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Mobilising citizens to invest in energy efficiency

An overview of concepts and approaches for encouraging decisions to invest in energy efficiency

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Abstract

One example of a way for citizens to contribute to the low-carbon energy transition is by investing in energy efficiency (EE). However, there are still multiple barriers that make the socially optimal level of adoption a complex target to achieve.

Over the past three decades, the debate on how to encourage EE has been guided by the physical–technical–economic model, which has a strong focus on devices and costs, and in which human behaviour has been seen as a trivial factor.

Fortunately, the advent of a new causal framework to model citizens' behaviour (behavioural economics) has started to enable the integration of the human factor into many policy areas, including EE. However, this integration is only in its infancy.

This report aims to further stimulate the policy integration of the human factor by providing policy actors, who are interested in encouraging citizens' decisions to invest in EE, with key conceptual and practical insights from four examples of energy-related social sciences (economics, behavioural economics, psychology and sociology).

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Executive summary

The role that energy efficiency (EE) plays in the fight against climate change is acknowledged worldwide. In particular, EE is seen as a 'win–win' solution, enabling not only greenhouse emissions to be reduced, but also consumer and societal welfare to be improved.

The European Union has identified EE as a priority in the decarbonisation scenarios that have been advanced in the 2050 energy roadmap ([1]) and in the European Green Deal ([2]). More specifically, the EU has acknowledged that EE can progress further by adopting different strategies across all main sectors, such as retrofitting walls and roof insulation in residential buildings, improving energy management systems in commercial buildings, promoting the replacement of equipment in manufacturing industry and changing modes of transport.

However, the global rate of adoption of EE lags far behind the rate suggested by the cost analyses that assume consumers make choices in a purely economic rational way (Nauclér and Enkvist, 2009). Thus, promoting EE is an attractive goal but is not achievable in a straightforward way.

Over the past three decades, the debate on how to encourage EE has been guided by the physical–technical–economic model, which has a strong focus on devices and costs, and in which human behaviour has been seen as a trivial factor.

Fortunately, the advent of a new causal framework to model citizens' behaviour (behavioural economics) has started enabling the integration of the human factor into many policy areas, including EE (Troussard and van Bavel, 2018). However, this integration is only in its infancy.

A plethora of studies using different social science perspectives has investigated the factors underlying individuals' decisions to invest in EE and identified key concepts that can be leveraged to increase the effectiveness of EE interventions. However, translating these concepts into practice is often challenging because of an 'information gap' in policy understanding of the complexity surrounding human behaviour (Axon et al., 2018).

As noted by Fri and Savitz (2014, p. 185), 'Policy-makers need a better understanding of how social and behavioural research could bring value to their work', and one way to promote this might be by making 'existing behavioural research accessible in language that is easily understood by the energy policy community'.

This report aims exactly to contribute to facilitating knowledge transfer to EE practitioners and policymakers. In particular, the report aims to help tackle two main questions:

i. how to understand the factors affecting the decision to invest in EE (concepts and methods);
ii. how to encourage the decision to invest in EE (encouraging measures).

Policy context

The EU has called for carbon neutrality by 2050 in the communication on the long-term 2050 climate action strategy. This highlights the pivotal role played by EE in decarbonisation efforts, which seek to reduce the final energy consumed by 50 %, compared with 2005 ([3]).

As part of the European Green Deal ([4]), the Commission has proposed to raise the 2030 greenhouse gas emission reduction target to at least 55 %, compared with 1990 levels, and a key initiative of the European Green Deal is to boost EE investments. In addition, on 14 October 2020, the European Commission launched a

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([1]) European Commission, Communication from the Commission to the European Parliament and the Council – Implementing the Energy Efficiency Directive – Commission Guidance, COM(2013) 762 final, (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013DC0762).

([2]) European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions – The European Green Deal, COM(2019) 640 final, 11.12.2019 (https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf).

([3]) European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank – A clean planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy, COM (2018) 773 final, 28.11.2018.

([4]) European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – The European Green Deal, COM(2019) 640 final, 11.12.2019 (https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf).

new specific strategy to promote EE investments in buildings: ‘A renovation wave for Europe – Greening our buildings, creating jobs, improving lives’ ([5]). This initiative builds on other building-related measures agreed under the clean energy for all European package, such as the requirement for Member States to publish a long-term building renovation strategy, the updated energy performance of buildings directive (Directive (EU) 2018/844) ([6]), and EU Member States’ national energy and climate plans. As part of the renovation wave package, the European Commission has also strengthened its commitment to tackling energy poverty with the recommendation on energy poverty ([7]). More specifically, the renovation wave package identifies EE investments in the built environment as a central lever for addressing energy poverty (defined as the ‘inability to keep home adequately warm’ ([8])). Investing in the EE of the built environment can, indeed, not only lead to a decrease in energy demand for services, such as keeping a warm/cool indoor temperature (depending on local outdoor conditions), but also contribute to alleviating energy poverty.

The European Structural and Investment Funds, such as the European Regional Development Fund, the European Social Fund and the Cohesion Fund, have also extensively promoted EE projects, as these funds support the economic and social development of EU Member States. Finally, investing in the EE of the built environment has also been recently highlighted as a key strategy for the post-coronavirus disease 2019 recovery ([9]).

Despite the plethora of measures encouraging the decision to invest in EE, the current level of EE adoption in EU is still far from optimal (Nauclér and Enkvist, 2009).

Encouraging measures, such as financial instruments, have certainly played a prominent role in the promotion of EE investments, but they have proven not to be sufficient in unlocking the full potential of EE. For example, a recent review of national financing mechanisms supporting EE investments in buildings across Europe highlighted that a transition from subsidy-focused measures to a more diverse portfolio of instruments is key to promoting EE investments in a more effective way (Bertoldi et al., 2021). Among these, novel financing models, such as the one-stop shops, have been proposed as a valid alternative to overcome non-economic barriers (Boza-Kiss and Bertoldi, 2018). These alternative models implicitly account for the human factor underlying the decision to invest in EE, by reducing the complexity characterising the renovation journey and by boosting trust.

The new energy label generation ([10]) introduced in March 2021 is also an example of an approach that accounts for the human factor. In particular, experiments have been undertaken to generate evidence on the most effective label designs, namely those based on the simple A-to-G scale, which have been more effective at making consumers understand the differences in EE than the labels that used to be adopted based on a numerical/alphabetical scale (Troussard and van Bavel, 2018). Approaches of this kind can adequately complement the portfolio of existing instruments aimed at boosting EE investments.

Policy recommendations of relevance to European Union policymakers

A policy agenda that seeks both efficacy and acceptance should be able to account for the real complexity of people’s behaviour in relation to EE. Therefore, it must be guided theoretically by an integrated perspective through which reality can be addressed (Bammer, 2006), and practically by integrated methods through which a change can be promoted (Frodeman et al., 2017). This report proposes two main recommendations for developing such a policy agenda.

([5]) European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A renovation wave for Europe – Greening our buildings, creating jobs, improving lives, COM(2020) 662 final, 14.10.2020.

([6]) European Union, Directive 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, OJ L 156, 19.6.2018.

([7]) European Commission, Commission recommendation of 14.10.2020 on energy poverty, C(2020) 9600 final, 14.10.2020 (https://ec.europa.eu/energy/sites/ener/files/recommendation_on_energy_poverty_c2020_9600.pdf).

([8]) Eurostat, European Union Statistics on Income and Living Conditions [ilc_mdes01]. (https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_mdes01&lang=en)

([9]) https://ec.europa.eu/info/strategy/recovery-plan-europe_en

([10]) https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/about_en

Recommendation 1. Analyse EE decisions through a mixed approach

The first step is analysing the type of EE decision that has to be encouraged, which can be differently interpreted by policymakers, scientists and citizens.

For example, some non-visible investments (such as renovating one's home) can be more urgent than others (i.e. lower-class households are more likely to live in houses that are not energy efficient and to have inefficient heating (cooling) systems and appliances). Moreover, EE investments are influenced not only by economic (such as capital, information) and behavioural drivers and barriers, but also by the conditions of everyday domestic life. Therefore, EE investment decisions should be explored through a combined approach that quantitatively assesses theory-driven hypotheses over identifiable variables, and through the elicitation of inputs from citizens through engagement activities and qualitative methods.

Recommendation 2. Implement encouraging measures that are identified through both citizen engagement and objective measurement

A screening of the measures that are already in place to encourage investments in EE should then follow. Subsequently, an assessment of how these are implemented and whether they can be improved or replaced, drawing from energy-related social sciences and citizens' voices, should be implemented.

For example, behavioural sciences suggest that a way to enhance the impact of incentive schemes aimed at encouraging investments in non-visible EE measures would be by tapping into the normative influence of highly visible and comparable renovations (i.e. by coupling the incentives for non-visible EE measures with incentives for home amenity renovations (i.e. kitchen, bathroom, living rooms, etc.)). However, citizens do not only care about what others think when deciding to renovate or not. In particular, they are members of the household and associate meanings, and emotional and symbolic connections with their homes when thinking about renovations. Therefore, before implementing an objectively method-driven policy measure, citizens should be engaged in a co-design process in which they co-produce and trial a prototype to achieve a shared solution.

1. Introduction

The European Green Deal ([11]) initiative represents a revolutionary turning point in the centralised approach undertaken in the low-carbon energy transition in Europe. In particular, it urges concerted actions involving not only multiple levels, from the supranational to the local, but above all European citizens.

Like any other strategy contributing to the Sustainable Development Goal targets (Alberti et al. 2019), especially those related to sustainability, the Green Deal calls for a combination of multilevel initiatives. More specifically, the initiative centres on the role of citizens, by setting the ambition that everyone should be an active protagonist in the process of greening Europe, such as by taking ownership of energy production and using energy efficiently. This initiative builds on the vision 'of an Energy Union with citizens at is core, where citizens take ownership of the energy transition' ([12]). Within this vision, citizens contribute to the process of greening Europe by making more informed consumption choices, using energy more efficiently and making optimal investment decisions.

One example of a way for citizens to contribute to the low-carbon energy transition by making optimal investment decisions is by investing in energy efficiency (EE). In particular, the adoption of low-carbon technologies providing a certain service but using less energy is one of the main ways to reduce CO_2 emissions produced by households. This is especially crucial for the building sector, which alone produces 36 % of greenhouse gas emissions in Europe ([13]).

Adopting EE measures is a practical way for citizens not only to contribute to the green transition but also to enhance their budgeting capacities. In particular, investing in EE enables people to spend less income on energy bills and other costs. That is the reason why it is often labelled as a 'win–win' opportunity. However, there are still multiple barriers that make the socially optimal level of adoption a complex target to achieve.

The empirical observation of the suboptimal level of investments in EE has been at the centre of a long debate among scientists, who, having labelled it as an 'energy efficiency gap' or 'paradox', have long attempted to identify its determinants and potential ways to tackle it (Hirst and Brown, 1990; Jaffe and Stavins, 1994). At the same time, policymakers have long attempted to close the gap by promoting EE adoption using several economic interventions. Despite these attempts, citizens are still largely prevented from engaging in the energy transition by investing in EE.

One of the potential reasons for such a lag is that the approaches that have often been adopted to understand and encourage the decision to invest in EE have not sufficiently factored in human behaviour.

For decades, energy policy has been mainly informed by science, technology, engineering and mathematics (STEM) disciplines, as a response to the diffused narrative pushing for technology development (Sovacool et al., 2015). However, as a result, it has discounted other studies in energy-related social sciences highlighting how fundamental the human factor is in shaping energy demand (Lutzenhiser, 1993; Wilhite et al., 2000).

Fortunately, with the exception of economics, which has always been treated as the most 'sciency' of the social sciences and thus entitled to inform the policy table as a STEM subject, social science disciplines (such as behavioural sciences and sociology) have now recently started feeding into the energy policy debates.

A recent example of an effort made by the European Commission to promote the integration of energy-related social sciences and humanities into energy policy resulted in the creation of the Shape Energy platform ([14]), of which an insightful output is the Think Piece Collection. This collection advocates for the social sciences to be more involved in energy policymaking and, more specifically, for an interdisciplinary approach to better address the ambition to increase the uptake of EE measures (Foulds and Robison, 2018).

The uptake of EE represents an investment decision, which substantially differs from the more habitual, often automatic, decisions on how to use energy (Rivas et al., 2016), and has been generally understood through the lenses of economics and, recently, also behavioural sciences (Gillingham and Palmer, 2014). However, there is still untapped potential to understand and address this decision using other energy-related social science lenses, such as sociology. For example, although economics and behavioural sciences focus on individual actions, sociology enables the collective dimension surrounding the decision to invest in EE to be captured. Factoring in this plethora of complementary social science lenses would enable EE policy to be more effective.

([11]) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal
([12]) https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en
([13]) https://ec.europa.eu/info/news/focus-energy-efficiency-buildings-2020-feb-17_en
([14]) https://www.shapeenergy.eu

As pushing the energy transition through EE requires cross-sectoral and multilevel collaborations among different actors, the composite knowledge of the human factor in EE has to be accessible not only to a few expert actors. This report aims exactly to provide those actors who are interested in encouraging investments in EE with key conceptual and practical insights from four examples of energy-related social sciences (economics, behavioural economics, psychology and sociology). In particular, the concepts and interventions reviewed in this report are meant to further stimulate the policy integration of the human factor, and to help policymakers better appreciate and address the factors enabling citizens to contribute to the green transition by investing in EE.

2. Understanding citizens' decision to invest in energy efficiency: concepts

Energy policymaking has been traditionally informed by the physical–technical–economic model (PTEM), which focuses on the physical characteristics of buildings and technologies and aggregate effects on energy prices (Lutzenhiser, 1993). Such an approach reflected a long-diffused narrative on technological development as the main strategy for tackling environmental challenges (Sovacool et al., 2015; Wilhite and Norgard, 2004). Within this narrative, human behaviour was considered a trivial factor, as it was generally assumed that it was not able to drive the expected environmental and economic benefits in the same way as the technological and economic factors.

However, a wealth of studies demonstrated how the human factor can shape energy-related issues. More specifically, energy-related social science disciplines (such as behavioural sciences, economics and sociology) explicitly investigate how human action, shaped by social and individual factors, affects the energy system (Foulds and Robison, 2018).

For decades, only economics, considered the most 'sciency' of the social sciences, contributed to the technical and physical analyses informing the energy policy table. However, despite being a social science discipline, it did not enable effective integration of the human factor into policy discourses (Foulds and Robison, 2018). As for the observed phenomenon of the **EE gap** ([15]) (Hirst and Brown, 1990; Jaffe and Stavins, 1994), traditional economics offered only the concept of market failure to understand why citizens do not optimally invest in EE, but the discipline failed to explain the other non-economic factors that prevent citizens from optimally shaping the energy system through their investment decisions.

Underlying this partial effectiveness is the reference assumption on which economics has been traditionally based, namely the assumption that citizens are rational decision-makers who always have access to the relevant information and seek only to maximise their wellbeing consistently with their preferences (Loewenstein and Chater, 2017).

Fortunately, these unrealistic assumptions about human behaviour have been challenged by an abundance of empirical and experimental evidence, which has led to the development of a new field in economics, namely behavioural economics (Troussard and van Bavel, 2018). With the advent of this new causal framework, not only has policy analysis started to better account for citizens' behaviour, but policy interventions have also started to be justified on more than just economic grounds, such as market failures, which could also be justified on behavioural grounds, such as internalities ([16]) (Loewenstein and Chater, 2017).

Since then, insights from behavioural sciences (such as behavioural economics and psychology) have enriched the policy cycle in a broad range of policy areas, including EE (Baggio et al., 2021). These steps represent huge progress for the integration of the human factor into EE policymaking. However, the integration of the human factor is only in its infancy.

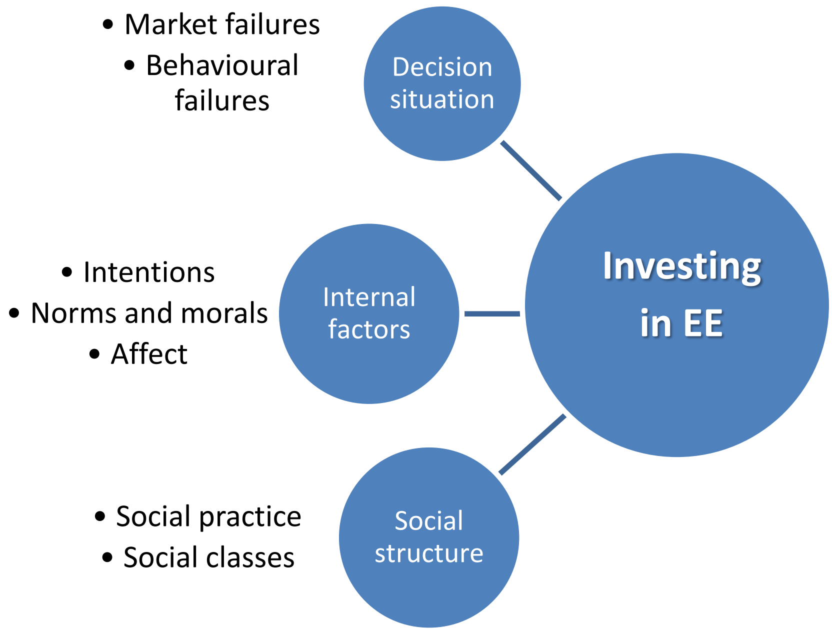
The perspectives taken by economics and behavioural sciences capture only one dimension related to the decision to invest in EE, namely the individual dimension. Conversely, the collective aspect of citizens' decision to invest is still largely overlooked in EE policymaking (Foulds and Robison, 2018). The sociological perspective could enable light to be shed exactly on these collective aspects, such as how social structures shape citizens' needs, attitudes and, in turn, actions (Lutzenhiser, 1993). However, the interaction between policy and the sociological perspective is still limited (Jackson, 2005, p. 63). One motivation lies in the fact that policymaking is dominated by evidence-based framing, whereby the knowledge used to inform policy analysis is deduced through rigorous methods and assumed to be generalisable (Greenhalgh and Russell, 2009). However, reality might not necessarily be objective. For sociology, reality can be socially constructed and knowledge is generated by interpreting individual meanings; therefore, subjective experiences can also be valid sources of knowledge (Sovacool et al., 2018). Forgoing these aspects would lead to decontextualised interventions, which will be effective only partially (Labanca and Bertoldi, 2018).

In Sections 2.1–2.4, we first provide an overview of how traditional economics has enabled the decision to invest in EE to be addressed. Then, we provide an overview of the main concepts provided by three example social science disciplines (behavioural economics, psychology, sociology) that are useful for identifying the non-economic factors affecting the decision to invest in EE. The perspectives offered by these three

([15]) That is, the gap between the optimal level of EE adoption and the empirically observed level.
([16]) That is, the costs that individuals impose on themselves and are not able to internalise.

disciplines are complementary. In particular, each discipline focuses on a specific aspect of the decision to invest in EE: the decision situation, internal factors and social structure (see Figure 1).

Figure 1. The aspects underlying the decision to invest in EE



Source: Own creation.

2.1. Neoclassical economics

From the traditional economic perspective, underinvestment in EE is a failure of consumers to pursue an economically optimal decision. In particular, the decision not to invest is suboptimal, because it is associated with a loss in both societal welfare and personal income.

The perspective taken in economics is that of **agency**; namely, individuals are assumed to be autonomous decision-makers who determine social phenomena through their decisions. Therefore, social phenomena are scrutinised as outcomes of economically relevant decisions. In doing so, the decision problem faced by individuals is formalised, exploiting three fundamental concepts: **utility, preferences and rationality**.

The concept of **utility**, introduced by 18th- and 19th-century thinkers, such as Hume, Smith, Bentham, Mill and Jevons, was borrowed by neoclassical economists to treat economic decisions in a tractable way, namely by assuming that they were driven by the overarching goal of maximising one's well-being or utility (Harsanyi, 1992).

To make proper use of utility in the modelling of economic behaviour, neoclassical economists introduced the additional concept of **preferences**, by which they meant the order that individuals assign to available options. By assuming that observed behaviour, such as consumption choices, represents real preferences (revealed preferences theory (Samuelson, 1938)), economists could then estimate one's utility simply as a mathematical representation of people's preferences (utility function).

Utility and preferences are two building blocks of all economic decision models. The third building block is people's **complete rationality**. Although the first interpretation of utility in economics was a measure of one's happiness, since the second half of the 20th century economists have abandoned the psychological considerations and have started applying the ***Homo oeconomicus*** model to explain human actions. In particular, they have developed a set of axioms on how people ought to choose (i.e. in a rational way), to describe the behaviour of a **representative group of individuals** rather than the behaviour of real people. This simplification has enabled economists to predict the behaviour of individuals who obeyed these axioms in the whole economic system.

Overall, within this framework, it is assumed that a representative consumer:

- chooses the option that maximises only his or her utility (profit);
- knows all the available alternatives and the related information;
- has consistent (innate and stable) preferences between options.

When presented with the choice to invest or not in EE, the consumer is then **assumed** to have chosen the service of the equipment using energy because this represents the option that maximises his or her utility consistently with his or her preferences. However, before choosing, a rational consumer has to take into account two additional features that characterise an investment decision: the benefits (cost savings) that accrue from the service are **delayed** with respect to the time in which the decision is made; moreover, they are **uncertain.** The **expected utility theory** (EUT) and the **discounted utility** (DU) **model** enable predictions to be made about a consumer who faces exactly this kind of situation, namely when he or she has to make **risky** and **intertemporal decisions**.

According to the EUT, an individual presented with two or more risky options should multiply the monetary value of each option by the likelihood that the option will pay off (so he or she should compute the expected value) and choose the option with the highest expected value. This theory enables a **single measure of risk aversion** to be derived in one domain and predictions to be made about how a representative individual would choose when facing risky options, including in other domains ([17]). As a result of its tractability, the EUT has been widely employed in the empirical estimation of risk aversion for several goods, such as those that protect the environment (Farsi, 2010).

According to the DU model (Samuelson, 1937), when presented with an option that has consequences at different points in time (i.e. an intertemporal decision), individuals seek to maximise the sum of present and future benefits, and the present value of these future benefits is determined using a **constant rate**. This constant discount rate (assumed to follow an exponential form) enables all non-economic motives underlying intertemporal choices (such as the degree of patience) to be condensed into **one single parameter** and implies that preferences are **time consistent**, that is the passage of time does not affect investment decisions. Owing to its simplicity in capturing the general human tendency to be impatient, but also to its similarity to compound interest formulae, this theory dominated the standard modelling of intertemporal choices and is still used as standard for cost–benefit analyses in public policy (Frederick et al., 2002). An implication of this model is that a perfectly rational individual would discount future benefits using the correct costs of capital and thus would always choose to invest in EE, given that this is the economically optimal option (i.e. the present value of future energy savings exceeds the initial cost of capital of EE investments (Nauclér and Enkvist, 2009)). Thus, from the traditional economic perspective, if individuals fail to invest in EE, this is not related to the way consumers make decisions (Kubiak, 2016).

However, traditional economics enables another long-debated phenomenon to be explained that relates to the way consumers make decisions. This phenomenon, first introduced in 1866 by Jevons, is called **rebound effects** and relates to the observation that technology improvements (such as EE), by reducing the price of the service they provide (such as energy), create an increase in demand for that service. Therefore, when energy prices are constant, the EE gains yielded by technological improvements will result in an increase in energy consumption that will backfire on those gains (direct rebound effect (Sorrell and Dimitropoulos, 2008)). These rebound effects have been and are still at the centre of debates among economists, notably because of the implications for the measurement of the actual **size** of the EE gap.

Rebound effects are among the factors that might lead to the **energy performance gap**, that is, the difference between estimated energy savings and achieved energy savings (Galvin, 2014). When they are not taken into account, it is likely that the estimated energy savings, and thus also the magnitude of the EE gap, will be overstated (Gerarden et al., 2017). At the same time, it is not easy to quantify rebound effects.

Despite the ongoing debate on the size of the EE gap, traditional economics enables an explanation of why individuals underinvest in EE, when moving from the consumer perspective to the market perspective. In particular, in neoclassical economics, the reason why individuals underinvest is due to market characteristics and failures (Bertoldi, 2020). The perspective associating the EE gap with these market failures has long provided the only rationale for implementing interventions, namely those that are aimed at correcting the

([17]) Usually a certain functional form for the utility function is assumed along with the Arrow–Pratt forms (Arrow, 1965, Pratt, 1978).

market. In Sections 2.2.1–2.2.4, we summarise the main market barriers preventing individuals from investing in EE.

2.1.1. Imperfect information

Investments in EE are likely to be prevented by a lack of, or imperfect, knowledge of the existence or the functioning of those measures. Collecting information is indeed generally not free (transaction costs (Sanstad and Howarth 1994). In some cases, better informed buyers might be unable to convey information credibly to the market, exacerbating the risk of EE investments (Anderson and Newell, 2004). This market failure from asymmetric information provides a rationale for interventions in the form of information provision.

2.1.2. Split incentives

Split incentives are a typical principal–agent problem arising from asymmetric information. They reflect a situation in which the principal (the tenant) has incomplete information about the service (EE of the building), and the agent (the landlord) underinvests in the EE of the property, for fear of not being able to recoup in rent the costs of investments (Gillingham et al., 2012). An initial response to this problem is generally implemented in the form of contracts that align the incentives of the landlord and the tenant, or through government regulation (de T'Serclaes, 2007).

2.1.3. Credit constraints

EE technologies are associated with high upfront costs. This makes EE investments affordable only for those who have the financial resources or capability to access credit (Golove and Eto, 1996). Limited access to credit may also result from credit rationing reinforced by the fact that the lenders lack information about the returns from EE investments'. This capital market failure provides a rationale for interventions in the capital market.

2.1.4. Regulatory failures

In order to decide which technology to invest in, a rational consumer needs to consider the cost of the equipment, the efficiency of the equipment and the price of energy ([18]). However, because of regulatory failures or non-inclusion of negative externalities that are associated with the provision of energy services, energy prices might fail to reflect their true cost. This regulatory failure can be corrected with interventions that internalise the negative externalities associated with fossil energy combustion, such as through a domestic carbon trading system, leading individuals to use fewer fossil fuels (Brown, 2001).

2.2. Behavioural economics

The assumptions of rational choice provided neoclassical economics with a tractable model for depicting human actions and for analysing social phenomena, characterised by the interaction of many individuals. However, when it comes to the analysis of human actions, such as citizens' decision not to invest in EE, those assumptions fail to provide an empirically relevant description of how individuals actually behave. Informed by the evidence that individual behaviour deviates in a systematic way from the neoclassical economic assumptions, a new causal framework drawing from psychology emerged, enabling real behaviour to be modelled: behavioural economics. Within this framework, a citizen is modelled as a decision-maker who decides to invest in EE not only because this is the most cost-effective, profitable option for her/him, but also because of other non-economic factors, such as the fact that EE allows the environment to benefit. This alternative framework shifted the focus in economics from the rationality of outcomes to the rationality of the process underlying decisions (Curtin, 2016).

In particular, it highlights that individuals are rational decision-makers who, rather than aiming to maximise their utility, aim to reach satisfying utility levels and have limited cognitive resources when making decisions (i.e. they are bounded rational individuals (Simon, 1955, 1957)). As a result, when making decisions under bounded rationality, individuals use shortcuts, namely **heuristics** (Tversky and Kahneman, 1974). Although useful for dealing with complex environments, these tools might lead to **behavioural failures**, namely deviations from the rational choice model's assumptions (Shogren and Taylor, 2008). This framework thus enabled an explanation of why citizens do not optimally invest in EE. In particular, in addition to the market characteristics and failures, underinvestment in EE is also due to behavioural failures (usually categorised as

([18]) In neoclassical economics, EE is defined as the ratio of either product or service to energy consumption.

non-standard preferences, non-standard beliefs and non-standard decision-making (DellaVigna, 2009).

The acknowledgement of such behavioural failures provides another rationale for interventions that adds to the economic rationale that aims to correct market failures (Loewenstein and Chater, 2017). In Sections 2.2.1–2.2.3 and in Figure 2, we summarise the main behavioural failures underlying why individuals fail to invest in EE.

2.2.1. Non-standard preferences

2.2.1.1. Risk preferences

The EUT enables the basic intuition of an individual's risk aversion to be captured. However, the EUT is not always supported by empirical evidence (Holt and Laury, 2005). Models drawing from behavioural economic literature have been proposed as alternatives, to capture behavioural anomalies in decisions under risk. Prospect theory (Tversky and Kahneman, 1979, 1981) is the heart of these alternative models. More specifically, it accommodates the evidence that individuals systematically use decision weights that differ from objective probabilities (probability weighting), instead of computing their utility as the weighted sum of the outcomes and their probability of occurring (as predicted by the EUT). Moreover, it captures the evidence that individuals evaluate decision outcomes in terms of gains and losses relative to a **reference point**, usually the status quo, and assess losses as being larger than equal-sized gains (**loss aversion**). The implication is that individuals would be less willing to invest in a risky option when there is the prospect of a loss. These mechanisms addressing risk attitude explain why citizens underinvest in EE, as investing in EE is a risky option (energy savings following the high upfront cost can be uncertain) (Häckel et al., 2017). More specifically, when an individual perceives that the EE investment has the potential for a loss (such as higher energy bills or less comfort), they might disregard that option and prefer the known (usually more inefficient) option (Heutel, 2019).

2.2.1.2. Time preferences

The DU model describes individuals choosing between outcomes that occur at different points in time as if they were using a discount rate that does not depend on the time period, categories and goods. Conversely, since the seminal work of Dubin and McFadden (1984), Hausman (1979) and Train (1985), the model has been confronted with the evidence that discount rates implied from observed EE investment choices actually exceed the opportunity costs of capital. In addition, extensive experimental evidence has shown that individuals use discount rates that decline over time (**hyperbolic discounting**). In particular, individuals who exhibit hyperbolic discounting behaviour prefer consumption options that provide immediate benefits while disliking those that provide delayed benefits in the future, even if the delayed benefits are larger (O'Donoghue and Rabin, 1999). This evidence not only highlighted that the discount rates implied from consumption behaviour (subjective discount rates) might not necessarily be a good basis for discounting the benefits and costs of a public policy (social discount rate), but also enabled an explanation of why people underinvest in EE (Newell and Siikamäki, 2015).

There are many explanations behind these present-biased preferences, such as the limited ability of individuals to plan ahead (Ballinger et al., 2003), which can be impaired by the surrounding environment. The implication is that people who live in conditions of stress or resource scarcity have stronger present-biased preferences and might be less likely to make decisions providing delayed benefits, such as EE investments (DellaValle, 2019). In addition to cognitive ability, debt aversion might also explain present-biased preferences. This is particularly true in the presence of high present costs, such as those for EE investments. More specifically, debt aversion might prevent individuals from investing even if they are offered soft loan options to overcome the high upfront costs (Schleich et al., 2019).

2.2.1.3. Proenvironmental preferences

Behavioural economics highlights that individuals display not only cognitive deviations but also motivational deviations from rational choice assumptions. In particular, individuals are heterogeneous not only in their preferences but also in their degrees of self-interest and motivations (Sacco and Zarri, 2003).

This heterogeneity in motivations and degrees of self-interest help explain additional factors that influence citizens' decision to invest (or not) in EE. More specifically, some citizens might be willing to invest in EE measures even in the absence of external incentives, because they are motivated to protect the environment, namely they display proenvironmental preferences (Schleich et al., 2016).

The four main motivations that explain proenvironmental preferences (Frey and Stutzer, 2006) can positively influence the decision to invest in EE.

1. Individuals who display **impure altruism** ('warm glow' (Andreoni, 1989)) are intrinsically motivated to invest in EE. In other words, they might receive a positive emotional response from the mere act of adopting measures that benefit the environment.
2. Individuals who display **pure altruism** ('prosocial orientation' (Bénabou and Tirole, 2006)) might be motivated to invest in EE because they care about the level of actual environmental protection achieved.
3. Individuals who think this is the right thing to do relative to their **personal norms** might be willing to invest in EE. For example, individuals might be willing to invest in EE, because they think it is a good way to comply with the scripts of their identity. This way they will maintain self-consistency and avoid cognitive dissonance (Akerlof and Kranton, 2000; Festinger, 1957).
4. Individuals might be willing to invest in EE because they think this is the right thing to do relative to a **social norm**. More specifically, it might be that a particular group attaches a social value to EE investments, and individuals decide to invest because they think that the group thinks it is appropriate ([19]), while anticipating social disapproval if they decide otherwise (Bicchieri, 2005; Elster, 1989).

Assessing the underlying motivations behind EE investments is also crucial to understanding sources of rebound effects. For example, in addition to the reduced service cost arising from technological improvements, an additional potential source of rebound effects is **moral licensing** (Dütschke et al., 2018), which 'occurs when past moral behaviour makes people more likely to do potentially immoral things without worrying about feeling or appearing immoral' (Monin and Jordan, 2009). Therefore, if individuals are motivated to invest in EE because they attach a moral value to it (i.e. they think that is the right thing to do), it is likely that there will be higher rebound effects following their investment decision (i.e. they will feel entitled to consume more electricity to heat their apartment later on).

2.2.2. Non-standard beliefs

2.2.2.1. Incorrect beliefs about the future

The standard rational model assumes that, on average, consumers have correct beliefs about the distribution of future events. Extensive experimental and empirical evidence has instead shown that individuals have systematically incorrect beliefs. For example, individuals might have certain beliefs about the future benefits of an energy-efficient technology, and if these beliefs underestimate the true values individuals might underinvest, even if their investment would have been profitable (Allcott and Greenstone, 2012).

2.2.3. Non-standard decision-making

2.2.3.1. Status quo bias

Individuals might underinvest in EE, because they are biased towards the status quo (Schubert and Stadelmann, 2015). In particular, individuals might display a tendency to choose options that maintain the current situation (such as the current stock of appliances) while forgoing considering better, more efficient options (Blasch and Daminato, 2020).

There are many causes underlying status quo bias (Samuelson and Zeckhauser, 1988), and some are of particular relevance to EE investments. In particular, when individuals perceive that benefits from EE are uncertain (**uncertainty**) or they are psychologically committed to costly investments they made in the past (**sunk cost fallacy**), they might end up overusing their current appliances to amortise investment costs.

([19]) So they hold normative and empirical expectations (Bicchieri, 2005).

2.2.3.2. Limited attention

As individuals are bounded rational (Simon, 1955), they might not pay attention to all the attributes of the information they have (DellaVigna, 2009), and as a result they might make ill-informed decisions. Such limited attention might explain underinvestment in EE. For example, in the context of energy-efficient technologies, individuals might direct more attention to a salient feature, such as the high price, and disregard other crucial but less salient attributes, such as low running costs. This is especially true when individuals, in addition to displaying limited computational abilities to calculate the savings over the lifetime of the technology, also have limited energy-related knowledge (**energy financial literacy**) (Blasch et al., 2018).

Attention can also be limited by individual subjective experience. For example, because of **availability bias**, individuals might direct their attention only to pieces of information that are familiar or easily accessible (Jungermann et al., 2010). Therefore, individuals might end up not investing if the process of acquiring information has hassle or friction factors (Bertrand et al., 2004).

2.2.3.3. Framing

Individuals might underinvest not only because they do not have enough information about EE, but also because the format of the information presented when investing in EE does not focus individual attention on the relevant elements for making well-informed decisions. The influence of the format of information on choices is called **framing** (Benartzi and Thaler, 2002). More specifically, given that individuals have imperfect information-processing capacities, they base their choices on the elements that capture their attention more. For example, individuals may increase their willingness to invest in EE when they are provided with information making salient future cost savings (Newell and Siikamäki, 2014). Similarly, they may be more willing to invest in EE technology when presented with information on EE as a way to avoid losses rather than to gain benefits (Frederiks et al., 2015).

Figure 2. Summary of factors affecting the decision to invest in EE, as identified in traditional and behavioural economics

High upfront costs

Credit constraints, debt aversion, limited attention

Investing in EE requires access to liquidity; however, individuals might be **debt averse,** and **credit** might not be easily granted when lenders lack information on EE.

The **high upfront price** is more **salient** than low running costs. If this captures an individual's attention, this might discourage investment.

One-shot and durable decision

Status quo bias, incorrect beliefs, non-standard time and risk preferences, limited attention

Investing in EE can be associated with the replacement of a known technology, but **uncertainty about benefits** and commitment to old investments might prevent new investments.

It requires a careful examination of the cost and benefits. However, individuals might fail to invest when they have **incorrect beliefs** about benefits or when they perceive that there is a potential loss (such as lower comfort).

Individuals might fail to calculate savings over the technology lifecycle, as they might have **limited cognitive ability** to plan ahead and **limited energy-related knowledge**.

Technical information

Split incentives, asymmetric information, limited attention, framing

Investing in EE requires **technical information,** but this not accessible to all. Buyers might be unable to provide information to the market credibly.

Tenants might have **incomplete information** on the EE of the house, and landlords might underinvest out of fear of not being able to recoup the costs in the rent.

Individuals might not invest if information:

- is not easily **accessible**;

- does not make **future cost savings salient**.

Environmental protection

Proenvironmental preferences

Individuals might decide to invest in EE because of:

(1) **warm glow** (they enjoy knowing the environment is benefiting);

(2) **prosocial orientation** (they want to maximise the level of environmental protection);

(3) the fact they think it is the **right thing to do** (they want to be consistent with their personal norms);

(4) the fact they think it is the **socially accepted thing to do** (they want to conform with a social norm).

Source: Own creation.

2.3. Psychology

The decision to invest in EE is a type of 'one-shot' proenvironmental behaviour (Abrahamse et al. 2007). Although economic decision models focus on the features characterising the decision situation and the incentive structure that might promote or inhibit these behaviours, psychological decision models focus on internal factors. More specifically, psychology focuses on uncovering the origins and antecedents of behaviours. With specific regard to proenvironmental behaviours, psychology has one of the biggest merits in having extensively and explicitly investigated their antecedents and origins. This abundant research can be categorised in terms of the antecedent under scrutiny: intentions, norms and morals, and affect (Steg and Vlek, 2009), for an overview, see Figure 3).

2.3.1. Intentions

One of the most prominent psychological theories that has been adopted to investigate proenvironmental behaviours is the theory of planned behaviour (TPB) (Ajzen, 1991). As the conventional economic framework, TPB is a 'rational choice' theory, as it is centred on the idea that individuals are self-interested and focused on maximising utility when making decisions. In particular, behaviour is the result of a deliberate process underlying the evaluation of associated costs and benefits. Extending the theory of reasoned action, which identifies attitudes and subjective norms as explanatory variables of behaviour (Fishbein and Ajzen, 1977), the TPB identifies the 'intention' to act as the only antecedent and key determinant of behaviour. This intention is brought about by:

- **attitude** towards the behaviour, for example the result of the individual beliefs about the behaviour and the evaluation of consequences associated with the behaviour;
- **perceived behavioural control**, for example the perceived difficulty or ease of engaging in a certain behaviour;
- **a subjective norm**, for example perceived (dis)approval of the behaviour by relevant reference people (e.g. family, friends, colleagues).

A meta-analysis of studies adopting the TPB as a framework showed that the factors advanced by this theory are able to explain 39 % of the variance in intentions to behave and 27 % of the variance in actual behaviours (Armitage and Conner, 2001). In general, the TPB should be preferred in identifying and evaluating the weight of factors associated with intentions, when the behaviours being investigated are precise and not subject to ambiguous interpretations (Yuriev et al., 2020).

2.3.2. Norms and morals

A number of studies have explicitly focused on **values** and **beliefs** as the main antecedents of proenvironmental behaviours and concluded that those who display altruistic, prosocial, self-transcendent and biospheric values are more likely to engage in proenvironmental behaviours (Nordlund and Garvill, 2002; De Groot and Steg, 2010; Ateş, 2020). Other studies have focused on **environmental concerns** as the main antecedents of proenvironmental behaviour, and, although there is still no unique definition, there is a consensus on how to measure them, namely with the **New Environmental Paradigm scale** (Dunlap and Van Liere 1978; Dunlap et al. 2000).

Another stream of studies has focused on **moral obligations** as the main antecedents of proenvironmental behaviours. The most prominent psychological theory is the value–belief–norm (VBN) theory (Stern, 2000), which extends the norm activation model (NAM) (Schwartz, 1977). These theories explicitly enhance the self-interested utility maximisation assumption, by accounting for altruistic concerns. In particular, the VBN theory has been developed as an extension of the NAM, which assumes that behaviour is driven by individual's personal norms, for example the moral obligation to engage in certain behaviours, and identifies a causal chain of factors that lead to proenvironmental decisions. These factors represent one's core values affecting one's beliefs about his or her relationship with the environment, which in turn affect one's awareness of the consequences of one's own actions and their effect on the environment; this in turn affects the level of responsibility that an individual wants to assume. Ultimately, assumed responsibility activates a moral obligation to act.

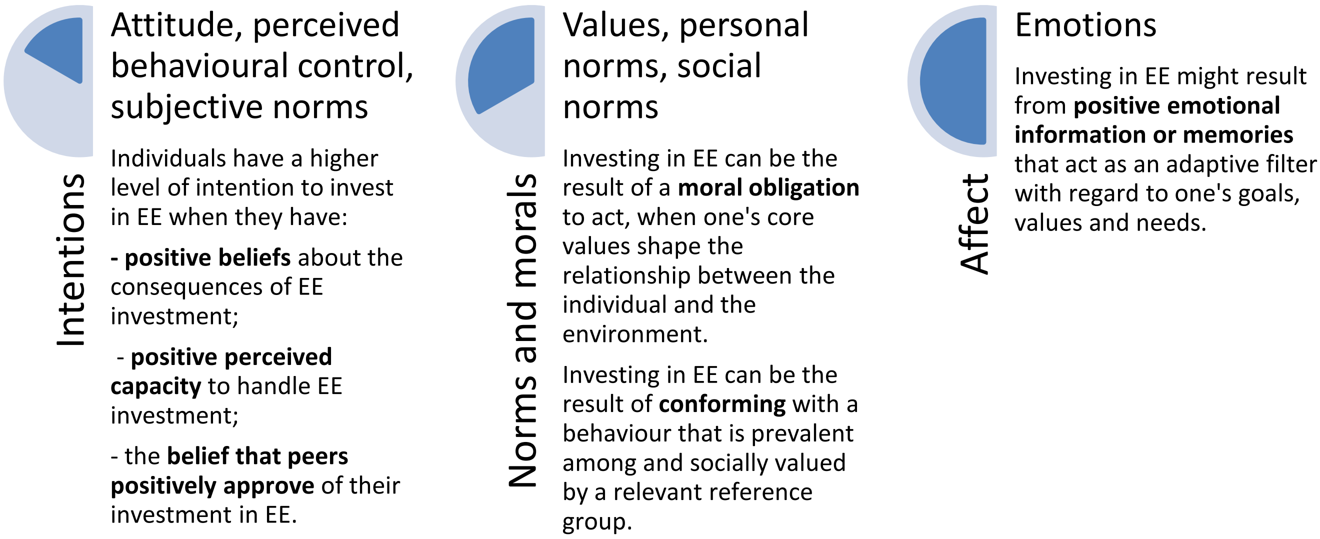
An antecedent related to personal norms and values are **social norms**. These have been the main focus of the theory of normative conduct (Cialdini et al., 1990, 1991). Within this theory, social norms operate through two distinct channels: descriptive (what most people do) norms and injunctive (what ought to be done) norms. The more norms are salient, the more they are likely to influence behaviour. The main factors that lead individuals to adjust their behaviour so that it conforms with a social norm are accuracy, affiliation and consistent self-image (Cialdini and Goldstein, 2004). Appeals to social norms have been proven to affect proenvironmental behaviours, such as the adoption of photovoltaic systems, especially when the target population is made aware of the fact that the behaviour has already been adopted by their reference group (i.e. neighbours) (Jager, 2006).

2.3.3. Affect

Emotions represent another crucial antecedent of behaviour. Although for a long time they were considered only counterproductive to the correct functioning of the human mind, the past two decades have witnessed an increase in research highlighting that emotions can actually contribute to making optimal decisions. In particular, by acting as filter for new information, emotions enable attention to be focused on goals, needs and values, and set the stage for subsequent behaviours (Brosch et al., 2014).

With respect to proenvironmental behaviours, the appraisal–emotional approach (Brosch et al., 2014) has been advanced to explicitly explain energy-related decisions by integrating the role of emotions. By acknowledging that emotions can act as drivers to promote positive behaviours, proenvironmental behaviours can be explicitly promoted through information-based interventions that generate positive emotions.

Figure 3. Summary of factors affecting investment in EE identified by psychology

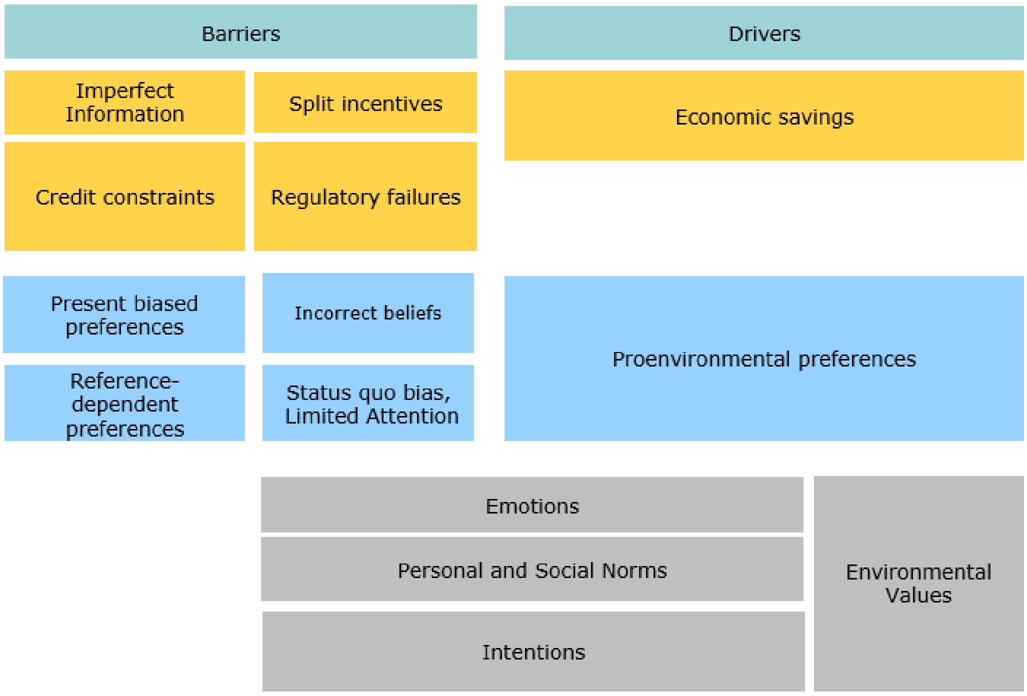


Source: Own creation.

2.4. Sociology

Economic and psychological decision models centre on the notion of agency, as they take the individual as the unit of analysis; that is, individuals are assumed to be autonomous decision-makers who determine social phenomena through their decisions (Sovacool et al., 2018). In the context of EE, these perspectives suggest that the solution to the problem of a suboptimal level of EE adoption is through the removal (promotion) of the decisional barriers (drivers) to optimal decision-making (see Figure 4 for an overview of barriers and drivers). This discourse on the removal of barriers to proenvironmental behaviours has dominated the discourse of energy and climate policy tables, next to technology policy and carbon pricing (Stern, 2007).

Figure 4. Overview of barriers to and drivers of EE investment decisions



Source: Own creation.

However, this approach has been criticised by sociologists, as the term **barriers** reflects a top-down approach (Jensen, 2005) and an individualistic view of action (Shove, 1998). For example, it is not obvious that individuals universally share energy technologies, standards and practices (Shove, 1998).

With a focus on **structure** rather than on agency, sociological perspectives allow the relationship between human actions and energy to be studied through a broader lens that takes into account how the sociotechnical context affects energy-related practices. Therefore, they enable the collective dimension surrounding energy-related decisions to be better accounted for (Lutzenhiser, 1993). These perspectives also allow the social implications of energy transition measures, such as EE, to be accounted for by enabling frames of justice to be integrated (Dunlop, 2019).

The dichotomy in theories between agency and structure mirrors a long-standing debate in social sciences on whether humans are capable of autonomous social action, or whether the historical and social processes, in which people are **embedded**, prevent their action. Sociologists have extensively explored this debate, by investigating how 'social structures' constrain or enable the autonomy of people, their needs, attitudes and expectations, and thus their behaviour (Giddens, 1979, 1984). In particular, social structures are human artefacts that include laws, conventions, regulations, cultures and habitual practices of meaningful groups, and physical structures, such as technologies and the built environment (Galvin, 2020). For example, changes in the design of houses, energy technologies, supporting infrastructure and institutions (e.g. electricity grids, utility tariffs and services) can influence the expectations of thermal comfort and the associated energy-related practices (Shove, 2003).

In Sections 2.4.1–2.4.2 and in Figure 5, we refer to two main social structures that surround citizens' decision to invest in EE.

2.4.1. Social practice

Social practices are an example of social structures and are the focus of social practice theory (SPT) (Shove et al., 2012). SPT highlights that individuals are not autonomous decision-makers; rather, they are practice carriers (Shove, 2003; Wilhite, 2014).

Within this approach, energy is used not for its own sake but as part of accomplishing social practices, such as cooking, showering, and keeping warm and cool, which people value as part of their everyday life (Warde, 2005). SPT originates from structuration theories, such as that of Giddens (Giddens, 1979, 1984), in which agency has to be considered a process entangled in the routine practices of everyday life. Therefore, within this approach, rather than being seen as decontextualised one-shot decisions, the decisions related to EE are analysed through the lens of the routine and the practices shared with family and friends that constitute life at home (Wilk and Wilhite, 1985; Wilson et al., 2015).

Shove and colleagues (Shove and Pantzar, 2005) have advanced this theory and other earlier theories that interpreted social practices as a unit of analysis, to explicitly analyse environmental effects of practices. More specifically, they defined practices as being made up of three main components: material (physical aspects of performing a practice), meaning (referring to understanding, emotions and beliefs associated with the practice) and competence (skills and knowledge needed to perform the practice).

Some authors have argued that ‘the interaction between policy and social practice is as yet so limited that it would be difficult to see how policy could make use of this position’, especially because, as the result of endogenous and emergent dynamics, social practices cannot be seen as causal factors of behaviours (Jackson, 2005, p. 63). At the same time, proponents of SPT criticise the current policy perspective that targets exogenous factors using a mix of decontextualised behaviourally and technologically driven EE improvements in order to reach sustainable goals. Therefore, they propose SPT as an alternative policy agenda that targets all the constituents of practices, namely meanings, competences and involved materials (Labanca and Bertoldi, 2018). By doing this, it will be possible not only to better acknowledge the relational nature of energy demand (Hargreaves and Middlemiss, 2020), but also to better understand how to structurally reorganise technological outputs and associated shared meanings and competences (Labanca, 2017; Labanca and Bertoldi, 2018).

2.4.2. Social class

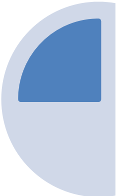
Another prominent social structure is social class, which ‘is given by the distribution of the various forms of capital … firstly economic capital … ; secondly cultural capital … ; and thirdly two forms of capital that are very strongly correlated, social capital, which consists of resources based on connections and group membership, and symbolic capital, which is the form the different types of capital take once they are perceived and recognized as legitimate’ (Bourdieu, 1987, p.4).

Understanding how EE investments diffuse across and within social classes in a target context can help policymakers address questions related to justice and avoid exacerbating existing inequalities. An adequate framework for accomplishing this aim is provided by the social theories of vertical diffusion and horizontal diffusion (Bartiaux et al., 2016).

Vertical diffusion relates to the process of diffusion of a practice from the upper class to the middle and lower classes (Bartiaux, 2008). In particular, vertical diffusion is associated with social visibility, whereby people from lower classes are likely to imitate upper class practices to gain status. This is the case with highly visible practices, such as installing solar panels (Keirstead, 2007).

However, not all energy-related practices are visible. Such practices are more likely to diffuse horizontally. In this case, diffusion occurs between similar individuals connected in the same network (Rogers 2010), through casual conversation, thanks to a reciprocal feeling of trust (Berelson et al., 1968). Such interpersonal communication has been shown to promote the diffusion of energy-related practices such as engagement in EE (Mustafa 2010).

Figure 5. Summary of factors affecting investment in EE identified by sociology



Social Practices

Involved materials, meanings, competences

EE technologies provide energy that is used for practices embedded in social life; therefore, they cannot be analysed in isolation from the social context in which practices that use energy occur.

Understanding energy practices means understanding the **physical aspects** of performing a practice, the **meaning** associated with the practice, and the **competences** needed to perform the practice.

Social class

Status, trust

Investing in EE can be the result of a desire to imitate the upper class and thus **gain status**. This is especially true when the investment is visible.

Investing in EE can be the result of interpersonal communication among **similar individuals who trust each other**. This might also apply to non-visible investments, like insulation measures.

Source: Own creation.

3. Understanding citizens’ decision to invest in energy efficiency: methods

Chapter 2 provided an overview of the factors affecting the decision to invest in EE, as identified by traditional economics, behavioural economics, psychology and sociology. This chapter provides an overview of the main techniques (summarized in Table 1) that these disciplines adopt to assess the nature and magnitude of these factors and, potentially, new factors.

Table 1. Summary of methods and disciplines

	Quantitative methods			*Qualitative methods*
	Experiments	Surveys	Data analysis and statistics	Focus groups, interviews, ethnography
Discipline	Behavioural economics; psychology	Economics; psychology; sociology	Economics; psychology	Sociology
Description	Enable mechanisms to be explored	Provide information about a target population	Enable relationships among variables of interests to be tested	Enable grounded insights to be explored

Source: Authors, modified from (Sovacool et al., 2018).

3.1.1. Experiments

Experiments are used not only in physics and life sciences, but also in social sciences, namely in psychology and economics. Although they have been used extensively in psychology, it was only a couple of decades ago that they were also embraced by economists. Economic experiments have provided the empirical evidence needed to challenge neoclassical economic assumptions and thus enabled the alternative theoretical framework of behavioural economics to be developed (Falk and Heckman, 2009). Experiments are especially useful when it comes to studying phenomena for which it is difficult to make causal inferences in naturally occurring situations. This is the case for the study of the underlying mechanisms of decision-making. By enabling the features of the decision environment to be controlled, the laboratory enables the truthfulness of theories of behaviour to be tested and the diversity of individual preferences and attitudes to be captured.

Although both economic and psychological experiments aim to uncover the determinants of decision-making that is relevant to real-world situations, there are fundamental epistemological differences in the way the two disciplines conduct experiments (Ariely and Norton, 2007).

In economics, experiments are the result of abstraction; namely, laboratory tasks are created to simulate the essential features of a phenomenon under scrutiny, assuming that individual decisions are sensitive to incentives. As a result, an experimenter has control of individual preferences; that is, he or she is sure to elicit an individual’s true preferences, by providing experimental subjects with an adequate monetary payment (**induced value theory** (Smith, 1976)). Therefore, in order to be able to derive conclusions, experimental economists strive to recreate the incentive structure surrounding a real-world phenomenon under scrutiny in the laboratory.

In psychology, experiments include manipulations that change an individual’s goals, assuming that individual decisions are sensitive to contextual factors of specific settings. As a result, an experimenter uses confederates, cover stories and deception. Therefore, in order to be able to derive conclusions, psychologists strive to create proxies of contextual aspects of the phenomenon under scrutiny in the laboratory (Ariely and Norton, 2007).

Although they enable causal knowledge of the phenomena under scrutiny to be generated, experiments have been associated with some concerns, such as the fact that participants might behave differently in the laboratory, because they know they are being observed (Hawthorne effect), and that laboratory experiments with only students do not provide representative evidence. That is the reason why, like any other research method, experimental results improve the state of knowledge when they are complemented with information resulting from other methods (Falk and Heckman, 2009).

3.1.2. Surveys

Surveys are frequently used by psychologists, quantitative sociologists and economists to elicit information about people's preferences for goods, and intentions to engage in certain behaviours, values and beliefs.

In psychology and sociology, they are extensively used to elicit constructs to understand behaviour. Researchers aim to get high response rates from a representative sample of the target population, pay attention to the format (as an example, ratings yield better results when they are labelled only with words) and reduce social desirability bias (i.e. individuals over-report (or under-report) when they are asked questions about admirable (or not socially respected) behaviours) (Krosnick, 1999). As stated behaviour might not always match actual behaviour (**intention–action gap**), survey items on behaviour might not be suitable for directly predicting how individuals will behave in practice (Alemanno and Sibony, 2015), but only indirectly through correlated variables (Wilson and Dowlatabadi, 2007).

Compared with other social sciences, surveys are used less in economics, highlighting the view that what matters is what individuals do, not what they say (i.e. individuals do not have an incentive to respond truthfully to a hypothetical question (Scott, 1965)). However, the reality is that surveys are used in economics not only to collect information on facts of past or current economic life (i.e. income, expenditure, etc.) but also to understand the **'how and why'** behind individual behaviour when no other desirable measure is available. This is especially the case for environmental economics, in which a prominent research aim is to measure values of goods or good attributes for which there is no objective measure of value, such as the benefits of preserving environmental resources. In these cases, the **contingent-valuation survey** is employed to elicit individual willingness to pay (WTP) for preserving environmental resources (Boulier and Goldfarb, 1998). This preference survey is usually undertaken in different formats: (i) one-shot binary choice – that is, individuals are asked to choose among a series of two options; (ii) a sequence of binary choice questions – that is, individuals are asked to choose among two options; and (iii) a multinomial choice question (also called **choice experiment**) – that is, individuals are asked to pick the preferred option out of a series of alternatives. This preference survey is still at the centre of a debate in economics, as it is hypothetical and thus WTP can be overstated. Overall, there is agreement on the need to pay attention to the way data are modelled, and to the format and the type of good in the question, as these might also be the reasons for implausible estimates of individual preferences (Carson and Groves, 2007).

3.1.3. Data analysis and statistics

Surveys and **experiments** allow data to be collected on a phenomenon under scrutiny, such as the decision to invest in EE. However, in order to explain what is behind that decision, researchers need to establish relationships among variables. Different quantitative research methods exist, and the choice depends on the available data and the practices of the discipline. Below, we briefly document the methods that have been used in the energy research and social science domain (Sovacool et al., 2018).

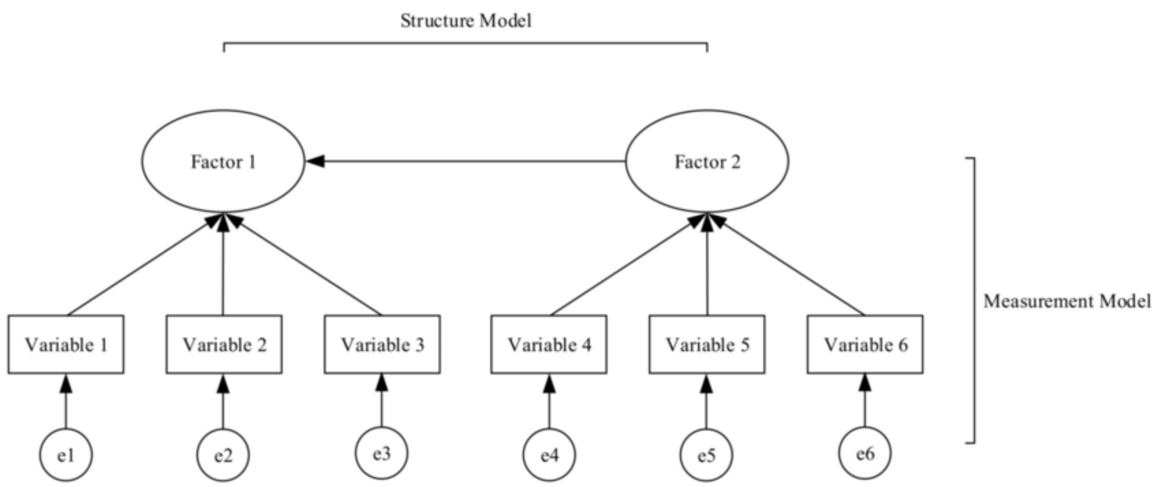
Bivariate analysis enables relationships between two variables to be explored. However, apart from when data come from a controlled experiment, the relationship can be presented only as **correlational** rather than **causal** (Wooldridge, 2015).

Multivariate analysis, such as multiple regression or multivariate analysis of variance, enables the association between independent variables (i.e. age, gender, time preferences) on one dependent variable (i.e. decision to invest in EE) to be explored. Regressions are typically employed in economics and allow clear hypotheses between two variables (i.e. time preferences predict decision to invest in EE) to be explored while holding other factors constant (i.e. age, gender).

When the quality of data is likely to be poor (as in the case of secondary data, such as statistics on energy consumption, which can be subject to measurement errors), econometric techniques have to be employed. **Logistic regression** is adopted when the dependent variable is categorical (it takes a finite number of values), whereas linear or non-linear regression is employed when it is continuous (it can take an infinite number of values) (Wooldridge, 2015). Discrete choice modelling is a type of logistic regression explicitly employed to explain and predict individual choices between two or more alternatives, such as different appliances, given some relevant characteristics. A particular type of discrete choice modelling is the **latent-class models**, which allow individual heterogeneity to be represented (Hensher et al., 2005).

Structural equation models (see Figure 6 for an example) are employed when a theory offers many layers of causation; that is, individual values affect individual beliefs about EE technologies, which in turn affect one's decision to invest in EE (Mulaik, 2004).

Figure 6. A structural equation model



Source: Wikipedia.

Factors analysis allows confirmatory tests to be made and similar variables to be grouped together under a single measure, and is usually employed in psychology. For example, multiple survey items are required to develop a measure for proenvironmental attitudes (Rummel, 1988). **Cluster analysis** enables similar individuals or cases to be identified but cannot be used for testing the statistical significance.

3.1.4. Focus groups and interviews

Psychology and economics fall into the category of positivist modes of inquiry; namely, they assume that reality is objective, and generalisable knowledge is generated by discovering relationships among variables having predictive power. To do this, they use deductive hypothesis-testing and quantitative methods. However, for other social sciences, such as sociology, in which reality can be socially constructed, knowledge is generated by interpreting individual meanings and actions. Thus, interpretive disciplines, such as sociology, use an inductive approach and qualitative methods to deepen a phenomenon rather than to generalise by testing hypotheses (Sovacool et al., 2018).

Interviews (semi-structured or unconstructed) are the most common form of qualitative data collection. They can be conducted with individuals or groups, targeting the general population or particular groups. They are particularly useful for eliciting personal experiences, meanings and perspectives.

Focus groups are less time consuming than interviews and are usually the initial phase of a larger study that also employs quantitative collection data.

As for surveys, there is always the risk that participants will provide socially desirable responses, especially because both interviews and focus groups are conducted face to face. That is the reason why interviewers are often required to demonstrate other skills, in addition to those required for collecting quantitative data.

Direct observation and participant observation (**ethnography**) enable the issues that might arise from the face-to-face interaction to be overcome. In this case, the researcher directly observes actual behaviour. However, the first method can be subject to the researcher's misinterpretation, and the second is very time consuming (Yin, 2003).

Overall, given that the same social phenomenon can be interpreted from multiple perspectives, a **'methodological triangulation'**, i.e. the adoption of multiple methods (Denzin and Lincoln, 2011), should always be promoted, since it might help not only to overcome the limitations of individual research but also to gain more comprehensive understanding of the problem under scrutiny.

4. Social sciences in action

Like any societal problem addressed by public policy, the problem of the EE gap has been mostly tackled by adopting a scientific approach (Wagle, 2000). The scientific approach to policymaking results in the application of theories and methods enabling the best available evidence to be provided to make rational judgements on a policy issue, and is usually defined as the **evidence-based** approach (Bacchi, 2000). In particular, policymaking aims to identify and implement solutions that work (Greenhalgh and Russell, 2009), by drawing from a type of knowledge that assumes reality to be objective, discovered through objective measurement (Sovacool et al., 2018). With regard to the problem of the EE gap, the knowledge that has mostly informed EE policymaking has come from economics, and lately also from **behavioural sciences** ([20]) (Foulds and Robison, 2018; Loewenstein and Chater, 2017), and has informed a range of interventions justified on both economic and behavioural grounds. These are described in Section 4.1.

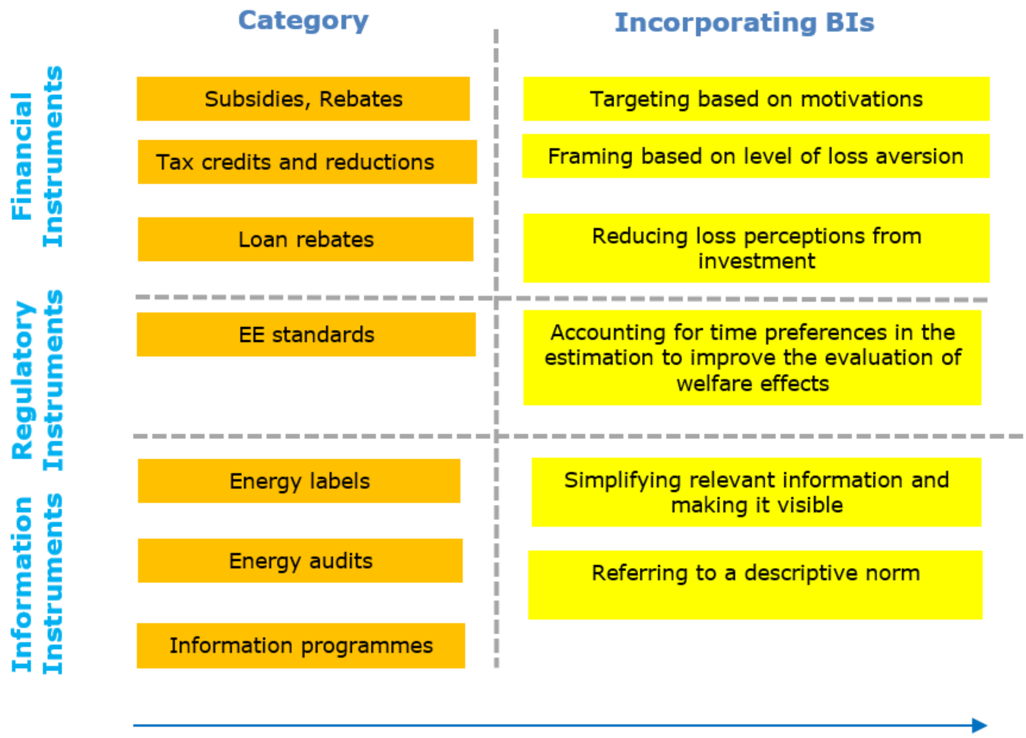
For other disciplines, such as sociology, reality is socially constructed, and knowledge is generated by interpreting individual meanings and actions, to deepen a phenomenon rather than to generalise (Sovacool et al., 2018). When considering that reality is socially constructed and can be interpreted differently, a complementary approach to the evidence-based approach can be proposed, namely an approach that considers the policymaking process a tool for enhancing **collective knowledge** (Wagle, 2000). This alternative framing is especially crucial to the problem of the EE gap, as laypeople's subjective experiences might enable light to be shed on the more endogenous dynamics underlying the decision to invest (Mylan, 2015). In Section 4.2, we discuss how sociology can be applied to this alternative way of framing the EE policymaking process.

4.1. Promoting decisions to invest in energy efficiency

For decades, in order to tackle policy problems, including the **EE gap**, traditional policies relied on interventions justified on economic grounds (such as externalities and information asymmetries), resulting in mandates or bans (changing the availability of options), financial incentives (subsidies and taxes) and non-regulatory instruments (such as mandatory disclosure of information) (Loewenstein and Chater 2017). These instruments were designed on the assumption that that changes in behaviour could be promoted only by providing more incentives and information (Hertwig, 2017). Thereafter, with the advent of behavioural economics, interventions could also be justified on behavioural grounds, such as internalities ([21]) (Loewenstein and Chater 2017). Since then, insights from behavioural sciences (such as behavioural economics and psychology) have enriched the whole policy cycle in a broad range of policy areas, including EE (Sousa Lourenco et al., 2016). Behavioural insights not only can be incorporated into the implementation of traditional interventions, such as financial, regulatory and information instruments, to magnify their overall impact (Figure 7), but can also enrich the policy toolbox through additional instruments (Figure 8). These additional instruments can be categorised into (i) nudges, which enable those behavioural failures that prevent individuals from executing their intentions to be addressed directly, by altering the decision structure or by assisting the decision (Münscher et al., 2016), and (ii) boosts, which enable individuals to be empowered to make complex decisions autonomously, by promoting core competencies (Hertwig, 2017).

([20]) That is, the disciplines that systematically study human behaviour, such as behavioural economics and psychology.
([21]) That is, the costs that individuals impose on themselves and that they are not able to internalise.

Figure 7. Summary of how traditional instruments promoting EE are complemented by behavioural insights (BIs)



Source: Own creation.

4.1.1. Financial instruments

Financial incentives consist of subsidies, tax credits, tax deductions, rebates or loan subsidies (Gillingham et al., 2009). These have been traditionally implemented with the assumption that individuals are more willing to invest in EE if provided with the financial motivation to do so, given that EE is associated with high upfront costs.

However, behavioural sciences suggest that individuals are sensitive not only to the monetary incentives of taxes and subsidies, but also to the way they are framed. For example, subsidies and tax credits can be more effective than an equivalent tax (Hassett and Metcalf, 1995). Similarly, direct subsidies might be more effective than tax deductions when individuals perceive a potential loss from investing in EE (i.e. when they are uncertain about future benefits of investing in EE) (Heutel, 2019). A direct subsidy might be also more effective than a tax when individuals undervalue energy costs, as they will be less sensitive to an energy tax (Allcott et al., 2014). Because of loss aversion, a sale tax waiver might be more effective than an income tax credit (Gallagher and Muehlegger, 2011). Similarly, a zero interest loan might be more effective than a rebate (Revelt and Train, 1998). Behavioural sciences also suggest that the provision of future energy 'guarantees' might be effective in reducing the perception of potential losses from EE investments, namely when energy providers or governments share with the investor not only the future benefits of EE investments, but also the costs and risks (Fischbacher et al., 2015).

Behavioural sciences also put forward the view that the effectiveness of financial incentives depends on not only how they are framed but also which motivations they target. First, by providing an extrinsic (monetary) motivation to do something, financial incentives might have a backfiring effect on those individuals who are already intrinsically motivated (because of altruism and warm glow) to invest in EE (Gneezy and Rustichini, 2000; Frey, 1997), as incentives might prevent individuals from attributing the investment choice to themselves (Festinger 1957). Therefore, to prevent such a crowding-out effect, financial incentives might be complemented with messages that crowd in intrinsic motivation, like those that make salient that investing in EE enables the environment to be protected (Hilton et al., 2014).

Second, behavioural sciences suggest that financial incentives might have different effects on those who are motivated by reputational concerns. Some individuals might invest in EE because they seek social approval or a social class upgrade. In this case, financial incentives for visible EE measures might have a detrimental effect, as individuals will be prevented from showing their sacrifice by investing. To avoid such crowding-out effects, subsidies should be directed at less conspicuous proenvironmental measures (such as home insulation) (Sexton and Sexton, 2014), or should be made accessible only to lower-class categories (Bartiaux et al., 2016). This last measure would also be effective in containing existing inequalities, as it might prevent wealthier individuals from free-riding by applying for subsidies that they do not need. In addition, as individuals motivated by reputational concerns are more likely to renovate their home amenities (i.e. kitchen, bathroom, living rooms, etc.) because these are highly visible, they might be more willing to exploit incentives to invest in non-visible EE measures when these are coupled with the promotion of amenity renovations. This way, the incentive scheme would effectively tap into the normative influence of highly visible and comparable renovations to promote EE investments (Wilson, 2008).

Overall, the same financial intervention might have different effects on individuals. Therefore, it is crucial to understand individual heterogeneity, especially when financial instruments have to be implemented, as these are very expensive from a government perspective. In particular, to avoid unintended consequences, policymakers should explore heterogeneity in motivations before implementing an incentive-based intervention, by promoting the inclusion of items, such as those developed by Falk et al. (2016) in the context of large-scale surveys. Such a pre-screening analysis might allow the uncovering of potential levers, such as a high degree of altruism in the target context, and inform the design of an effective incentive scheme. For example, individuals could receive monetary incentives after being categorised into groups (Schofield et al., 2015).

4.1.2. Regulatory instruments

By imposing bans on certain types of products that do not meet certain conditions, regulatory instruments change the options available to consumers. In the context of EE, these have been implemented in terms of product standards, in order to set a minimum level of EE, for heating and cooling systems and insulation measures, for example. Usually standards are implemented based on *ex ante* estimates of cost and benefits (i.e. energy savings). However, those estimates often result from implicit modelling assumptions about individual behaviour and needs, and do not consider welfare losses from reduced available options. Behavioural sciences might improve the evaluation of welfare effects of standards, by making the modelling more realistic. For example, when inconsistent time preferences are explicitly taken into account, standards can enhance the welfare of individuals who display a high preference for the present (Tsvetanov and Segerson, 2014). At the same time, introducing a set of standards, rather than a single one-size-fits-all standard, that are based on estimates that take into account people's meanings and needs might help prevent the failed translation of increased efficiency into reduced energy demand (Cass and Shove, 2018).

Behavioural sciences can also inform regulatory instruments that are different from standards, such as those that protect consumers from the risk of private actors exploiting people's weaknesses. As innovative financing mechanisms and business models enabling EE investments are emerging more and more (Bertoldi et al. 2021), policymakers can exploit insights from behavioural sciences to monitor whether these mechanisms are designed in a way that exploits consumers' cognitive weaknesses to unethically increase profits (i.e. sludging), and whether a regulatory measure has to be implemented (Loewenstein and Chater, 2017).

4.1.3. Informational instruments

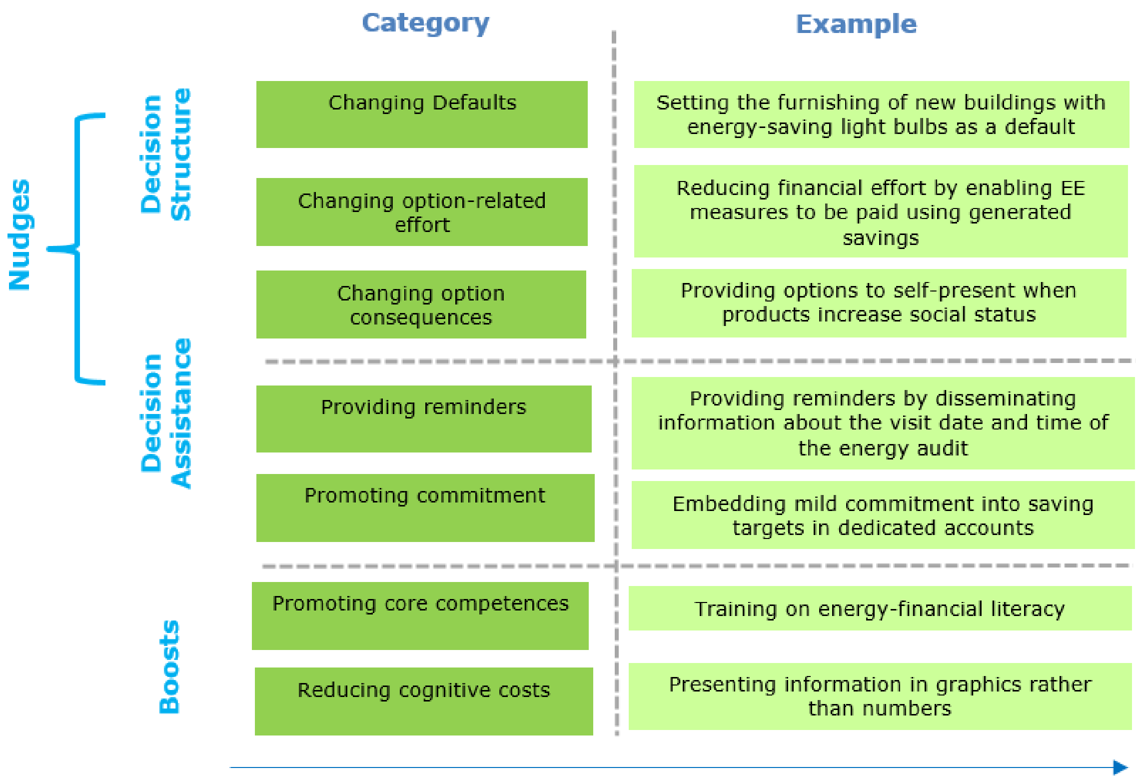
In addition to capital, information is an essential condition for investing in EE. Information instruments disclose technical information, such as energy savings, mainly through labels, audits and information programmes. As financial measures, information instruments have been traditionally implemented with the assumption that individuals might be more willing to invest in EE if provided with more information. However, behavioural sciences suggest that individuals are sensitive not only to the availability of relevant information, but also to the way it is framed and by whom it is provided. In practice, insights from behavioural sciences can magnify the impact of informational interventions, by improving the presentation (i.e. reframing the information, making it salient, providing reference points) of '**decision-relevant information**' (Münscher et al., 2016).

Energy labels provide individuals with useful information that helps them to decide whether or not to invest in EE. However, their introduction does not always translate into an increase in investment in EE. Energy labels can thus be enriched with behavioural insights, in order to make information disclosure more effective in promoting actual investment decisions. For example, energy labels might make operating costs more salient at the point of purchase (Newell and Siikamäki, 2014).

Energy audits provide individuals with information about current inefficient losses and energy use, as well as recommendations on how to improve the energy performance of their homes and appliances. These mechanisms are useful for increasing the awareness of the EE of one's home. On average, energy audits increase investments in home renovations (Frondel and Vance, 2013). However, the response to an energy audit is heterogeneous and does not always result in the audit recommendations being followed. The context-specific features of a population target, the language and trust are crucial for the energy audit programme to succeed (Fuller, 2010). For example, individuals might not trust the information that is provided by the audits (Palmer et al., 2013). Insights from behavioural sciences can contribute to increasing the impact of audit programmes by tailoring the delivery of advice and information to a specific target context. For example, in contexts characterised by a low level of trust, implementing energy events in the target community before offering the energy audits enables the community-level energy culture to be shifted, trust in the auditor to be encouraged and a subsequent uptake of EE measures. This is particularly true when a trusted community member works as a facilitator during the energy events (M. G. Scott et al., 2016a). These insights can be of particular relevance to enhancing the impact of a new emerging business model, namely a one-stop shop, which enables the complex journey of renovation to be simplified (Boza-Kiss and Bertoldi, 2018).

Information programmes are traditional interventions aimed at increasing individuals' awareness of problems, such as environmental issues (Hungerford and Volk, 1990). By providing individuals with basic energy-related knowledge, these programmes might increase individuals' willingness to invest in EE. However, providing individuals with more information might not necessarily translate into a change in behaviour if individuals do not have the motivation to change (Hertwig, 2017).. Therefore, information programmes enhanced by behavioural insights might provide the motivation to invest in EE by offering a descriptive norm, such as by making salient the fact that a certain percentage of peers have already invested in EE (DellaValle and Zubaryeva, 2019).

Figure 8. Summary of behavioural instruments for promoting EE investment decisions



Source: Own creation.

4.1.4. Nudges

4.1.4.1. Decision structure

EE practitioners and policymakers can act as choice architects by influencing the decision structure, such as by changing the effort required to select an option or the consequences associated with an option. One of the most prominent interventions of this kind is the pre-selection of the default option, which is the option that is immediately available to individuals (Carroll et al., 2009). One of the reasons why individuals might fail to invest in EE is that perceived future uncertainty makes individuals prefer the status quo (Alberini et al., 2013). Choice architects can pre-select the default option to counter this behavioural failure. For example, pre-selecting a green option, such as setting the furnishing of new buildings with energy-saving light bulbs as a default, can effectively increase the choice of energy-efficient light bulbs (Dinner et al., 2011). Although default options might be seen as a regulatory instrument similar to mandates and bans, they are effective instruments that change behaviour in the desired policy directions while leaving individuals free to opt out (the cost of which can vary) (Sunstein and Reisch, 2016). At the same time, their implementation always needs to be preceded by a careful assessment of the right default to select and the level of heterogeneity in individual preferences (Madrian, 2014). For example, defaults might work well if the target group is homogeneous (Carroll et al., 2009). Conversely, in some contexts, rather than providing individuals with a pre-selected option, requiring individuals to make an active choice might be more effective. This is particularly the case when the targets are individuals with a low perceived ability to control their environment, such as vulnerable individuals (DellaValle 2019), or when there is the risk that choice architects might be self-interested and use defaults to increase their profits in a non-transparent way (Sunstein and Reisch, 2016).

When an active choice is required, choice architects can change the decision structure by reducing the effort associated with that choice. For example, to reduce perceived financial effort that prevents individuals from adopting EE measures, choice architects can change the factors that affect perceived financial effort (Münscher et al., 2016), such as by enabling individuals to pay for the EE measures using the generated energy savings (Team, 2011).

Finally, choice architects can change the decision structure by connecting the choice of an option with social consequences (Münscher et al., 2016). For example, individuals are more likely to choose green products when they are connected with an increase in status, and self-presentation is made possible (Griskevicius et al., 2010).

4.1.4.2. Decision aids

Choice architects can promote EE investments by providing decision-makers with assistance in following their intentions (Münscher et al., 2016). Commitment devices, reminders and goal setting are techniques that assist decision-makers in overcoming behavioural failures, such as present bias and limited attention, which prevent individuals from investing in EE. For example, providing reminders by disseminating information about the visit date and time of the energy audit is likely to increase the final audit uptake (Gillingham and Tsvetanov, 2018). Providing individuals with a planning aid or prompting them to make a plan can be effective in helping individuals switch to more energy-efficient appliances (Madrian, 2014). Finally, promoting 'dedicated accounts' offering concrete saving targets that require a mild commitment (for example, there might be a penalty for early withdrawal) might be effective in tackling the behavioural failures that prevent individuals from saving for EE investments. For example, offering the possibility of committing oneself to saving a certain amount might be an effective way to mobilise microsavings that are useful for financing durable energy-saving goods. This is crucial not only to promoting investments in EE but also to alleviating **energy poverty**, as low-income individuals might also have access to the necessary capital (Arestis and Sawyer, 2015).

4.1.5. Boosts

Although information programmes might increase individuals' awareness of problems, in order to make use of that information, individuals need basic skills and abilities. In contrast to nudges, boosts are interventions that target competencies rather than behaviour, with the aim of empowering individuals to make complex decisions autonomously (Grüne-Yanoff and Hertwig, 2016; Hertwig, 2017; Hertwig and Ryall, 2020), such as the decision to invest in EE. Boosts aim to specifically promote human agency, by targeting area-specific (e.g. understanding energy information) and general competencies (e.g. statistical literacy), as well as the related context (e.g. information representation). For example, training that provides, in addition to knowledge of energy-related issues, some basic financial concepts can boost the skills needed to make calculations, thus easing EE investment decisions (Blasch et al., 2017). In addition, disseminating information about the EE benefits that have not materialised yet in a cognitively undemanding way, for example with graphical representations, might be an effective way to promote optimal decision-making (Hertwig, 2017). Boosting interventions are especially crucial to vulnerable individuals who, by being boosted to make decisions autonomously, can take more control over the decisions that affect their lives (DellaValle and Sareen 2020).

4.2. Citizen engagement in the energy efficiency policymaking process

The evidence-based framing of EE policymaking aims to identify and implement the solutions that work (Greenhalgh and Russell, 2009). However, policymaking can also be a tool for enhancing democracy, by developing a collective understanding and enacting knowledge (Wagle, 2000).

Such an alternative framing is especially crucial when considering policies dealing with energy, as this is not a good but a social relation (Stirling, 2014). At the same time, by shifting behaviours and by shifting access to services, EE measures risk further reinforcing social injustice across different social categories (Pellegrini-Masini et al., 2020). For this reason, it is crucial to create a space in which citizens can have their say on all the phases of the policymaking process (Pereira and Völker, 2020). This might not only enable 'societal ceilings' to be overcome and the collective acceptance of measures cycle to be boosted, but also help tackle unequal distribution of power (Hammond, 2020). In particular, when marginalised actors, whose voices are rarely represented in the decision-making process, are engaged, they can improve the quality of the policy agenda with their inputs (Lieu et al., 2019). At the same time, they can gain greater control over the decisions affecting their lives (DellaValle and Sareen 2020). Institutionalising citizen engagement in the policymaking process will also make engaged citizens develop deliberative capabilities (Button, 2018), and policymakers will become sensitive to the differential effect that policy measures have on different social classes (Wagle, 2000).

During the stage of understanding the policy problem that needs to be addressed, engaging involved actors through focus groups can enable knowledge of experiences, expectations, feelings, tensions and beliefs about a certain issue to be gained (Pereira and Völker, 2020). For example, lighting practices are imbued with socially shared meanings and values (i.e. lights not only illuminate but also create ambience, safety and convenience) (Crosbie and Guy, 2008). In addition, although they are measures that are crucial to guiding the work of building designers and social actors to reduce energy demand, in some contexts standards might yield unintended consequences of sustaining and sometimes escalating present (inefficient) conventions (Shove, 2018). Such endogenous dynamics underlying energy-related practices make citizens the most knowledgeable stakeholders about the environment in which they live, and failing to leverage this knowledge in the policymaking process will likely make EE policies partially effective (Della Valle and Bertoldi, Forthcoming). Conversely, enabling citizens to share their meanings, needs and aspirations might enable them to influence the content and the framing of a policy through their inputs, such as by enriching the estimates underlying standards according to their needs.

During the stage of designing the policy measures, co-design methods for policymaking can be implemented to engage different stakeholders in the production of a shared solution (Pereira and Völker, 2020). For example, individuals might not trust the information that is provided by energy audits (Palmer et al., 2013). Although energy audits are a promising measure to promote EE, by increasing the awareness of the EE of one's home, the response to an energy audit does not always result in the audit recommendations being followed, because this is highly dependent on the context-specific features of a target population (Fuller, 2010). Co-design methods might lead to a shared situated solution that encourages trust in the auditor and subsequent uptake of EE measures, such as the implementation of an energy event that is facilitated by a commonly identified trusted community member (M. G. Scott et al., 2016b).

5. Conclusions

One example of a way for citizens to contribute to the low-carbon energy transition is by investing in EE. However, the actual rate of adoption of EE lags far behind the rate suggested by analyses that assume consumers always choose the option that is most profitable.

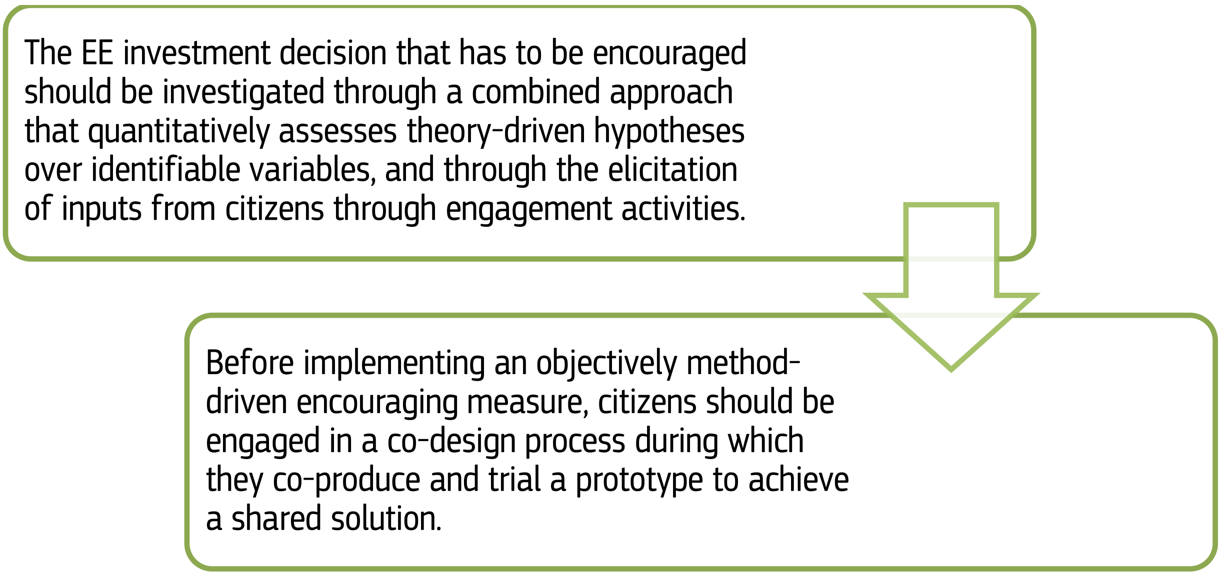
Although the factors affecting the decision to invest in EE have been studied from different disciplinary perspectives, EE policymaking has been traditionally informed by the PTEM, which focuses on the physical characteristics of buildings and technologies and aggregate effects on energy prices.

Fortunately, with the advent of behavioural economics and the application of behavioural sciences to policy, EE policy has started to better account for the human factor in EE. However, the perspectives taken by economics and behavioural sciences capture only one dimension related to the decision to invest in EE, namely the individual dimension. For example, the collective aspect of citizens' decision to invest in EE, which can be well explained by the sociological perspective, is still largely overlooked on the energy policy agenda.

Leveraging multiple perspectives and translating them into practice is, however, challenging, because of an 'information gap' in policy on how to understand the complexity of factors that influence human behaviour (such as the decision to invest in EE). This report aimed exactly to contribute to closing this gap. In particular, first, it outlined the main concepts and approaches to understand the non-economic complexity surrounding the decision to invest in EE; then, it discussed the available instruments for promoting the decision to invest in EE and how they can be further improved. Finally, it presented the sociological perspective as an opportunity to complement the dominant EE policymaking approach through the engagement of citizens in the EE policymaking process.

A policy agenda that seeks to increase EE investment decisions should be able to account for the real complexity of people's behaviour in relation to EE. This report proposed some key concepts and methods for developing such a policy agenda.

Figure 9. Integrating the human factor into the EE policy agenda



Source: Own creation.

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Abbreviations

BIs	behavioural insights
DU	discounted utility
EE	energy efficiency
EUT	expected utility theory
NAM	norm activation model
PTEM	physical–technical–economic model
SPT	social practice theory
STEM	science, technology, engineering and mathematics
TPB	theory of planned behaviour
WTP	willingness to pay

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