CONSEED

CONSumer Energy Efficiency Decision making

REPORT ON EUROPEAN UNION ENERGY EFFICIENCY LABELLING POLICY: CURRENT IMPACT AND RECOMMENDATIONS FOR THE FUTURE

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Executive Summary

This report focuses on how findings of the CONSEED project can inform European Union (EU) policy on energy efficiency labels. The CONSEED project explored how households and firms make decisions in relation to their energy-consuming investments. The methods used include a combination of surveys, field trials and experiments. Each examined how providing information, at the point-of-sale, on the costs of energy use can influence consumer behaviour. In general, our findings suggest that adding monetary information, e.g. in the form of likely energy costs over a year, to existing energy efficiency labels would increase the demand for more efficient goods, particularly for properties and cars.

The adoption of more energy efficient goods by households and firms is important for achieving EU climate targets set by the "Clean energy for all Europeans" package[1]. Improvements in buildings and transport is key. Buildings account for 40% of the EU's energy consumption and most of the building sector has a very significant energy-saving potential through the adoption of energy efficiency.[2] The transport sector accounts for almost a quarter of all EU greenhouse gas (GHG) emissions and also offers a major opportunity for significant energy reductions through the adoption of new, lower-emission drive trains and through modal shift (switching to public transport, for example).[3]

On a like-for-like basis, more energy efficient goods are often more expensive to purchase but have a lower energy cost during the lifetime of the good. However, where consumers discount future energy savings at a greater rate, this may result in a devaluation of future benefits of energy efficiency and low levels of investment. This is part of the "energy efficiency gap" and is well documented in the research literature.

There are several policy instruments that can help reduce this gap. Among the most popular instruments are labelling schemes (see Deliverable 1.1 in CONSEED). The labels aim to manage informational failures regarding the energy efficiency of a good. For example, in buildings, Energy Performance Certificates in various formats are in place throughout the EU. These certificates assume that buyers and renters are not fully aware of building energy consumption, and provide information to increase the salience and therefore demand for energy efficient buildings. Labels are also in place for cars and large household appliances.[4] In terms of large household appliances, a common labelling system is in place throughout the EU. In contrast, the labels for buildings and for cars are not harmonised to the same degree.

In terms of the effectiveness of labelling policy in increasing demand for energy efficiency, there are few examples in existing research that compare market demand before and after the introduction of labels, or to a control group with no labels. However, a European Commission report from 2015 found that the

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[1] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans
[2] https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-performance-of-buildings
[3] https://ec.europa.eu/clima/policies/transport_en
[4] https://ec.europa.eu/clima/policies/transport/vehicles/labelling_en and https://europa.eu/youreurope/business/product/energy-labels/index_en.htm

combined effects of energy labelling and Ecodesign regulations have reduced EU energy consumption, reduced household energy bills, and that the vast majority of EU consumers now recognise and understand the labels.[5] This latter finding is also supported by the latest Eurobarometer (2019) findings where 79% of consumers say the label influenced their purchase.[6] Furthermore, once a labelling system is in place, many studies, particularly in relation to property, show that buyers are willing to pay a premium for higher energy efficiency levels.[7]

In terms of future labelling amendments, prior research from the appliance sector shows that the success of a label depends on the format, the information given, its colour, its size and the credibility of the institution that creates the label. For transport, one study shows the importance of ensuring the energy efficiency metric is contextualised (for example, that carbon emissions are accompanied by general household carbon targets for comparison). There are, however, a growing number of studies in the appliance sector which demonstrate that showing energy consumption in monetary terms (euros) rather than in physical terms (kWh) increases the share of low-energy sales.

The CONSEED project explored the energy efficiency investment processes in greater detail. Our decision model identifies a large number of potential benefits, costs, enablers and barriers to the adoption of lower-energy goods. Our core research question explored whether providing monetary information on energy use can influence investment decisions. This was carried out using controlled field trials, discrete choice experiments and surveys across household and business sectors (services, industry and agriculture) for a range of different energy-consuming goods.

There are a number of general findings from the surveys. In terms of knowledge gaps, a sizable proportion of households and firms are both unaware of existing consumption levels and of the benefits of investing in more energy efficient options. Furthermore, it is apparent that some are not investing due to internal financial constraints (lack of internal financial reserves) and external credit limitations (such as difficulty getting a loan from a financial institution). Existing labelling is generally considered helpful, influential and clear. However, we also observed a relatively high share of individuals who believe labelling is potentially manipulated by suppliers. Such a finding may be the result of recent scandals in the car market (highlighted during one of our focus groups).

Our main empirical tests explored the effects of monetary energy labels relative to labels showing energy use in physical terms (such as kWh per annum). In this regard, four of the five experiments for households (two field trials and three discrete choice experiments) show that monetary labels increased the demand for energy efficiency. This increase is larger for goods with higher shares of energy expenditure (such as cars and buildings).

[5] https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v5.pdf
[6] https://ec.europa.eu/info/news/eurobarometer-survey-confirms-public-support-energy-policy-objectives-2019-sep-11_en
[7] A challenge for the general literature, and for policymakers, is that the energy efficiency premium, for example relating to property, is not known prior to labelling and therefore the success of the policy cannot be accurately appraised.

These experimental findings imply that the salience of relative long-term energy costs can be increased by adding monetary energy efficiency labelling. While an EU-wide labelling amendment would be challenging due to geographical differences in energy consumption and energy prices, online/in-store long-run comparative energy cost calculators could be used to inform households of the cost implications of different goods. Furthermore, such calculators could also incorporate household-specific factors and expectations, such as existing energy efficiency levels, family size and long-run energy price expectations.

Affordability and financial constraints identified in surveys are also likely to be an impediment to energy efficiency adoption for many households and firms. In this regard, the 2016 *Smart Finance for Smart Buildings* initiative makes a number of recommendations which will increase the flow of finance for energy efficiency investment. Its third pillar, on de-risking, explicitly states the need for finance providers to recognise the potential default (decrease) and collateral (increase) effects of energy efficiency investments, and there is a growing body of research supporting this de-risking mechanism of energy efficiency. CONSEED's understanding of investment costs is also useful for policymakers for the design of energy finance products. Firstly, lower cost financing would clearly increase the uptake of energy efficiency projects. Secondly, our analysis of energy savings suggests that payback periods can be longer than the term of traditional consumer loans. In this regard, the terms of energy efficiency loans have more general financial stability implications.

The three main policy recommendations arising from the CONSEED project to increase the adoption of energy efficiency are summarised below and explained in more detail in Section 3 (pages 22-24):

- Add energy cost forecasts at the point of sale
- Labelling should account for differences across countries and households
- Align loan terms with energy efficiency payback periods

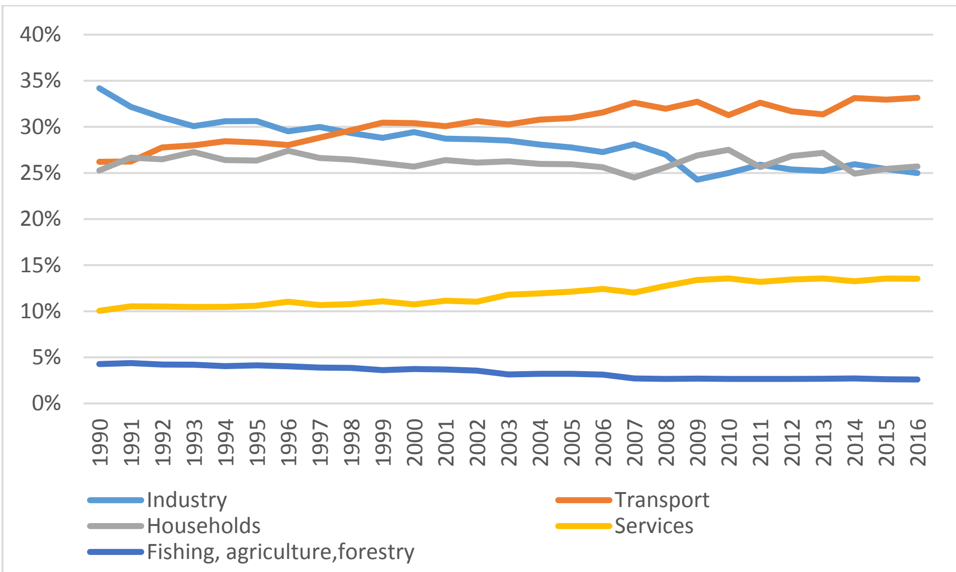
1 Effectiveness of Existing Labelling Policies

This section has two aims. The first, covered in Section 1.1 below, is to review the EU's energy labelling policy, outlining which sectors are subject to labels and which are not. The second, in Section 1.2, reviews the existing research literature on the impact and effectiveness of these labelling policies.

1.1 Policy Framework

The subsections below outline the existing EU policy framework in relation to energy efficiency labels, for seven different sectors – three in the household sector (property, appliances and cars), two in the services sector (appliances and property), and one in both industry (machinery) and agriculture (machinery) sectors. These sectors cover 97% of final energy consumption in the EU in 2016 and the share of each of five main sectors is shown in Figure 1. While the agricultural sector has low direct consumption, its GHG emission share is considerably higher due to livestock (11%).[8] In terms of trends, since 2000, agricultural consumption has shown the largest decline (32%), followed by industry (17%) and households (2.1%). However, consumption has increased in the services sector (23%) and the transport sector (6.6%).

Figure 1: Share of Final Energy Consumption by Sector in 2016



Source: *https://www.eea.europa.eu/data-and-maps/indicators/final-energy-consumption-by-sector-9/assessment-4*

[8] https://www.eea.europa.eu/data-and-maps/daviz/change-of-co2-eq-emissions-2#tab-dashboard-01

1.1.1 Household – Property

There are numerous supply and demand policies which impact the energy efficiency levels of European buildings. The main legislative documents in the EU are the 2010 Energy Performance of Building Directive (EPBD) (Directive 2010/31/EU), the 2012 Energy Efficiency Directive (Directive 2012/27/EU) and the 2018 Amending Energy Efficiency Directive (EU 2018/2002). The EPBD outlines a number of high-level building standard requirements: Member states must apply minimum energy requirements and devise their own national plans to increase the number of "nearly zero-energy" buildings. On the latter, the EPBD states that all new buildings will be at the nearly zero-energy standard by December 2020.

In relation to energy efficiency labelling, the key high-level EU informational policy is set out in the EPBD. This establishes the system of Energy Performance Certificates (EPCs) to inform buyers and renters of a building's energy attributes prior to committing to buy/rent. The EPBD has three specific requirements in relation to EPCs. Firstly, the EPC must include the energy performance of a building with reference values. Secondly, the EPC must be stated in advertisements in commercial media, and thirdly, the EPC must be shown to the prospective new tenant or buyer and handed over to the buyer or new tenant.

1.1.2 Household – Appliances

The household sector is responsible for roughly one quarter of total energy consumption in the EU. And the consumption of electricity by appliances represents half of the total electricity consumption by households (ADEME, 2016). However, when household transport is also considered, the overall contribution of the sector is higher.

There are two core policy pillars in relation to appliances within the EU: Ecodesign regulations, which set out minimum mandatory energy efficiency levels for appliances, and energy labelling, which directs consumers towards more energy efficient goods. A recasting of the Energy Labelling Directive for household appliances was accepted in January 2017 (Directive 2017/1369/EU). The energy labels will be reformed in the course of 2021 in order to be simpler and more understandable by consumers. A new element of the labels will be a QR code which will direct the buyer towards additional online information for the good. However, the exact content of this additional online information is unknown. Furthermore, in October 2019, the European Commission adopted new measures for goods such as refrigerators, washing machines, dishwashers and televisions (C(2019) 2120-2027) which will improve the life span, maintenance, repair, reuse, upgrade, recyclability and waste handling.[9]

1.1.3 Household – Cars

Road transport is a major contributor to EU GHG emissions, responsible for roughly one fifth of total emissions, and is the only sector where emissions are still rising.[10] Light-duty vehicles (cars and vans) are responsible for 15% of the EU's CO_2 emissions. As part of its policy to reduce those emissions, the EU has

[9] https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889
[10] https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-11

implemented binding targets for manufacturers of new cars and vans, across an entire manufacturer's fleet, while consumer choices are targeted via labelling.

The 1999 Car Labelling Directive (Directive 1999/94/EC) requires EU member states to provide relevant information, including a label with fuel efficiency and CO_2 emissions, although it does not harmonise the presentation of the energy labels across countries. Specifically, the directive requires each member state to ensure that:

- A label of fuel economy and CO_2 emissions is displayed near each new car model at the point of sale.
- A guide on fuel economy and CO_2 emissions is produced on at least an annual basis, and should be available to consumers free of charge.
- A poster (or display) is exhibited with a list of the official fuel consumption data on CO_2 emissions data for all new car models at the point of sale.
- All promotional material includes the official fuel consumption and CO_2 emission data.

Furthermore, Regulation 122/2009 covers the labelling of car tyres, which includes a colour-coded categorical scale similar to car labels to indicate fuel efficiency (covers sales from 2012).[11] An improvement to this label is currently being considered.[12]

1.1.4 Services – Appliances

While total energy consumption in the EU decreased by 7.1% between 2005 and 2016, consumption in the services sector increased by 3.8% (European Environment Agency, 2018). Although data on energy consumption by sub-sector is available only for a limited number of countries, it seems that the most important sub-sectors in terms of energy consumption are the trade sector (wholesale and retail trade) and private and public offices, both contributing 26% of the total energy consumption (Gynther et al., 2015)

The main appliances of interest are heating, cooling and ventilation devices. Cooling, in particular, plays a vital role in many services sub-sectors' energy consumption. For instance, in wholesale and retail trade, refrigeration accounts for between 30% and 60% of the sector's energy consumption (European Commission, 2016). 'Professional cold' appliances were estimated to consume around 116.5 TWh (in 2012) and commercial refrigeration (including both refrigerators and freezers) consume 85 TWh (in 2013).[13] Air conditioning and ventilation is a common cooling demand in hotels, restaurants, and other food service outlets, offices, etc. As cited in Styles et al. (2013), 20-50% of energy costs in hotels are attributable to heating, ventilation and air conditioning (HVAC) systems (Baker et al., 2008). More specifically, electricity accounts for approximately 40% of the energy consumed in a hotel, and, of this, approximately 40% is used by lighting, 26% by HVAC, 6% by water heating, 5% by food services, and 18% by other (Styles et al., 2013).

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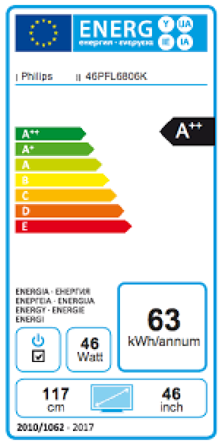
[11] https://ec.europa.eu/energy/sites/ener/files/documents/user_guide_-_tyres_en.pdf
[12] https://ec.europa.eu/info/news/commission-proposes-improved-tyre-labelling-rules-2018-may-17_en
[13] www.coolproducts.eu

Commercial appliances are also covered by the EU's Ecodesign regulations (often under the so-called Voluntary Agreements) and labelling requirements. For example, there are minimum energy efficiency bounds for all heating and cooling goods, ventilation units, industrial fans, pumps, transformers, computers and electric motors. While energy efficiency labelling is less prevalent in the commercial sector, labels are in place for local water and space heating/cooling, lighting, and for professional refrigeration. Recent Ecodesign amendments (2019) revised design standards applying to commercial appliances (such as lights, power supplies, electric motors, transformers, refrigerators), which will affect their life span, from maintenance and repair to recyclability and waste handling.[14]

Figure 2: Example of EU television label



1.1.5 Services – Buildings

As with residential dwellings, Directive 2010/31/EU covers the energy requirements in commercial buildings. However, the specific implementation details and plans associated with these high-level EU-wide rules is at member state discretion. For example, in Ireland, the codes outlined in the 2017 Building Regulations for Buildings other than Dwellings ensure that, for new commercial buildings, they are at the nearly zero-energy standard, that energy is sourced from renewable sources, and that structures limit heat loss and avail of available heat gains. Further, the same regulations require the installation of energy efficient space heating and cooling systems and the design of buildings so as to limit the need for air conditioning. Lastly, new buildings should provide energy efficient artificial lighting systems and controls, and, relatedly, that owners/occupants should have sufficient information about the building, the fixed building services, controls and maintenance requirements.

The EU-wide informational policies outlined above for residential buildings, in particular Directive 2010/31/EU, related to energy efficiency labelling of buildings, and Directive 2012/27/EU, regarding more timely and accurate metering of electricity and gas, also apply to commercial buildings and their occupants. A further demand-focused informational policy for firms in Directive 2012/27/EU ensures that member

[14] https://ec.europa.eu/commission/presscorner/detail/en/QANDA_19_5889

states develop programmes which will encourage small and medium-sized enterprises (SMEs) to undergo energy audits and implement the recommendations and that enterprises that are not SMEs are required undergo such audits at least every four years.

1.1.6 Industry – Machinery

The industry sector accounted for 38% of global total final energy use in 2016. This represents a 1.3% annual increase in energy consumption since 2010, with 1.2% growth from 2015 to 2016 (IEA, 2018). However, in the EU, the sector's energy consumption has declined significantly over the past two decades.

Global growth in energy consumption has been driven largely by a continuing long-term trend of production growth in energy-intensive industrial sectors. In accordance with that, it is also one of the key energy consumers with potential for both an increase in energy efficiency and high energy savings for the future. Electric motors, which are used for conveyor belts or pumps, for example, currently use almost two thirds of energy consumed within the industry sector. Improving energy efficiency and shifting towards best available technologies can help reduce energy demand.

The main emission-related EU-wide policy applicable to industry is the EU *Emission Trading Scheme* (EU ETS) which covers carbon dioxide, nitrous oxide and PFCs in energy-intensive industry sectors including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals While no energy efficiency labelling directives exist for industrial products, in October 2019, the EU introduced eco-design requirements for certain types of industrial machinery. These include power transformers (C(2019) 5380) and welding equipment (C(2019) 6843), as well as motors and external power supplies (C(2019) 2125-2126), which were also mentioned above. Moreover, the 2012 Energy Efficiency Directive establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020, which includes the industrial sector.

In December 2018, the European Parliament and the Council of the European Union adopted the revised Energy Efficiency Directive, including a new 32.5% energy efficiency target for 2030, and measures to revise the Directive to make sure the new target is met. This includes an extension of the requirement to achieve new savings in final energy consumption of 0.8% each year beyond 2020, an updated Primary Energy Factor (PEF) for electricity generation of 2.1 (down from 2.5), and monitoring efficiency levels in new energy generation capacities. Member states shall assess and, if appropriate, take measures to minimise the impact of the direct and indirect costs of energy efficiency obligation schemes on the competitiveness of energy-intensive industries exposed to international competition.

1.1.7 Agriculture

As with industry, there is no energy efficiency labelling directive at the EU level relating to agriculture. However, this is likely due to the fact that direct energy inputs (fuel and electricity) are not a major component of input costs in this sector (GHG emissions are predominantly derived from livestock and land use, and energy inputs used are often subject to favourable tax treatments or exemptions). For example, the Irish National Farm Survey 2017 shows that fuel accounts for just 3.4% of total farm expenses.[15] The

[15] https://www.teagasc.ie/media/website/publications/2018/NFS2017_web.pdf

greenhouse gas emissions from the sector in the EU are mostly attributable to methane and nitrous oxide linked to livestock.

As with other sectors, there are EU-wide technical standards covering tractors, although these do not relate directly to energy consumption. EU regulation 2015/96 lays down the limit values for emissions of gaseous and particulate matter pollutants to be applied in successive stages, and the test procedure for internal combustion engines intended to power agricultural or forestry vehicles. These regulations follow Directive 97/68/EC on the limits for carbon monoxide, hydrocarbons, oxides of nitrogen and particulates.

1.2 Literature Review

In this part of the report, we review the existing research literature on energy efficiency and energy efficiency labels which varies substantially across sectors. This sub-section is structured along four main headings, reflecting both the availability of research and sectors of interest in the CONSEED project: property, appliances, transport, and machinery. A theme that is common across much of the literature is the difficulty in disentangling the effect of an energy efficiency label from other effects, including the direct effect of energy efficiency itself on the value of a good or service.

1.2.1 Residential Properties

Most studies which explore the impact of energy efficiency on housing costs use hedonic regression techniques applied to historical sales data. In general, house buyers value energy efficiency: properties with higher energy efficiency ratings have higher sales prices. For example, in The Netherlands, Brounen and Kok (2011) show that buildings certified as "Green" (A, B or C rating) receive a 3.7% sales premium while Chegut et al. (2016) show that A-rated properties in the affordable housing market receive a 6.3% premium (relative to C-rated). Hyland et al. (2013) also find a positive sales effect in Ireland and show that each improvement along the Building Energy Rating scale leads to a 1.3% increase in sales price and that properties in the highest A-rated category receive a 9.3% premium relative to the median category. In Spain, de Ayala et al. (2016) find that properties in the A, B, C or D category have a 5.4% price premium. Significant sales premiums are also observed in England (Fuerst et al., 2015), Wales (Fuerst et al., 2016) and Denmark (Jensen et al., 2016).

Studies employing survey data are less supportive of a link between energy efficiency and property values. For example, Murphy (2014) finds that only 10% of respondents in the Netherlands said that energy efficiency ratings influence their buying decisions. Amecke (2012) also finds that ratings are less effective, with respondents suggesting that ratings are not helpful for understanding the financial implications of efficiency improvements and that energy efficiency is only a minor criterion when purchasing a dwelling.

For the rental market, a premium is also observed. In Germany, Cajias and Piazolo (2013) show that a 1% increase in a building's energy consumption leads to a 0.08% decline in rents. Furthermore, in a multi-region analysis, European Commission (DG Energy) (2013) finds that energy efficiency improvements are associated with a 4.4% rent increase in Austria (for a one letter improvement: D-rating to C-rating, for example) and a 3.2% increase in Belgium (for a 100 CPEB point increase). In Ireland, Hyland et al. (2013) find that each Building Energy Rating improvement raises rents by 0.5%. Using a discrete choice experiment (DCE), Carroll et al. (2016a) also find that Irish renters value energy efficiency improvements, but that this relationship mainly holds for efficiency improvements at the lower-end of the efficiency scale (i.e. improving the least efficient properties).

While there are few studies which focus specifically on the services sector, there is a large body of literature exploring the effects of energy labels/certificates on commercial real estate rents and prices. Similar to the residential property sector, these studies predominantly use hedonic regression techniques to control for a range of property and locational characteristics (with some methodological extensions: panel data techniques employed by Das et al. (2011) and propensity score weighting techniques employed by Eichholtz et al. (2013) and Chegut et al. (2013)).

In the US commercial property market, studies generally find large and statistically significant price premiums associated with higher energy efficiency ratings (Energy Star or Leadership in Energy and Environmental Design (LEED) certification). An early example is from Eichholtz et al. (2010) who, using a sample of 1,813 properties between 2004 and 2007 from the CoStar database, show that sales prices for certified buildings are 16% higher. Fuerst and McAllister (2011a) find even higher premiums of 25% for LEED and 26% for Energy Star (using a larger sample of 6,157 transactions from 1999 to 2008). Numerous other examples from the US literature show similar effects, including Wiley et al. (2010) (extra $\$30/ft^2$ for Energy Star and $\$130/ft^2$ for LEED), Eichholtz et al. (2013) (13% for Energy Star and 11% for LEED) and Das and Wiley (2014) (16% for Energy Star and 11% for LEED). Das and Wiley (2014) also show that premiums increase with property size but decrease with property age, and that certified properties achieve higher premiums during periods of limited development and high vacancy. Robinson and McAllister (2015) find different size interaction effects and show that premiums tend to be higher for smaller, lower value buildings (and not significant for higher value properties).

Outside of the US, results also suggest an efficiency premium, but not universally so. For example, in the UK, Fuerst and McAllister (2011b) do not find that EPC improvements or BREEAM[16] certification lead to higher sales prices (N = 708) while Chegut et al. (2013) find a 18-24% BREEAM premium in the London area. Chegut et al. (2013) also show that the marginal effect of green building certification decreases when more green buildings come on the market at a given location. While Bonde and Song (2013) also find no significant price effects for improved efficiency (as measured by the EPC) in Sweden, in Australia, Newell et al. (2014) observe a 9.4% premium for the 5-star NABERS certification and a 11.8% premium for the Green Star rating scheme.

A rental premium in the commercial sector is also observed in most prior studies. In the US, significant rental premiums are observed in Eichholtz et al. (2010) (3%), Wiley et al. (2010) (15-17% for LEED and 7-8.6% for Energy Star), Fuerst and McAllister (2011a) (5% and 4%, respectively), Eichholtz et al. (2013) (6% and 2%) and Das and Wiley (2014) (11% and 16%). Das et al. (2011) find that the green premium is counter-cyclical: positive and significant in down-markets, but substantially reduced in up-markets. In the

[16] BREEAM refers to the Building Research Establishment Environmental Assessment Method, a method of assessing, rating and certifying the sustainability of buildings in use since 1990 in over 50 countries. NABERS refers to the National Australian Built Environment Rating System, an official initiative to measure and compare the environmental performance of Australian buildings and tenancies.

UK, most studies also find a rental premium, with exception to Fuerst and McAllister (2011b). Fuerst et al. (2013) find that the most efficient buildings received a 12% premium (this result appears to be driven by the youngest cohort of state-of-the-art, energy-efficient buildings). In the London office market, Chegut et al. (2013) find large premiums for BREEAM certification (20%). Fuerst and van de Wetering (2015) find similar results in the UK (23-26%). In the Netherlands, Kok and Jennen (2012) observe a 6.5% rental premium (EPC A-C compared to D or lower). Different results are observed in Australia, with Newell et al. (2014) finding significant rental premiums but Gabe and Rehm (2014) finding no significant effects.

1.2.2 Household Appliances

Studies, experiments and surveys from the literature focus on testing how a label can influence the purchasing decision and consumer behaviour. For an energy labelling scheme to be effective in terms of affecting consumers' choices, individuals must be aware of its existence, must understand the information provided, must trust the label and must find the information useful (Tigchelaar et al., 2011; Waechter et al., 2016, 2015a, 2015b). Consumers who tend to not trust the information contained in the label are less likely to buy energy efficiency goods (Dietz, 2010). Many empirical studies which analyse the effectiveness of energy labels find that the success of a label depends on its format, size and colour, the information it provided, and the credibility of the institution that supports the campaign, among other factors (Banerjee and Solomon, 2003; Brazil and Caulfield, 2017; Codagnone et al., 2016; Issock et al., 2018). Some studies have estimated the willingness to pay for the energy efficiency attribute contained in the label (see, for example, Galarraga et al., 2011 and Waechter et al, 2016.).

Other studies go further in reducing the informational gap and propose alternatives which help consumers to make better informed purchases. Providing running-cost information additionally to the current average annual energy consumption is likely to improve the effectiveness of the label for appliances (Allcott and Sweeney, 2015, Carroll et al., 2016b, Deutsch, 2010, Kallbekken et al., 2013, Stadelmann and Schubert, 2018). Currently, the energy consumption information is displayed in physical terms (kWh/annum). The addition of information has been tested in the literature. For example, Kallbekken et al. (2013), focusing on fridge-freezers and tumble driers, tested the role of monetary energy cost information through labels and tested the role of providing energy cost information on energy efficiency demand through sales staff training. Their results show a positive effect of such information on tumble driers. Allcott and Sweeney (2016), with similar approaches, find that information and sales incentives need to be treated jointly if they are to influence consumer purchases. Stadelmann and Schubert (2018) compare the effectiveness of labels in different scenarios (no label, EU Energy label and monetary energy label) for freezers, tumble driers and vacuum cleaners and found that the presence of any of the two labels increase the sales for efficient appliances. However, Carroll et al. (2016b) designed a 5-years energy consumption cost label for tumble driers and did not find an effect of such information on energy efficiency sales.

1.2.3 Cars

There are sound reasons for expecting labelling in relation to fuel economy and CO_2 emissions to have an effect on consumer decisions, even in the presence of imperfect information (Allcott and Sweeney, 2015), hidden and transaction costs (Huang et al., 2018), or rational inattention to fuel costs (Sallee, 2014). Despite the strong reasons for believing it should work, it is difficult to measure the impact in practice. A strong common element among studies attempting to estimate the impact of existing fuel economy labels for cars is that they point to the difficulty of disentangling the effect of the label from other effects. Governments use a range of policy instruments to try to influence fuel economy and emissions, and technological improvements lead to improved fuel efficiency over time. It is therefore extremely demanding to try to disentangle the effect of labelling from the effects of the other instruments and market developments. It is, however, possible to evaluate certain dimensions of the labelling scheme (such as implementation and consumer awareness). Using experimental methods, it is also possible to assess likely impacts on behaviour of labelling in isolation.

The European Commission conducted an evaluation of the labelling scheme for passenger cars in 2016, reported in Haq and Weiss (2016). When it comes to consumer awareness of the label, they find that consumers in EU countries are generally informed about fuel consumption and CO_2 emissions of new cars, and that awareness of the CO_2 label seems to be increasing over time. However, Codagnone et al. (2016) find that 45% of respondents from 10 member states were not familiar with the label.

Haq and Weiss' main conclusion regarding the effectiveness of the labelling scheme in changing consumer behaviour is that:

> *"By 2014, passenger cars registered within the EU on average emitted 123 g CO_2/km, suggesting a decrease in the distance-specific CO_2 emissions of new cars by 28% since the year 2000 […] …it is not possible to determine whether the observed decrease is related to the introduction of the car labelling scheme. Anecdotal evidence suggests that the mandatory fleet-average CO_2 emissions target […] may be the main driver behind both the substantially reduced CO_2 emissions of new cars at type approval and the increasing discrepancy between type approval and on road CO_2 emissions."*

The discrepancy between type approval and on road fuel consumption (and emissions) may reduce the effectiveness of the labelling. To illustrate the importance of this, Haq and Weiss estimate that for the average car (emissions of 123g CO_2/km), actual emissions may be around 40% higher, and with a fuel price of €1.50 per litre and annual mileage of 20,000km, the label underestimates yearly fuel costs by almost €700. They also note that this observed and well-known discrepancy may undermine trust in the label.

Due to the challenges associated with disentangling the impact of the label (in isolation) on consumer behaviour, there is limited research on which to base any estimate of the impact. One important exception is Codagnone et al. (2016) who conducted a lab experiment and a 10-country online survey experiment. Based on the lab experiment they conclude that the results "confirm the higher effectiveness of fuel economy and running costs as compared to emissions information in capturing consumers' attention and influencing choices". However, based on the online experiment they find that labels do not have a significant impact on the willingness to pay for more fuel-efficient cars (but promotional material does). Their overall conclusion is that "no effects were found for information on CO_2 emissions."

Daziano et al. (2017) conducted a DCE to test the influence of CO_2 emissions information on car purchases in the USA. They find that "the current means of presenting CO_2 emissions information (in grams per mile) results in estimated willingness to pay (WTP) to reduce CO_2 that is significantly lower than those with context, and not even statistically different from zero". Their results indicate that the information might be more effective in influencing behaviour when it is contextualized. Specifically, they find better results when the information is presented as tons per year or pounds per month, or as a percentage of the emissions target set by the US Environmental Protection Agency.

Two recent studies shed further light on the potential role of labelling in wider policy packages. Damert and Rudolph (2018) developed policy recommendations for decarbonization of passenger cars based on a literature review. While their focus is on coercive instruments such as emission standards, excise duties, vehicle taxes and sales quotas, they include labelling as a “further supportive instrument” together with public procurement and purchase incentives. They recommend a revision of the labelling scheme, specifically, that “more meaningful indicators, e.g. based on the vehicle’s energy consumption instead of its weight, should be introduced to increase transparency and reliability.”

Dineen et al. (2018) studied new passenger car CO_2 performance in EU member states and attempted to disentangle the causes for differences in average CO_2 emissions intensity across countries. They find that EU-wide policies have played a role in reducing the average emissions intensity, but that “countries with CO_2-differentiated vehicle taxes are observed as more likely to have achieved greater reductions in CO_2 emissions.” They conclude that the most successful countries have aligned the vehicle taxes with broader policy packages – that includes labelling. Thus, whereas the study highlights the role of CO_2-differentiated vehicle taxes, it also points to a potential role (without drawing any strong conclusions) of labelling in enhancing the effectiveness of a broader policy package.

With the important caveat that there is limited research on the topic, our tentative conclusion is that the mandatory fuel economy and CO_2 emissions labels – at least in their current forms – probably have a limited impact on average consumer behaviour in isolation. They may, however, serve to support the effectiveness of other policy instruments also aiming to encourage consumers to purchase more fuel efficient (or low carbon) cars, such as fiscal incentives. One common thread is that several of the studies find that contextualizing the information (e.g. as costs or in physical units that people can relate better to than grams CO_2 per km) might make the labelling more effective in influencing purchasing behaviour. Adding information on running costs is likely to make the labels more effective in influencing consumer behaviour. These overall recommendations have been relatively consistent at least since the previous EU-commissioned review of the directive by Branningan et al. (2011) who also highlighted harmonization of implementation and including running costs.

1.2.4 Industrial Machinery

In Europe, energy efficiency in the industry sector has improved by 30% at an average annual rate of 1.8% per year in the period 1990 – 2009. The highest increase in energy efficiency was recorded in chemicals (54% decrease in energy consumption), followed by machinery (40% decrease in energy consumption) and steel (26% decrease in energy consumption) (IEA, 2018). A number of studies, in both the EU and the US, have identified a range of factors that act as the principal barriers to investments in improving energy efficiency . These include long payback periods, lack of capital, lack of profitability, lack of personnel, risk of production disruption and lack of time or commitment (Abadie et al., 2012, Fleiter et al., 2012, Johansson, 2015)

2 The CONSEED Project

The EU has a goal to reduce joint energy consumption by at least 32.5% by 2030, based on projections undertaken in 2007 for that year. It has introduced energy labels for electric appliances and a range of other energy-using goods, labels for tyres and CO2 labels for cars, and energy performance certificates for buildings. These help consumers choose the most energy efficient goods. According to the European Commission's calculations, European consumers can save about €100 billion annually – about €465 per household – on their energy bills, if they buy more efficient appliances. However, consumers do not always buy the goods that would give them the largest energy savings over time.

The EU-funded CONSEED project is a contribution to the understanding of what explains this "energy efficiency gap" and of ways of reducing it. CONSEED ran surveys, field experiments and DCEs to understand the wide range of factors that influence consumers when they buy electric appliances, cars or properties. The research looked at energy consumers across five European countries: Greece, Ireland, Norway, Slovenia and Spain. The research covered various consumer groups, including both households and professional consumers from the services, agricultural and industrial sectors. The comprehensive database of empirical data enables an examination how different consumer groups interact with existing energy efficiency labels and certificates, and the identification of areas where policies can be improved.

2.1 Findings for Households

Three principal methods were employed to explore investment decisions of households: surveys, DCEs, and field trials. Consumer surveys were carried out in Greece, Norway, Spain, Slovenia and Ireland for three goods: appliances, cars and property. Following this, DCEs were employed to explore the effects of monetary labelling in Norway, Greece and Slovenia, while field trials were carried out in Ireland and Spain.

2.1.1 Surveys

CONSEED partners carried out representative household surveys in five European countries for three goods (appliances, cars and property). For more on the results, see the CONSEED Consumer Survey Report (WP3). Below we highlight eight key findings from the surveys of European households, which provide insights into consumer decision-making, and implications for future energy policy in the region.

1. While there is considerable heterogeneity across goods and countries**, most European households value** energy efficiency **when investing** in appliances, cars and property. Energy efficiency is generally ranked in the top three attributes (which includes price) when investing and is considered "very important" by 48-72% for appliance purchases (shares in Spain and Greece), 54-57% for property (Ireland and Slovenia) and 44% for cars (Norway).
2. Most households (40-63%) see a **strong link between choosing more energy efficient goods and lowering their household-specific environmental impact** ("strongly agreed" shares). For property, most households see the link between energy efficiency, comfort and property value.
3. **Knowledge gaps relating to the consumption of existing goods and of the savings associated with upgrading to higher** energy efficiency **are prevalent**: About a third of households fully understand ("strongly agreed" share) how much their existing goods consume. In terms of

understanding how much they will save if they upgrade, again, about only about a third answer that they are *fully* aware of the financial benefits.

4. **Low uptake of** energy efficiency **is partly due to lack of affordability and/or lack of finance.** The share of households that cannot afford to upgrade ranges from 18-36% for property and 5-18% for appliances ("strongly agreed" shares). These shares increase considerably with the inclusion of "slightly agree" responses. In addition, finance constraints are also evident and range from 8% for cars in Norway to 47% for appliances in Greece. For property, about a quarter of households (Ireland and Slovenia) state that credit constraints prevent them from upgrading their energy efficiency .
5. In general, overall **awareness of existing EU** energy efficiency **labelling is high but the influence on investment is very mixed**: Conditional on being aware of labelling, only about a third of property and car buyers said that the label influenced their past investment decision (Note: These investments may have been prior to labelling date). For appliances, most (66-91%) said that EU labelling influenced their decision.
6. In terms of household engagement with labelling, **slightly more than half of households agree that labels help them to calculate their energy costs** (response conditional on being aware of the label).
7. **Many households believe that labels are potentially "manipulated" by suppliers.** Qualitative results from focus groups may support this finding – some participants highlighted recent emission scandals in the car industry as a reason to not trust labels in general.[17]
8. CONSEED surveys conducted a preliminary (prior to field trials and DCEs) comparison of monetary labels to existing EU labels. Although there is considerable heterogeneity across countries, most surveys show that **monetary information is both more understandable and influential and gives households a better understanding of their energy consumption and costs**.

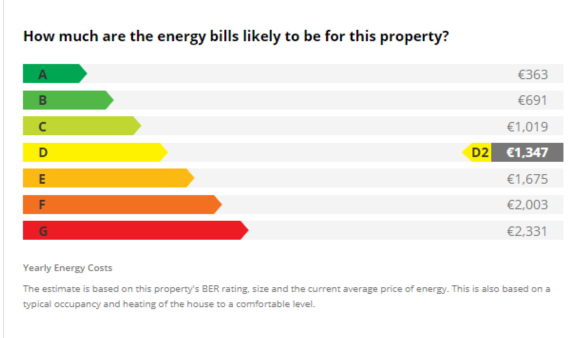
2.1.2 Field Trials

CONSEED partners in Ireland and Spain carried out large-scale labelling field trials for property and appliances, respectively. In the Irish trial, property advertisements were supplemented with a new property-specific energy cost (annual) label using details from the property's Building Energy Rating (kWh and size) and a common energy price. This label was randomly assigned to half the counties in Ireland (with one exception: we impose Dublin and surrounding counties to the treatment group). Results in counties that were treated with the new labels were then compared to results in control counties who received a similar energy label based on the existing metric (kWh/m^2/annum) – see Figure 3. The analysis period started in January 2017 and the new labels were applied between March 2018 and March 2019.

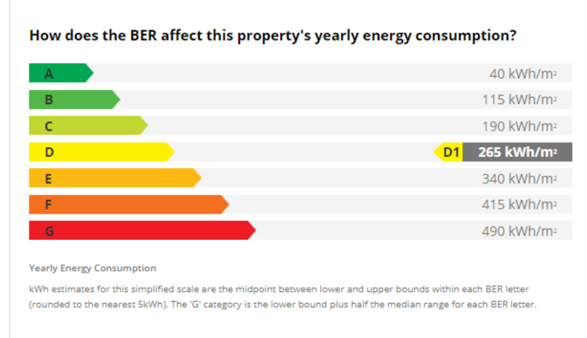
[17] For example, participants in focus groups in Ireland (property and tractors) mentioned the Volkswagen emissions scandal "Dieselgate" in relation to their general perception of energy efficiency label trust.

Figure 3: Label Examples from the daft.ie-TCD trial

Treatment Group Label



Control Group Label



Source: designed by TCD and daft.ie

For more on the results, see the CONSEED Report on Field Trials. There are three main findings from the Irish trial:

1. **A large** energy efficiency **premium existed before the trial (before March 2018),** implying that EE is already a very important consideration for property buyers. On average, each BER sub-category increase raises prices by about 4%.
2. **In control counties (where the new labels were not shown), the** energy efficiency **premium declined during the trial**. We suggest that this market-wide phenomenon could be linked to ongoing shortages of housing in Ireland during the trial period.
3. **The** energy efficiency **premium increased in treatment counties (where the new labels were shown), implying that the demand for energy efficient properties increased as a result of monetary labelling**. Specifically, the general premium decline observed in control counties during the trial period is offset by monetary labelling.

The Spanish field trial presented a lifetime energy savings label for washing machines, refrigerators and dishwashers with/without information on energy savings provided by staff. The experiment was run in 26 small retailers operating in four regions of Spain, Comunidad Autónoma Vasca, Comunidad Foral de Navarra, Cantabria and Aragón, from February to July 2018. Fourteen small retailers were assigned to the treatment group and twelve to the control group, according to retailers' characteristics and sales of 2017. Preliminary findings show that lifetime energy savings information (in €) promote the adoption of high energy efficient refrigerators (A+++) while this information is not effective for washing machines and dishwashers:

1. Compared to current labelling, displaying the information in monetary terms and training sales staff to explain this information **increased the probability of consumers buying more energy efficient refrigerators** (A+++).
2. **The** energy efficiency **premium increased in treatment stores for refrigerators** during the field trial, implying that Spanish consumers are willing to pay for energy efficiency when they receive lifetime energy savings information (in €).

3. Lifetime energy savings information does **not seem to be effective when promoting the purchase of high energy efficient washing machines (A+++) and dishwashers (A+++ and A++)**.

2.1.3 Experiments

DCEs were carried out for cars (Norway), property (Slovenia) and refrigerators (Greece). All experiments included energy efficiency within the set of choice attributes and randomised respondents to either a physical energy units frame (litres per 100 km, for example) or a monetary unit's frame (€ per 100 km, for example). The main findings are:

1. **All experiments show a high willingness to pay for** energy efficiency**, with the current energy efficiency label,** implying that energy efficiency is already a very important consideration for households.
2. For cars (Norway) and property (Slovenia), the **willingness to pay for** energy efficiency **increased as a direct result of adding monetary labelling**. However, no effects are observed for refrigerators (Greece).
3. While the **willingness to pay for** energy efficiency **is higher for women**, treatment did not generally have a stronger effect on women's decisions.

2.2 Findings about the Commercial Sector

CONSEED partners carried out six business surveys in five countries. This included three surveys of services firms – one on Irish property investment decisions by SMEs (office-based firms with less than 50 employees), and two on appliance investment decisions by hotels (in Spain and Greece). There were two surveys of industrial firms, in particular, manufacturing firms' decisions about machinery investment (in Norway and Slovenia), and one survey of tillage farmers, in relation to their decisions around tractor investment (in Ireland). The main findings can be separated across two categories:

1. **Awareness of Energy Efficiency**

- Energy efficiency **was, in general, an important attribute in business investment decisions**, with some exceptions (Irish property is the outlier). However, attributes which affect business continuity, such as **reliability, featured more prominently** for industrial firms and farmers.
- Similar to households, the majority of **businesses believed that** energy efficiency **reduces their environmental impact**. In this regard, the "strongly agree" shares ranged from 54% to 56% in Ireland (farms and services) to 43% in Spain (hotels) to 91% in Greece (hotels) (not explored in Norway or Slovenia).
- Where energy efficiency labels are already in operation (appliances in Spain and Greece, and property in Ireland), **awareness was generally high, ranging from 51% to 90%**. Most firms also said that **existing labelling influenced their last investment decision** (excluding Ireland, which may be due to the relatively recent rollout of energy efficiency labelling). Furthermore, most firms said that **existing labels helped them to understand the energy cost implications of different investments**. Similar to households, firms considered **labelling to be open to manipulation**.

2. **Obstacles to** energy efficiency **adoption**

- **There are knowledge gaps** in relation to both existing energy consumption levels and, more acutely, in relation to the financial benefits of upgrading their energy efficiency. In general, the majority of firms did not have a high level ("strongly agree" shares) of understanding (not explored in Norway or Slovenia).
- Similar to households, **some businesses did not invest in** energy efficiency **due to affordability and an expectation that finance could not be secured**. Severe affordability constraints ("strongly agree" shares) ranged from a low of 7% in Spain to 54% in Greece and severe financing constraints ranged from 13% in Ireland to 67% in Greece (not explored in Norway or Slovenia).
- When surveys compared non-monetary energy units to monetary energy costs (all surveys except Norway and Slovenia), **monetary energy labels did not increase influence or aid in the calculation of energy costs** (with the exception of property in Ireland).

3 Policy Recommendations

3.1 Future Energy Costs at Point-of-Sale

CONSEED Recommendation: Add energy cost forecasts at the point of sale.

Our household trials and experiments generally show an increased demand for energy efficiency when monetary estimates of energy consumption are displayed at the point of sale/advertisement. While we expect this is due to information gaps regarding energy savings (either missing information or biased information), the result may also be due to the increased salience, or prominence, of energy efficiency.

The addition of monetary energy labels has the potential to improve EU energy efficiency levels. However, policymakers should be aware of both 'rebound' and general equilibrium effects. Rebound effects imply that energy consumption reductions are lower than expected (as energy efficiency upgrades reduce the "cost" of energy services). General equilibrium effects refer to spillovers between markets, such as consumers spending their energy savings on carbon-intensive goods and services, such as flights.

The effects of monetary labels appear to be stronger for goods with higher total investment costs, such as property and cars, as the energy expenditure caused by these goods makes up a larger fraction of total household expenditures than for e.g. appliances. It is likely that the higher energy costs for these goods, in both absolute and relative terms, meant that monetary labels provided a larger 'shock factor' and a subsequent behavioural nudge. In this regard, framing energy costs over longer periods may be important: previous research (Heinzle, 2012) shows that the willingness-to-pay for energy efficiency increases when an appliance's energy costs are framed over longer time periods. Longer-term energy cost forecasts may also offset the possibility of 'present bias', by forcing households instead to consider the implications of long-term investments over a more complete timescale.

There are other benefits to monetary labelling more generally: if applied across all household goods, households would be able to identify which of their goods consume the most, and could therefore focus their energy/money-conservation efforts where savings are potentially highest.

Finally, the addition of monetary information on labels represents a major philosophical departure from existing informational policy in the EU, which is currently more in line with environmental and societal motivators of upgrading energy efficiency (principally, mitigating climate change). Existing non-monetary labelling may become more valuable to consumers if CO_2 reductions and climate change more generally become more of a concern. A low-risk approach is likely the communication of both monetary and CO_2 information, to appeal to both the cost-minimisers and/or CO_2-minimisers.

In the commercial sector, the situation is somewhat different. The CONSEED project did not formally test monetary labelling in this sector, however our surveys of monetary and non-monetary labels do not suggest similar benefits from such a policy for firms. Nonetheless, our findings indicate that many firms do not fully understand their existing energy consumption patterns or the financial benefits of upgrading to higher levels of energy efficiency. Therefore, a more thorough and targeted information campaign may be helpful to the commercial sector also.

3.2 Country and Household Consumption Differences

CONSEED Recommendation: Labelling should account for differences across countries and households

Consumption estimates could account for environmental differences across countries which affect consumption, heterogeneous consumers within countries, and predictable behavioural changes post-adoption. There are two conflicting findings in our surveys: respondents consider labels to be both trustworthy *and* open to manipulation (by sellers). The accuracy of consumption estimates was also questioned within our focus groups with reference to the topic of misleading vehicle consumption. Differences between expected and realised energy savings could impact future trust in EU energy efficiency labelling. While not formally tested in CONSEED, we expect that potential future declines in trust could be reduced by considering the following:

1. Where cross-country consumption differs consistently (for example, electric vehicle range is shorter in cold climates), country-specific consumption estimates should be provided based on cross-country analysis.
2. Household-specific estimates could be provided through apps and/or the proposed QR-code according to:
    a. Existing goods (model or year), with within-country average defaults.
    b. Energy service demand (for example, miles driven per week, washes per week or proxies based on family size, for example)
    c. Energy prices and price growth expectations
    d. Timeframe for the proposed investment
3. Energy forecasts could also incorporate "rebound effects", where prevalent (based on empirical findings)

3.3 Long-term Financing

CONSEED Recommendation: Align loan terms with energy efficiency payback periods

Long-term financing for energy efficiency should be offered, for example through the banking sector or through energy efficiency suppliers. Affordability and access to finance are a concern for many households and firms. The design of energy efficiency loan system provided through existing banks or energy efficiency suppliers needs to consider a number of factors:

1. CONSEED's analysis of energy costs and investments highlights that the payback period can be longer than the term of many standard consumer loans (which are generally five to seven years). This misalignment has potential welfare-reducing consequences as it increases the probability that the energy savings associated with the investment will not cover loan repayments during the loan term.
2. Studies show a relationship between higher energy efficiency and lower loan default. Such a relationship could potentially break down in the absence of an adequately trained and regulated supply-side (installers and suppliers). To ensure the financial stability of a large-scale energy

efficiency loan system, it is important that household receive the correct technical advice, that goods are installed correctly, and that funds are only used for energy efficiency.

3. In relation to business finance, similar credit and finance constraints are also evident for many firms. While our general financing recommendations for households above are equally relevant for firms, a key difference may be the appetite for longer terms: we expect that smaller and younger SMEs are less likely to demand longer-term loans given that their financial planning may be shorter-term. For energy efficiency investment to pay back within shorter horizons, such firms will may require higher levels of subsidy at origination.

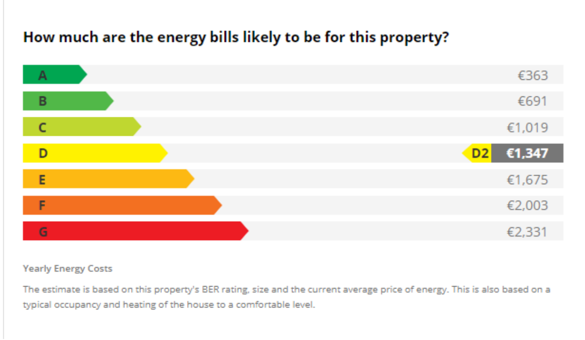
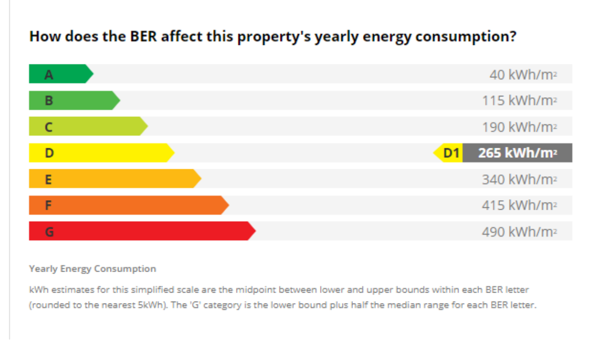
3.4 Conclusion

This report has outlined how the findings of the CONSEED project, which explored how households and firms make decisions in relation to their energy-consuming investments, can inform EU policy on energy efficiency labelling. Across a number of surveys, field trials and experiments in five member states, CONSEED examined, in particular, how monetary information, at the point-of-sale, on the costs of energy use can influence consumer behaviour. As outlined above, the findings of the project suggest that adding monetary information, for example in the form of likely energy costs over a year, could increase the demand for more efficient goods, particularly for properties and cars.

This report details, in particular, the three main policy recommendations from the CONSEED project. Firstly, energy cost forecasts should be added at the point of sale. Secondly, this labelling should account for differences across countries and households. And thirdly, loan terms for energy efficient goods should be aligned with energy efficiency payback periods. While an EU-wide labelling amendment would be challenging due to geographical differences in energy consumption and energy prices, online/in-store long-run comparative energy cost calculators could be used to inform households of the cost implications of different goods. Furthermore, such calculators could also incorporate household-specific factors and expectations, such as existing energy efficiency levels, family size and long-run energy price expectations.

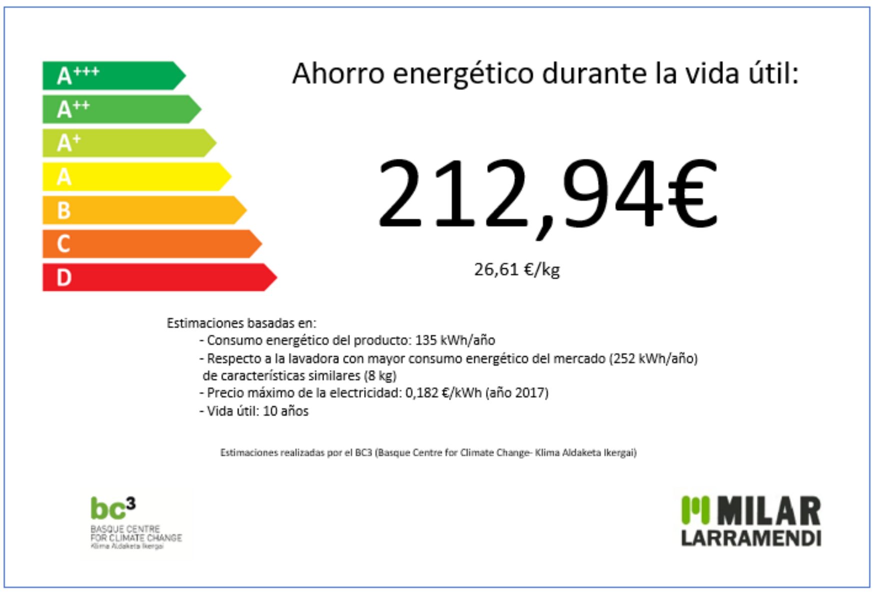
Appendix – Monetary Energy Label Examples

Figure A: Label Examples from daft.ie-TCD Property Field Trial in Ireland

Treatment Group Label	Control Group Label
	

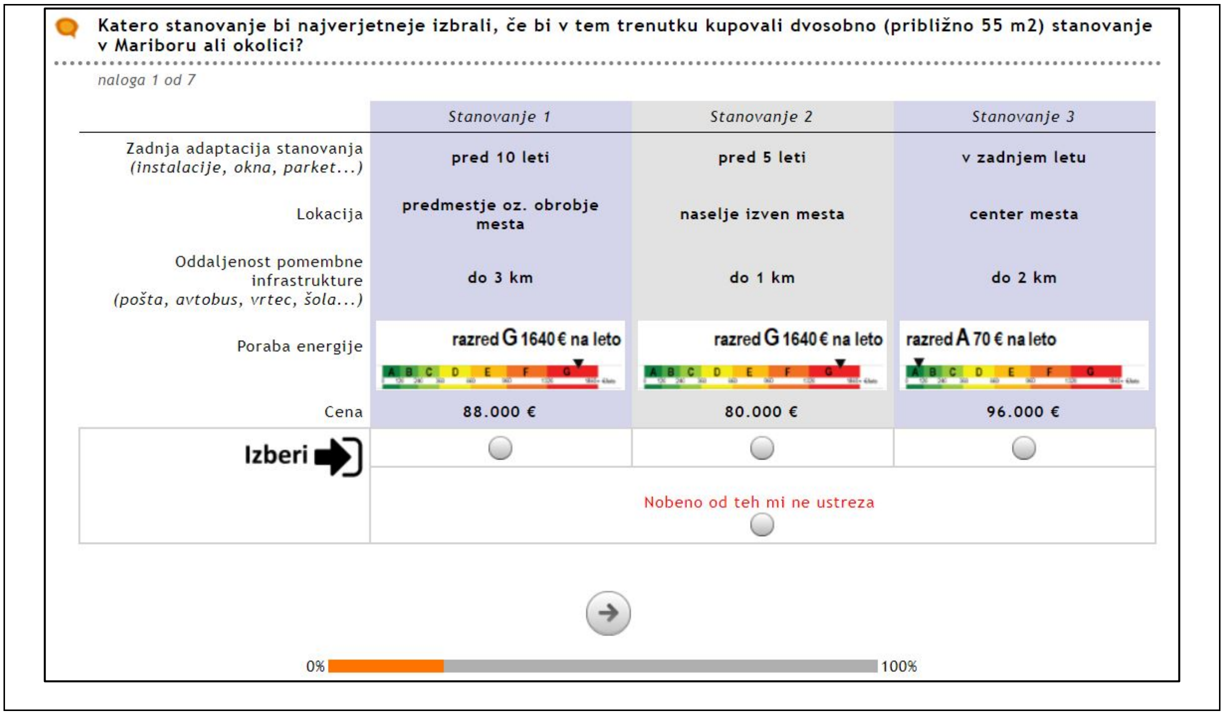
Source: designed by TCD and daft.ie

Figure B: Label Example from Appliance Field Trial in Spain



Source: designed by BC3

Figure C: Choice Example with Energy Cost Attribute from Property DCE in Slovenia



Source: designed by UL

Figure D: Choice Example with Energy Cost Attribute from Car DCE in Norway

Source: designed by CICERO

Figure E: Energy Label from Appliance DCE in Greece

Source: designed by AUA

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