modules like energy saving tips, individual feedback, and commitment. See also Andor and Fels (2018) who present a graphical overview of different intervention combinations in a larger set of studies. Bundling social norm information with other instruments in this way creates an identification problem, making it difficult to isolate the unique effect of norms. **It would be useful to conduct more**

field experiments capable of estimating the unique effect of social norms (see Delmas et al., 2013; Harries et al., 2013; Schwartz et al., 2013; Dolan and Metcalfe, 2015; Komatsu and Nishio, 2015; Bhanot, in press). In this call we echo Delmas et al. (2013, p. 737) who point out that while their meta-analysis "*suggests that information strategies [e.g., social norms, feedback on own consumption, energy saving tips] induce energy conservation, it is less clear which strategies work best, in part because many experiments simultaneously use more than one strategy leading to confounding issues [...]. It is [...] advisable to isolate individual strategies to assess their added value*" .

Information including simplification

Information has proven to be more effective when used in combination with other interventions (Abrahamse et al., 2005). However, studies often employ designs without including all the separate single interventions among the various experimental conditions. Therefore it is difficult to establish to establish if separate interventions combined generate additional effects.

The effects of information seem to depend largely on its specificity, and it may be that a more personalized approach such as tailoring could be more effective (McMakin et al., 2002). However, participating in an energy audit requires greater involvement and time commitment than reading a tip sheet on how to conserve electricity, thus it might be that other variables intervene in determining the effectiveness of the information interventions. With regard to this, Nisa et al. (2019) pointed out the need to evaluate the conditions under which the effect of information strategies may be boosted, for instance when delivered by trustworthy sources and easily available at the point of decision (Wolske and Stern, 2018).

Delmas et al. (2013) in their meta-analysis suggested that information strategies induce energy conservation, but it is less clear which strategies work best, in part because many experiments simultaneously use more than one strategy, leading to confounding issues and also because of the lack of methodological sophistication of some of the studies. To better identify the winning strategies, additional experiments are needed. **Sound experiments in energy conservation should use dedicated control groups, take sufficient baseline measurements and control for factors such as geography, climate variables, weather, and demographic characteristics. The field could also benefit from studies of longer duration and larger sample size**.

Monetary incentives

The general idea that material incentives affect different people differently (wherein some people attach greater importance to own material utility than others, see e.g. Fischbacher et al., 2001) and that contextual factors modulate incentive effects (e.g., Dufwenberg et al., 2011) finds substantial support in economic theory and should be more thoroughly investigated in the domain of energy-related behaviour, building on research by Reiss and White (2005), Schwartz et al. (2015), Xu et al. (2015) and others (see section 2.5). In other words, it would be useful to **replicate promising results on the contextual factors that modulate the effects of incentive-based interventions**.

In addition, the literature shows that the presence of incentives can alter the effect of interventions that invoke social norms, pro-environmental attitudes, and other inherent motives (Drews et al., 2020; but see Brent and Wichman, 2020; West et al., 2020). Results reported by Sudarshan (2017) showcase the potential importance of this issue for energy conservation campaigns. The author found that adding incentives to an intervention based on norms and feedback completely eliminated the positive effect that the intervention had in the absence of financial incentives to save energy. Pellerano et al. (2017) report a very similar finding.[13] **The usefulness of integrating financial incentives with non-monetary instruments (and vice versa) must therefore be carefully assessed in subsequent research.** It could for example be argued that public decision-makers might not want to implement financial incentives where the job can be equally well done by non-financial ones, as they might want so save that investment and only apply financial tools in situations where other things do not work, or work minimally.

Finally, **it might be useful to examine the long-term effects of incentives on behaviour and motivation**. In particular, it should be examined whether and to what extent their effect lasts when incentives are suspended (see for example Ito et al., 2018; Azarova et al., 2020). Similarly, the possibility of **measuring and modelling the effect of incentives on the intrinsic motivation to implement and maintain pro-environmental behavioural changes in the energy domain should be considered** (see Deci et al., 1999; Steinhorst and Klöckner, 2018).

Commitment

Subsequent research should provide an in-depth analysis of the **role of the emotional experiences that accompany commitment.** These would presumably depend on whether commitment was made or not, and (provided that commitment was made) on whether or not the actor successfully completed the behaviour or goal to which they committed. The possibility of negative (anticipated) emotions that may be associated especially with public commitment is discussed in Lokhorst et al. (2015), and results in Löschel et al. (2020) illustrate that people may prefer to avoid getting goal-setting nudges.

In addition, it might be appropriate to **investigate attitudinal, personality and contextual moderators affecting the success of commitment strategies.** Null results reported, e.g., in Lokhorst et al. (2015) stress the need for a careful implementation of commitment-based strategies, including the consideration of influential moderators of the

[13] While their results need to be interpreted with caution, Braito et al. (2017) reported interesting differences in psycho-social drivers of photovoltaic investments in two regions (northern Italy and southern Austria) with different levels of state financial support for these investments. For example, the motivation to protect the environment appeared to be less important in the northern Italian context, a result perhaps partly attributable to the availability of generous state incentives in that region. Interestingly, social norms had a similar role in the two regions.

interventions' effects (Pallak and Cummings, 1976; Matthies et al., 2006; Brandsma and Blasch, 2019; van der Werff et al., 2019).

At least from a theoretical perspective, a shortcoming of existing commitment-based interventions is that they are often coupled with other intervention elements, such as energy consumption feedbacks and energy saving tips (Abrahamse et al., 2007; Harding and Hsiaw, 2014; Mack et al., 2019; Mi et al., 2019; Legault et al., 2020). This, again, precludes a clear and straightforward attribution of the effect of interventions on commitment specifically. Consequently, future research should evaluate the unique effects of commitment and goal setting interventions

Lastly, to the best of our knowledge, there are no field experimental studies on the influence of prior commitment on subsequent eco-friendly technology adoption, despite the fact that these would be relatively easy to implement. For this reason, the possibility of broadening the scope of targeted behaviours when evaluating commitment-based energy saving interventions could also be considered.

Competition

As for other behavioral interventions, **competition campaigns are often paired with other strategies** (e.g., feedback, norms, energy saving tips, commitment, and prompts), **not allowing to separate the effect of competition itself from the effect of these other elements** (Senbel et al., 2014). Furthermore, because the competitions used different metrics and designs, mostly without any experimental design, **it is difficult to identify the most effective competitions or even the best practices for their design and implementation** (Vine and Jones, 2016). In relation to this, as pointed out by Bergquist et al. (2017), further research is needed with respect to how competition-based interventions should be employed in the field to maximize their impact, while avoiding negative side-effects.

As pointed out by Sintov et al. (2016), **future studies with larger samples, longer durations, and experimental designs would enable us to draw stronger conclusions about the effectiveness of competition-based energy reduction interventions**. Longer-term studies that collect follow-up energy use and self-report data in the post-interventions phases are also needed to investigate the durability of behaviour changes and to better understand the potential impacts of competitions and socio-feedback systems. **Future studies should also provide assessments of additional psychosocial and individual variables** (e.g., risk aversion, confidence, gender) **that can inform the processes of behaviour change**.

Collective vs. Individual Framing

While there have been many more studies conducted on the relationship between message framing and behaviour change in other areas such as safety and health, **there are far fewer studies related to pro-environmental behaviour change** (Cheng et al., 2011).

The literature shows that loss-framed messages often have greater behavioural impact than gain-framed messages, particularly when a self-referencing frame (i.e., emphasis in losses to oneself) is used and/or losses for the current generation are emphasised

(Fredericks et al., 2015). However, **various factors may moderate the motivational impact of a particular message frame** (e.g., gender, frequency of participation in the behaviour, level of engagement in environmental behaviours in general and propensity to change, level of risk associated with target behaviour, see Cheng et al., 2011), and **these should be further analysed to maximise the effectiveness of communication**. For instance, some evidence from persuasive social contexts suggests that while negative message frames may be more effective with self-referencing appeals, positive frames may be more effective given a self-other frame (i.e., emphasising the benefits to oneself and others) (Loroz, 2007).

The following figure (C) summarizes the research gaps inherent in each behavioural intervention described above

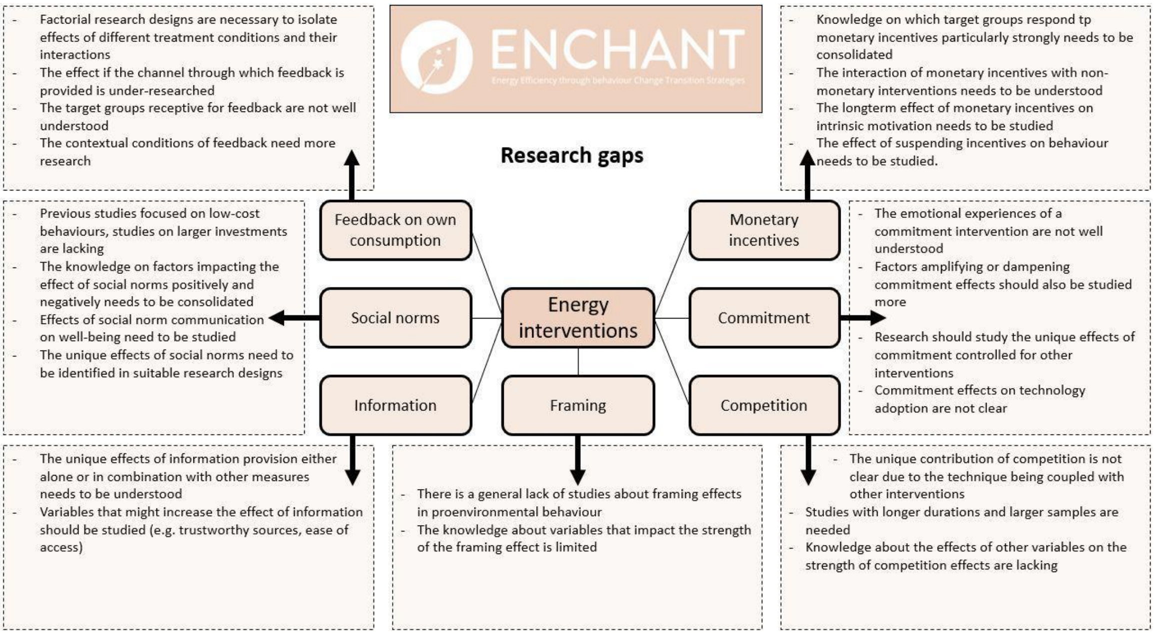


Figure C – research gaps emerged from the comprehensive review focused on energy-related behavioural interventions

3. Conclusions

Among the basic goals that drive the ENCHANT's endeavour, there is the assumption on the importance of understanding and systematically assess which strategies are more capable to mobilize individuals, groups and communities and stimulate a wider engagement in sustainable energy behaviours in our societies.

As a first step in the pursuit of this general goal, the focus of WP2 is to "Identify key factors affecting intervention impact on energy behaviour". This is aim linked to the activities of Task T2.1, where we have been analysing the existing literature in the domain of social and behavioural science, and produced a comprehensive review of existing behavioural interventions, drawing on established findings from previous studies, research projects and practical interventions where psychological science and behavioural insights have been applied to the domain of energy choices or sustainable lifestyles.

Given these identified objectives, in this report we have analysed and described a large set of published studies, systematic reviews and meta-analyses identified as useful to synthesize this broad corpus of studies. Our purpose has also been to discuss the good and bad practices affecting the success or failure of practical interventions as well as the major contextual boundary conditions that are linked to more or less successful practices to promote a sustainable energy transition.

Along with acknowledging the contribution of social and behavioural science for improving private energy efficiency in real life settings, one must also recognize the limits of many studies in this area, which are often based on small-scale pilot studies. Thus, an open issue for ENCHANT is to ascertain which intervention tools (either alone or combination with others) can be most effectively implemented, by which societal actor, in which cultural context. Answering these questions would allow to identify measurable effects the applicability of such programs in real-life, cost-efficient, and practical settings, thus making them more potentially scalable at the European level.

The literature review we conducted and presented here gives us some interesting insights on what the most effective approaches in behavioural intervention design could be:

First, we show that there is no "silver bullet" approach. None of the intervention types have reliably large effects (i.e., irrespective of context and the target population). However, some interventions seem more promising than others. In some cases, economically meaningful effects have been reported for incentive-based strategies (Faruqui and Sergici, 2010; Allcott and Taubinsky, 2015; Ito et al., 2018; Bollinger et al., 2020b), norms (Bator et al., 2019; Brülisauer et al., 2020).

Second, we discussed the advantages, as well as the problems associated with combining different intervention elements (e.g., social norms + financial incentives) in a single intervention "package". The problems with this approach are clear: confounding issues preclude a good understanding of what actually works and what does not work when bundling intervention elements without appropriate control conditions (cf. Delmas et al., 2013; Harries et al., 2013; Bhanot, in press). The potential promise of grouping different intervention elements, although logical (i.e., intervening on more than one aspect should produce bigger outcomes), is however less clear when it comes to the need of a systematic assessment, and much more research should be devoted to this important issue. As discussed in a recent paper by Drews et al. (2020), combining different intervention elements can lead to synergy (the intervention package as a whole having a stronger effect than each component of that package individually), but it can also lead to weakening of the effect of one or more of the intervention elements. While, intuitively, we might be led to assume that the more elements an intervention has the more effective it will be (cf. Abrahamse et al., 2007; Osbaldiston and Schott, 2012; Mack et al., 2019), research often rather suggests an absence of synergistic effects when using multiple intervention elements (Harries et al., 2013; Schwartz et al., 2015; Pellerano et al., 2017; Sudarshan, 2017).

Third, whether the intervention has a relatively strong effect on the whole or not, targeting the intervention to the most receptive groups can substantially increase its effect. The segmentation variables that we reviewed include for example contextual or background factors, such as baseline energy usage (Schultz et al., 2007, 2016; Allcott, 2011b), socio-demographic characteristics (Bollinger et al., 2020b; Rodemeier and Löschel, 2020; Stojanovski et al., 2020), political preferences (Costa and Kahn, 2013; Schwartz et al., 2015; Xu et al., 2015), and more (strictly sepaking) psychological factors, such as personal norms (Schultz et al., 2016; Steinhorst and Matthies, 2016) or values (Bonan et al., 2019; Brandsma and Blasch, 2019). Again, further research is needed to get a more robust and reliable understanding of the role of the various segmentation variables. From an applied perspective, one would like to obtain a list of segmentation variables that are relatively easy to observe or measure.

Fourth, researchers and practitioners need to pay closer attention to the broader, often unintended, effects of behavioural interventions. These can be positive, such as increased performance of behaviours not targeted by the intervention (Steinhorst et al., 2015) or enjoyment and other positive emotional experiences (Delmas and Lessem, 2014; Vesely et al., 2020). At the same, time, it is also important to be aware of the potential risks or negative side effects, such as avoidance (Löschel et al., 2020), motivation crowding out (Schwartz et al., 2015), experiencing negative emotions (Sussman and Gifford, 2012), and reactance (Bergquist and Nilsson, 2016). To find the best approach, interventions thus need to be thoroughly pre-tested prior to their large-scale roll out, which is one of the main practical goals of the ENCHANT project, and which will be in the focus of the ensuing tasks in WP2 as well as in the remaining WPs.

In conclusion, we can affirm that this first review of the available knowledge about the outcomes of different kinds of behavioural interventions in the energy domain, as well as of the main existing policies for the sustainable energy transition (either individual or structural), currently in place in different countries to promote, is a first step to pursue the ensuing tasks in the ENCHANT project in general, and in WP2 in particular.

In the next phases of the project, our efforts will be in fact focused on designing a set of intervention packages and identifying the main variables to be included in these packages (both in terms of independent variables to be tested and in terms of outcome indicators to be taken for assessing the interventions), as well as the practical implementation strategy and the main communication channels to be exploited.

This will then lead to the definition the protocols for standardised interventions for behavioural change, to be developed through participatory co-construction workshops, together with our user partners, where we will define the specific intervention matrix.

In so doing, we will be taking into account the practical constraints, the policy implications, the main infrastructures and policy schemes available across the different countries and partners involved in ENCHANT, focusing on one or more of the intervention types to be implemented (i.e., feedback, social norms, information, monetary incentives, commitment, competition, individual/collective framing).

Appendix A

The reader will notice that we are including articles relying on different methods and focusing on different behaviours in the tables below. Meta-analyses should be given greater weight when evaluating the evidence, as they are by design based on more observations than individual studies. Field experimental studies should also be given greater weight, as the results of online and lab studies do not always easily translate to field settings which are of primary interest to us here (Fehr and List, 2004; Levitt and List, 2007; Rondeau and List, 2008). Owing to their greater internal validity, experimental designs are generally to be given greater weight than non-experimental designs (cf. Falk and Heckman, 2009; Ferraro and Miranda, 2014, 2017; Wichman and Ferraro, 2017). Finally, studies on energy-related behaviours, rather than on other pro-environmental behaviours, best reflect the current project's thematic focus and should therefore be also given greater weight when evaluating the interventions.

Table A1: Overview of former research – social norms

Source	Main methodology used	Main target behavior(s)	Effect of social norm confirmed?
Abrahamse and Steg (2013)	Meta-analysis of field experimental studies[14]	Resource conservation	No effect (results for "socially comparative feedback" and for "social norm information and feedback")[15]
Andor et al. (2020a)	Meta-analysis of field experimental studies	Energy conservation	Small decrease in energy consumption
Bamberg and Möser (2007)	Meta-analysis of correlational studies	Various pro-environmental behaviours and intentions	Moderate positive correlation with pro-environmental behaviour (pooled correlations results) Large positive correlation with pro-environmental intention (pooled correlations results)

[14] Several relevant meta-analyses are available, and primary sources covered by meta-analyses included in Table A1 are not listed separately to avoid double-counting. Some double-counting may still be involved when the referenced meta-analyses include some of the same primary studies or when the referenced primary studies rely on some of the same data.

[15] For the purposes of this report, a change of less than five percent compared to control is considered a "small" effect, a change of 5-10 percent is considered a "medium-sized" or "moderate" effect, and a change of more than ten percent is considered a "large" effect. A change of 40 percent or less of a standard deviation compared to control is considered a small effect, a change of 40-80 percent of a standard deviation is considered a medium-sized effect, and a change of over 80 percent of a standard deviation is considered a large effect. A correlation below |.2| is considered a small effect, a correlation between |.2| and |.4| is considered medium-sized, and a correlation above |.4| is considered large. In case an effect reported in a primary study or meta-analysis is statistically indistinguishable from zero, we normally write that there was "no effect" (rather than that the effect was "small"). These cut-offs are selected ad hoc, based on established recommendations (e.g., Cohen, 1988) and taking into account perceptions of scholars and practitioners in the energy field. Our interpretation of the quantitative values reported in primary studies and meta-analyses is meant to give an approximate, qualitative sense of the quantitative data. A quantitative synthesis of previous research is beyond the scope of this report. A proper quantitative synthesis would for example need to take into account the number of observations on which each effect size reported in a primary study is based, and thus a small-scale pilot like Caballero & DellaValle (2020) would influence the overall aggregated effect size much less than a large-scale trial like Allcott (2011b).

Bergquist et al. (2019)	Meta-analysis of field experimental studies	Various pro-environmental behaviours	Small increase in pro-environmental behaviour
Buckley (2020)	Meta-analysis of field experimental studies	Energy conservation	No effect (meta-regression results, full model specification)
Delmas et al. (2013)	Meta-analysis of field experimental studies	Energy conservation	No effect (meta-regression results, full model specification)
Jachimowicz et al. (2018)	Meta-analysis of field experimental studies	Energy conservation	Small decrease in energy consumption (results for O power trials)
Klöckner (2013)	Meta-analysis of correlational studies	Various pro-environmental behaviours and intentions	Moderate positive correlation with pro-environmental behaviour (pooled correlations results) Large positive correlation with pro-environmental intention (pooled correlations results)
Nemati and Penn (2020)	Meta-analysis of field studies (experiments, quasi-experiments and observational studies)	Energy conservation	Moderate decrease in energy consumption (results for "simple comparative feedback" and "efficient comparative feedback")
Nisa et al. (2019)	Meta-analysis of field experimental studies	Various pro-environmental behaviours	Small increase in pro-environmental behaviour (results

			for "social comparison")
Osbaldiston and Schott (2012)	Meta-analysis of experimental studies	Various pro-environmental behaviours	Moderate increase in pro-environmental behaviour (results for "social modelling")
Pettifor et al. (2017a)	Meta-analysis of studies with various methodologies (e.g., stated choice experiments, surveys)	Acceptance of alternative fuel vehicles	Moderate increase in acceptance
Scheibehenne et al. (2016)	Meta-analysis of field experimental studies	Towel reuse by hotel guests (a behaviour associated with energy conservation due to less frequent washing)	Moderate increase in towel reuse
Andor et al. (2020b)	Field experiment	Energy conservation	Small, marginally significant decrease in energy consumption (the estimate reaches conventional levels of statistical significance in models with outliers removed)
Bator et al. (2019)	Field experiment	Energy conservation	Moderate decrease in energy consumption (result for the "feedback" treatment in Study 2)
Bollinger et al. (2020b)	Field experiment	Adoption of residential solar panels	Large increase in installations relative to control (result for the "pro-social" treatment; longer-term post-campaign

			effects not considered here)
Bonan et al. (2019)	Field experiment	Energy conservation	No effect
Brandon et al. (2017)	Field experiment	Energy conservation	Small decrease in energy consumption
Brandon et al. (2019)	Field experiment	Energy conservation during peak-load events	Small to moderate decrease in energy consumption (depending on treatment)
Brülisauer et al. (2020)	Field experiment	Energy conservation	Large decrease in energy consumption
Byrne et al. (2018)	Field experiment	Energy conservation	No effect
Caballero and DellaValle (2020)	Field experiment	Energy conservation	Mixed results depending on model specification (no effect in the model without controls; moderate decrease in consumption in the model with psycho-social controls; large increase in consumption in the model with household and demographic controls)
Crago et al. (2020)	Field experiment	Energy conservation	No effect
Henry et al. (2019)	Field experiment	Energy conservation	Small decrease in energy consumption
Holladay et al. (2019)	Field experiment	Take-up of home energy audits	No effect (result for social comparisons in terms of CO_2 emissions)

			Large increase in audit take up (results for social comparisons in terms of energy consumption and in terms of energy consumption expenditures)
		Investment in home energy-efficiency improvements	No effect
Kandul et al. (2020)	Field experiment	Energy conservation	Small decrease in temperature setting
Komatsu and Nishio (2015)	Field experiment	Motivation to conserve energy	No effect to small increase in motivation compared to control (depending on the type of normative message used)
List et al. (2017)	Field experiment	Energy conservation	Small decrease in energy consumption
Murakami et al. (2020)	Field experiment	Energy conservation during peak-demand hours	No effect
Myers & Souza (2020)	Field experiment	Energy conservation	No effect
Wong-Parodi et al. (2019)	Field experiment	Energy conservation	Large decrease in energy consumption
DellaValle and Zubaryeva (2019)	Stated choice experiment	Preferences for purchasing an electric vehicle	No effect
McCalley et al. (2011)	Laboratory experiment (hypothetical choice)	Energy conservation	Moderate decrease in energy consumption

Neumann and Mehlkop (2020)	Stated choice experiment and survey	Preferences for electricity generated from renewable sources	Large positive correlation
Bollinger & Gillingham (2012)	Observational study[16]	Adoption of residential solar panels	Small increase in the probability to install (result for zip code-level data)
Bollinger et al. (2020a)	Observational study	Adoption of residential solar panels	Moderate increase in the probability to install
Inhoffen et al. (2019)	Observational study	Adoption of residential solar panels	Large increase in the probability to install
Graziano & Gillingham (2015)	Observational study	Adoption of residential solar panels	Large increase in the probability to install
Richter (2013)	Observational study	Adoption of residential solar panels	Small increase in the probability to install
Rode and Weber (2016)	Observational study	Adoption of residential solar panels	Small increase in the probability to install
Barth et al. (2016)	Correlational questionnaire study	Intention to use an electric vehicle	Moderate to large positive correlations (results for the "general acceptance" scenario)
Bobeth and Kastner (2020)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation (result from bivariate correlation analysis)
Curtius et al. (2018)	Correlational questionnaire study	Intention to install residential solar panels	Small positive association

[16] While the focus of this literature review is on field experiments, examples of questionnaire and observational studies on energy efficiency and eco-friendly technology investments (e-cars, solar panels) are included due to a lack of social norm field experiments focusing on these high-cost, high-involvement choices.

Fornara et al. (2016)	Correlational questionnaire study	Intention to install solar panels and invest in thermal isolation of one's home	Small to moderate positive correlations (results from bivariate correlation analysis)
Haustein and Jensen (2018)	Correlational questionnaire study	Having purchased an electric vehicle	Moderate positive association
		Intention to purchase and use an electric vehicle	Small positive association
Jansson et al. (2017)	Correlational questionnaire study	Having purchased an electric vehicle	No unique effect
Kalkbrenner and Roosen (2016)	Correlational questionnaire study	Willingness to participate in community renewable energy projects	Moderate positive correlation (result from bivariate correlation analysis)
Korcaj et al. (2015)	Correlational questionnaire study	Intention to install residential solar panels	Moderate positive association
Lundheim et al. (in press)	Correlational questionnaire study	Intention to install residential solar panels	No effect
Mohamed et al. (2016)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation (result from bivariate correlation analysis)
Mohamed et al. (2018)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation (result from bivariate correlation analysis)
Moons and De Pelsmacker (2012)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation (result for "peer" norms from bivariate correlation analysis)

Moons & De Pelsmacker (2015)	Correlational questionnaire study	Intention to purchase an electric vehicle	Small, marginally significant positive association (result for "peer" norms)
Noppers et al. (2019)	Correlational questionnaire study	Intention to use smart energy systems	Medium-sized positive correlations with interest in smart energy systems and with intention to use them
		Intention to purchase an electric vehicle	Large positive correlations with interest in electric cars and with intention to purchase one
Parkins et al. (2018)	Correlational questionnaire study	Intention to install residential solar panels	Large positive association
Petschnig et al. (2014)	Correlational questionnaire study	Intention to purchase an alternative fuel vehicle	Small positive association
Rezvani et al. (2018)	Correlational questionnaire study	Intention to purchase an electric vehicle	Moderate positive correlation (result from bivariate correlation analysis)
Shi et al. (2017)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation
Simsekoglu and Nayum (2019)	Correlational questionnaire study	Intention to purchase an electric vehicle	Moderate positive association
Sparks et al. (2014)	Correlational questionnaire study	Intention to reduce energy consumption	Large positive correlation

Thøgersen and Ebsen (2019)	Correlational questionnaire study	Intention to purchase an electric vehicle	Large positive correlation (result from bivariate correlation analysis)
Vasseur and Kemp (2015)	Correlational questionnaire study	Potentially installing residential solar panels	No effect
Wang et al. (2016)	Correlational questionnaire study	Intention to purchase a hybrid electric vehicle	Large positive correlation (result from bivariate correlation analysis)
Wolske et al. (2017)	Correlational questionnaire study	Interest in residential solar systems	Large positive correlation (result from bivariate correlation analysis)
		Interest in talking to a solar panel installer	Large positive correlation (result from bivariate correlation analysis)
Wolske et al. (2018)	Online survey and experiment	Attitudes toward residential solar panels, intention to respond to a solar panel ad	Large positive associations
Yun and Lee (2015)	Correlational questionnaire study	Intention to use renewable energy systems (e.g., residential solar)	No to small positive association (results from bivariate correlation analysis for "social support" and "social norm", respectively)
Zhang et al. (2018)	Correlational questionnaire study	Intention to purchase an electric vehicle	Moderate positive correlation

Table A2: Overview of former research – incentives and costs

Source	Main methodology used	Main target behaviour(s)	Type of incentive or cost	Effect of incentive or cost confirmed?
Buckley (2020)	Meta-analysis of field experimental studies[17]	Energy conservation	Monetary information (information on electricity consumption costs)	Small increase (sic!) in electricity consumption (meta-regression results, full model specification)
			Various pricing strategies	No effect (meta-regression results, full model specification)
Delmas et al. (2013)	Meta-analysis of field experimental studies	Energy conservation	Monetary information (information on potential savings from energy conservation)	No effect (meta-regression results, full model specification)
			Various incentives, including rebates, cash rewards, and tiered electricity pricing	Small increase (sic!) in energy consumption (meta-regression results, full model specification)
Faruqui and Sergici (2010)	Meta-analysis of field	Energy conservation	Time-of-use electricity pricing	Small decrease in energy consumption

[17] Primary sources are not listed in Table A2 if a meta-analysis covering those sources is included here (to avoid double-counting).

	experimental studies		Critical-peak electricity pricing	Large drop in electricity demand during peak hours
Labandeira et al. (2017)	Meta-analysis of studies with various methodologies (e.g., surveys, analyses of micro-economic data)	Energy conservation	Energy price	Small short-term decrease in consumption in response to increased price (price elasticity equal to -0.221 in the GLS model) Moderate long-term decrease in consumption in response to increased price (price elasticity equal to -0.584 in the GLS model)
Labandeira et al. (2020)	Meta-analysis of studies with various methodologies (e.g., experiments, analyses of micro-economic data)	Energy conservation	Various incentives, including carbon tax, tax relief, and subsidies	Moderate decrease in energy demand
Maki et al. (2016)	Meta-analysis of experimental and quasi-experimental studies	Various pro-environmental behaviours	Various incentives, including cash rewards and coupons	Small increase in pro-environmental behaviour
Nemati and Penn (2020)	Meta-analysis of field studies (experiments, quasi-	Energy conservation	Monetary information (information on electricity	Moderate decrease in electricity consumption

	experiments and observational studies)		prices, information on potential savings from energy conservation)	(results for “pricing information” and “monetary incentives”)
Zhu et al. (2018)	Meta-analysis of studies with various methodologies (e.g., surveys, analyses of micro-economic data)	Energy conservation	Electricity price	Small short-term decrease in consumption in response to increased price (price elasticity equal to -0.228) Moderate long-term decrease in consumption in response to increased price (price elasticity equal to -0.577)
Allcott and Greenstone (2017)	Field experiment	Take-up of home energy audits	Subsidized audit price	Large positive effect (result for a $100 subsidy)
			Cash reward for participating in the energy audit	No effect
			Monetary information (information on economic benefits of energy-efficiency improvements and on available financing options)	No effects (results for the following treatments: “info: financial”, “financing: credit”, “financing: incentives”, and “prime: financial”)

		Investment in home energy-efficiency improvements	Subsidized audit price	No effect
			Cash reward for participating in an energy audit	No effect
			Monetary information (information on economic benefits of energy-efficiency improvements and on available financing options)	No effects (results for the following treatments: "info: financial", "financing: credit", "financing: incentives", and "prime: financial")
Allcott and Sweeney (2017)	Field experiment	Purchasing energy-efficient water heaters	Monetary information (information on financial savings over time from buying an efficient water heater)	No effect
			Rebate	No effect (result for a $25 rebate) Large increase in the probability to buy an efficient model (result for a $100 rebate)
Allcott and Taubinsky (2015)	Field experiment	Purchasing energy-efficient light bulbs	Monetary information (information on total user costs,	No effect

			including energy usage costs, for different types of light bulbs)	
			Rebate	Large increase in demand for energy-efficient light bulbs
Azarova et al. (2020)	Field experiment	Energy conservation during a 15-minute peak period	Reward in the form of seven days of free electricity if 50 percent consumption reduction is achieved	No effect (“monetary incentive” treatment effect estimated in the full model with date fixed effects; rebound effects not considered here)
Bollinger et al. (2020b)	Field experiment	Adoption of residential solar panels	Monetary information (information on economic and also on other non-financial benefits)	Large increase in installations relative to control (longer-term post-campaign effects not considered here)
Burkhardt et al. (2019)	Field experiment	Energy conservation during peak events	Critical peak pricing	Large decrease in electricity consumption during peak events
d’Adda et al. (2020)	Field experiment	Purchasing energy-efficient refrigerators	Monetary information (information on energy usage costs for different	Small drop (sic!) in demand for energy-efficient products (result from ordered probit regression

			available products)	aggregating across monetary information treatments)
Faruqui et al. (2013)	Field experiment	Energy conservation during peak events	Critical peak pricing	Large drop in electricity consumption during peak events
			Peak time rebate	Large drop in electricity consumption during peak events
Gillingham and Bollinger (in press)	Field experiment	Adoption of residential solar panels	Group pricing discount (an installation's price is a function of the total number of contracts signed as part of the campaign)	No effect (comparison of the "no group pricing" campaigns and the Round 5 "classic Solarize" campaigns)
Holladay et al. (2019)	Field experiment	Take-up of home energy audits	Reward for participating in the energy audit (gift card)	No effect (result for a $20 reward) Large, marginally significant increase in audit take-up (result for a $50 reward)
		Investment in home energy-efficiency improvements	Reward for participating in an energy audit (gift card)	No effect

Ito et al. (2018)	Field experiment	Energy conservation during peak-demand hours	Critical-peak electricity pricing (increased electricity price during peak hours)	Large decrease in electricity consumption
List et al. (2017)	Field experiment	Energy conservation	Offer of rewards (e.g., gift cards) for reductions in energy usage	Small, marginally significant decrease in energy consumption (intent-to-treat analysis)
Murakami et al. (2020)	Field experiment	Energy conservation during peak-demand hours	Rebate for reduced electricity use in peak-demand hours	Small decrease in electricity consumption during peak-demand periods
Pellerano et al. (2017)	Field experiment	Energy conservation	Monetary information (information on the participant's electricity tariff and on potential savings from energy conservation)	No effect
Prest (2020)	Field experiment	Energy conservation during peak-demand hours	Time-of-use electricity pricing	Moderate decrease in electricity consumption during peak-demand periods
Rodemeier and Löschel (2020)	Field experiment	Purchasing energy-efficient light bulbs	Monetary information (information on energy usage monetary	Less detailed information treatment: No effect (results from

			savings for different types of light bulbs)	regressions on pooled treatments) More detailed information treatment: Large drop (sic!) in demand for the most efficient light bulb, large increase in demand for the second most efficient light bulb, and large drop in demand for the least efficient light bulb (results from regressions on pooled treatments)
			Discount	Large increase in demand for the most efficient light bulb, no effect of discounts on other types of light bulbs (results from regressions on pooled treatments)
Royal and Rustamov (2018)	Field experiment	Energy conservation during peak-demand events	Critical-peak electricity pricing	Large decrease in electricity consumption

				during peak-demand events
Stojanovski et al. (2020)	Field experiment	Energy conservation	Monetary information (information on the participant's electricity tariff and on potential monetary savings from energy conservation)	Small, marginally significant decrease in energy consumption (intent-to-treat analysis)
Sudarshan (2017)	Field experiment	Energy conservation	Rewards for below-average and penalties for above-average electricity consumption	Moderate increase (sic!) in consumption (incremental effect of incentives compared to the "information only" treatment; compared to control, which is a less appropriate comparison here, there was no effect)
Yoeli et al. (2013)	Field experiment	Allowing the utility company to remotely switch off one's air conditioning during peak-demand events	Financial reward	No effect
Wolak (2011)	Field experiment	Energy conservation	Critical peak pricing, and critical peak	Moderate to large decrease in energy consumption

			pricing plus rebate	(depending on the sample)
			Hourly pricing with day-ahead notifications of high hourly prices	Small to large decrease in energy consumption (depending on the sample)
DellaValle and Zubaryeva (2019)	Stated choice experiment	Preferences for purchasing an electric vehicle	Monetary information (making future cost savings salient)	Moderate positive effect
Kormos et al. (2019)	Stated choice experiment	Preferences for purchasing "zero emission" vehicles	Subsidy	Large increase in stated demand
Neumann and Mehlkop (2020)	Stated choice experiment	Preferences for electricity generated from renewable sources	Monetary information (framing of costs of subscribing to a renewable electricity plan as foregone savings or as additional expenditures)	Large decrease in preferences for a renewable electricity tariff when the costs of switching to it are framed as additional expenditures rather than as foregone savings
			Increased price of electricity generated from renewable sources relative to a standard "grey" electricity tariff	Large decrease in preferences for the renewable electricity plan
Wolske et al. (2018)	Online experiment and survey	Attitudes toward residential solar panels,	Monetary information (gain vs. loss framing of	No effect

		intention to respond to a solar panel ad	projected financial savings stemming from an installation)	
			Monetary information (framing financial savings stemming from an installation as monthly, annual, or lifetime)	No effect
			Monetary information (detailed breakdown of how the projected savings were derived)	Small positive effect of more detailed information on attitudes, no effect on intention
			Projected financial savings resulting from an installation	Small positive effect of high savings (compared to low savings)
Azarafshar and Vermeulen (2020)	Observational study	Purchasing hybrid and electric vehicles	Point of sales incentives	Moderate positive effect (result for a C$1000 incentive, full model specification)
Carfora et al. (2017)	Observational study	Increasing the share of electricity generated from renewables (excl. hydro power)	Subsides	No effect

Clinton & Steinberg (2019)	Observational study	Purchasing electric vehicles	Rebate	Moderate positive effect (result for a $1000 rebate)
			Income tax credit	No effect
Datta and Filippini (2016)	Observational study	Purchasing energy-efficient appliances	Rebate	Large increase in sales (estimate using the probit model)
Dharshing (2017)	Observational study	Adoption of residential solar panels	Return on investment (influenced by installation costs, policy incentives and local irradiation)	Positive correlation
Gallagher and Muehlegger (2011)	Observational study	Purchasing hybrid-electric vehicles	Sales tax waiver, income tax credit	Large positive effects (estimates for the mean tax sales waiver and the mean income tax credit)
Gilbert & Zivin (2014)	Observational study	Energy conservation	Monetary information (arrival of one's electricity bill)	Small decrease in energy consumption in the week following the arrival of a bill
Ito (2015)	Observational study	Energy conservation	Rebate (electricity price discount when lowering one's electricity consumption)	No to small positive effect on energy conservation (depending on geographical location)

Jenn et al. (2018)	Observational study	Purchasing electric vehicles	Tax credit	Small positive effect (result for a $1000 tax credit)
			Subsidies for electric vehicle charging infrastructure	No effect
Kwan (2012)	Observational study	Adoption of residential solar panels	Residential cost of electricity from the grid	Strong positive correlation
			Various state, local and utility incentive policies	Strong positive correlation
Münzel et al. (2019)	Observational study	Purchasing electric vehicles	Various incentives, including rebates and tax reductions	Moderate increase in demand (result for aggregated financial incentives)
Narassimhan and Johnson (2018)	Observational study	Purchasing hybrid and electric vehicles	Various incentives including income tax credit, sales tax waiver and rebates	Small positive effect (estimate aggregating across vehicle and incentive types)
Qiu et al. (2019)	Observational study	Purchasing electric vehicles	Purchase subsidy	No effect
			Charging discount	Large positive effect
			Subsidies for charging infrastructure construction	Large positive effect
Wee et al. (2018)	Observational study	Purchasing electric vehicles	Various incentives, including home	Moderate positive effect

			charger subsidy and tax reductions	(result for a $1000 subsidy)
Zhang et al. (2016)	Observational study	Purchasing electric vehicles	Vehicle price	No effect
			Toll waiver	Small increase in demand
Wolske et al. (2017)	Correlational questionnaire study	Interest in residential solar systems	Concerns about the costs of solar	No effect (result from bivariate correlation analysis)
		Interest in talking to a solar panel installer	Concerns about the costs of solar	Small negative correlation (result from bivariate correlation analysis)

Table A3: Overview of former research – commitment and goal setting

Source	Main methodology used	Main target behaviour(s)	Effect of commitment confirmed?
Abrahamse and Steg (2013)	Meta-analysis of field experimental studies[18]	Resource conservation	Medium-sized, but statistically non-significant increase in resource conservation (results for "public commitment")
Andor et al. (2020a)	Meta-analysis of field experimental studies	Energy conservation	No effect (results for self-set goals)
			Small decrease in energy consumption (results for externally set goals)

[18] Once again, primary sources are omitted if a meta-analysis covering them is included in Table A3.

Lokhorst et al. (2013)	Meta-analysis of experimental studies	Various pro-environmental behaviours	Medium-sized increase in pro-environmental behaviour
Nisa et al. (2019)	Meta-analysis of field experimental studies	Various pro-environmental behaviours	Medium-sized increase in pro-environmental behaviour
Osbaldiston and Schott (2012)	Meta-analysis of experimental studies	Various pro-environmental behaviours	Small to moderate increase in pro-environmental behaviour (results for "commitment" and "goal setting", respectively)
Barata et al. (2017)	Field experiment	Energy conservation	No effect
Bell et al. (2016)	Field experiment	Energy conservation	Moderate increase in self-reported energy conservation behaviours
Ghesla et al. (2020)	Field experiment	Energy conservation	No effect (result for the "goal" treatment)
Legault et al. (2020)	Field experiment	Energy conservation	No effect (result for the motivational and goal-setting intervention)
Lokhorst et al. (2015)	Field experiment	Energy conservation	No effect on most behaviours, but a large increase in room temperature setting (i.e., an increase in energy consumption)
Loock et al. (2013)	Field experiment	Energy conservation	No effect to small decrease in energy consumption (depending on treatment)

Löschel et al. (2020)	Field experiment	Energy conservation	No effect
Shen et al. (2019)	Field experiment	Energy conservation	No effect
van der Werff et al. (2019)	Field experiment	Completely switching off unused appliances (instead of using standby)	No effect
Brandsma and Blasch (2019)	Online experiment	Willingness to completely switch off unused appliances (instead of using standby)	No effect in five out of six comparisons, a medium-sized, marginally significant effect in one comparison (intent-to-treat regression analysis)
Kroll et al. (2019)	Online experiment	Energy conservation	No effect
Momsen & Stoerk (2014)	Online experiment	Preferences for electricity from renewable sources	No effect (result for the "Priming-Intention" treatment)

Appendix B

Some statistics on energy demands and consumption in Romania are shown in figures below.

Figure B11: Source: (MEEMA, 2019)

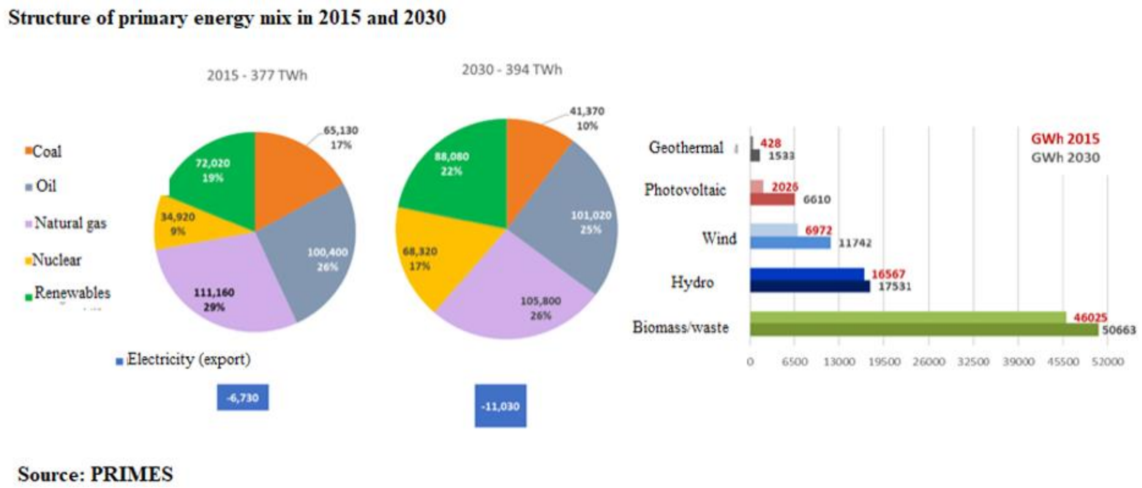


Figure B2: Source: (MEEMA, 2019)

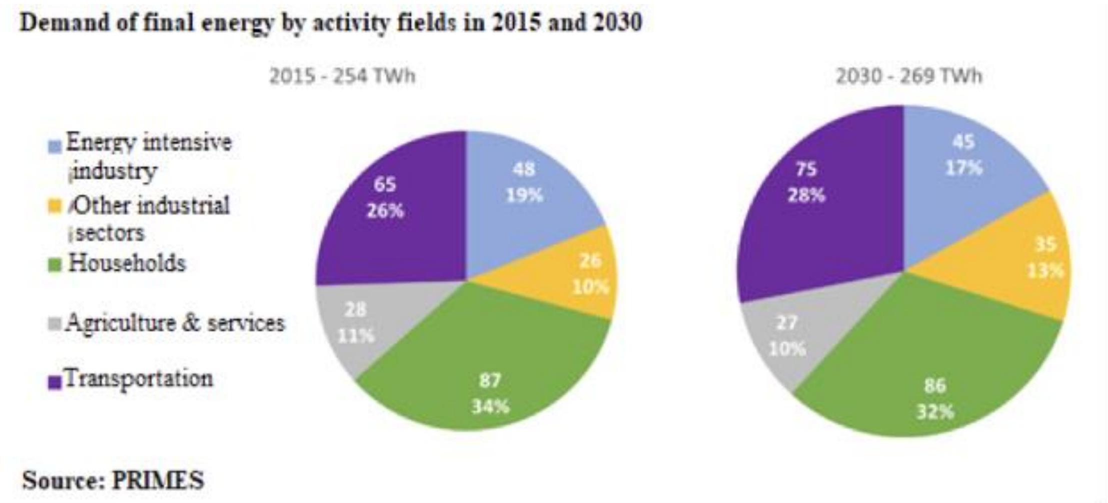
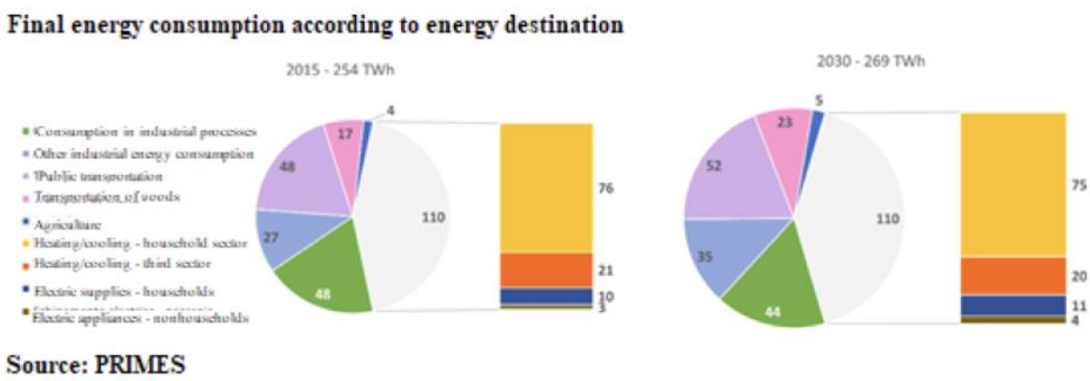


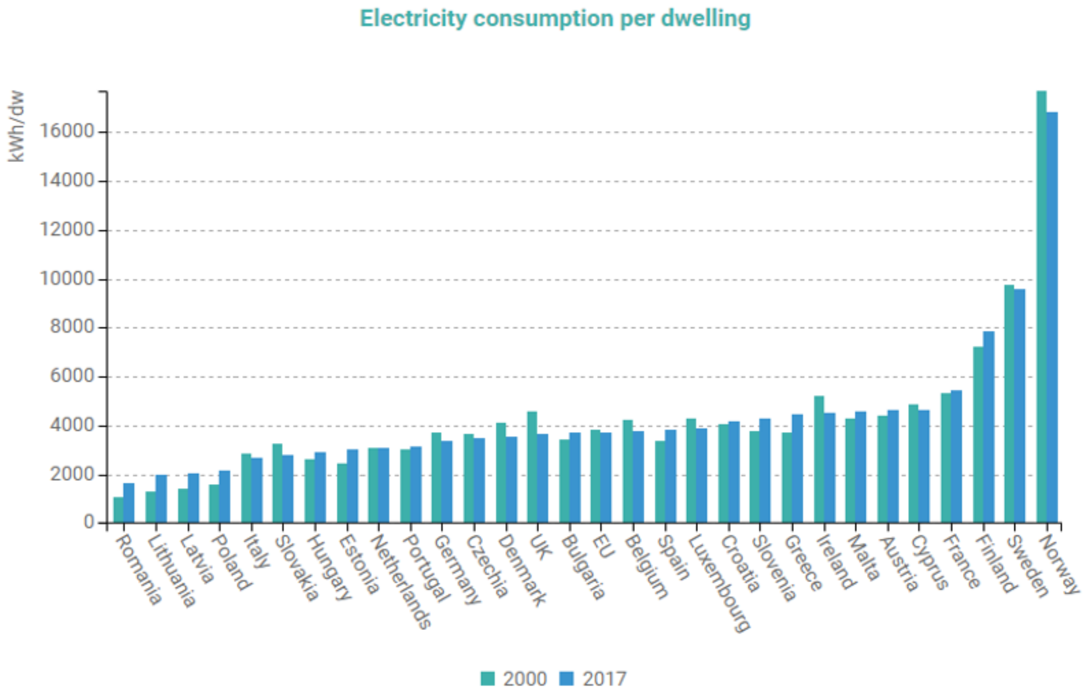
Figure B3: Source: (MEEMA, 2019)



Appendix C

Some statistics on energy demands and consumption in Norway are shown in figure below.

Figure C1: Electricity consumption per dwelling (Odyssee-Mure 2020).



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