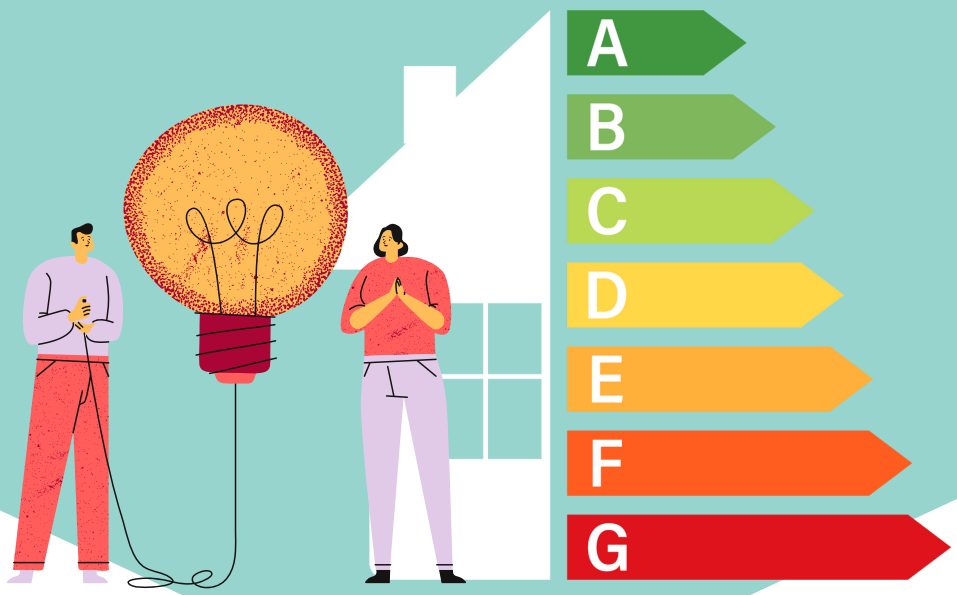
NUDGE

Nudging consumers towards energy efficiency through behavioural science

POLICY BRIEF

How to nudge households effectively and in a targeted manner to unlock hard to reach energy efficiency and flexibility potentials



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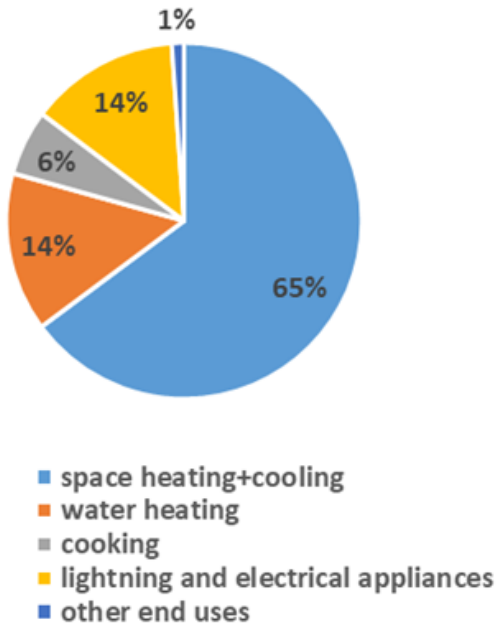
What is the issue and why is it important?

In order to successfully implement the energy transition, households will have to play an essential role. In 2021, **households** accounted for **27% of final energy consumption** in the EU [1]. The distribution among the different end-uses is shown in Figure 1.

Figure 1: The distribution among the different end-uses.
Source: Eurostat: Energy consumption in households - Statistics Explained (europa.eu).



However, the housing sector poses a **major challenge** due to its complexity, its diversity across the EU (e.g., strong differences in the respective shares of different energy carriers as well as the shares of different end uses) and its dependence on the behaviour of household occupants.

After local climate, the **second most important factor determining energy demand** (even more important than building characteristics) is the **behaviour of household occupants**. This is particularly important in relation to heating and cooling, the predominant energy-consuming activities in households.

Another significant level of complexity is added by the **increasing number of prosumers**. Prosumer households are households that produce their own energy (mostly via photovoltaics) and use this energy directly for their own energy needs. This can offer new opportunities in terms of a more flexible energy system and the integration of more renewable energy sources, but also poses new challenges in terms of grid stability or the implementation of appropriate regulatory conditions.

Overall, behaviour can have a significant impact and address several urgent needs:

- Reducing energy demand and greenhouse gas emissions in the residential sector.
- Unlocking hard-to-reach flexibility (for prosumers) and energy saving potentials.
- Helping households adapt to high energy prices and tackle energy poverty.

[1] Energy consumption in households - Statistics Explained (europa.eu)

On a large scale, behaviour can be influenced through regulations or financial incentives. However, a more targeted influence on behaviour, without the use of intensively discussed regulatory or financial instruments such as bans or higher prices, is also possible via so-called nudges. **Nudges** are a way of influencing the behaviour of energy consumers through (technical) interventions and indirect recommendations (e.g., default settings, social comparison, provision of information), making subtle changes to the choice architecture **to guide people towards better decisions** (without forbidding any option or significantly changing their economic incentives).
Unfortunately, **delivering such nudges in a targeted and effective way is very difficult** and faces several challenges:

External conditions (legal framework, market conditions (prices, etc.)) with much stronger impact (potential).

High heterogeneity in behaviour/profiles of energy consumers, including different levels of self-motivation, knowledge about and interest in energy matters, thermal comfort

Difficulties in consistently monitoring and evaluating their effectiveness.

The important question is therefore:

How can nudging be used to best support the achievement of climate and energy policy goals in households?

What we did in the NUDGE project

The NUDGE project focuses on three main areas, the results of which serve as the basis for the recommendations in this policy brief:

Understanding the behavioural factors that influence energy consumption.

NUDGE has **conducted surveys, interviews, and focus groups** with end users to understand the factors that influence their energy consumption. It has taken a mixed approach to the consumer analysis and intervention design with tasks combining surveys and field trials. Firmly rooted in behavioural science methods, it has been studying individual psychological and contextual variables underlying consumers' behaviour to tailor the design of behavioural interventions.

Designing nudging interventions

NUDGE **designed a variety of nudging interventions** that can be used to encourage people to use less energy. These interventions have been based on the tools and insights from behavioural science, such as defaults, framing, and social norms and can be delivered through different channels (smart mobile apps, dashboards, web portals, educational material and intergenerational learning practices).

Evaluating the effectiveness of nudging interventions

NUDGE has **evaluated the effectiveness of the nudging interventions** in **five different field studies** across Europe. The settings involved several different targets of the nudges:

Interdisciplinary project-based education on home energy consumption for children in Belgium

Efficient control of heating and DHW preparation for Natural Gas consuming boilers in Greece

Optimization of EV charging with self-produced PV power in Germany

Healthy homes for long-lasting energy efficiency behaviour in Portugal

Promoting distributed self-production for local energy communities in Croatia

What did we learn? What can policy makers do?

Based on our research and the relevant scientific literature, several recommendations can be derived in response to the question: "How can nudging be used to best support the achievement of climate and energy policy goals in households?"

How to nudge efficiently

Be aware of different energy user profiles (...or there is no one-size-fits-all nudge!)

People differ in their energy consumption profiles (including their motivations to use or save energy) so that different approaches may be appropriate to nudge them towards energy efficiency. Therefore, it is always important to implement a mix of several different nudges to be able to target all energy consumers. More details on this issue are given in NUDGE's first policy brief.

Be aware of the bigger picture (...or don't miss the forest for the trees!)

To design effective nudges, it is essential to understand the interplay between energy-saving behaviour, the respective nudges and external conditions such as the regulatory framework (see below). This understanding is also important to be able to adapt to changing circumstances regarding the energy system (e.g., new technologies or changing external conditions). During the NUDGE project this was the case due to the corona pandemic and the increasing energy prices, which both had a large impact on people's energy consumption behaviour [2].

[2] In general, it can be observed in the project that the magnitude of the effect of nudges is in the range of 0.4 to 3.5%, while, for example, the influence of rising energy prices and the associated public discussion in 2022 had significantly stronger impacts (effect overlaps). Behavioural changes could be observed e.g., in the German pilot project (increased investment behaviour in PV panels). As a result, the explanatory power of the models increases substantially after controlling for general differences across households and time periods.

Offering users real-time insights into their energy consumption (...or don't leave energy consumers in the dark!)

Real-time feedback on energy consumption is one of the most important building blocks for raising energy consumer awareness and empowering consumers to understand and adjust their consumption behaviour [3]. One way to implement this are digital infrastructures such as smart meters and other smart sensors, which would even allow personalized information and interventions based on the energy consumption behaviour. It is therefore essential not only to accelerate the roll-out of smart meters across Europe (see also Monitoring), but also to make the data available to end users as close to real time as possible.

Use default settings and/or naturally occurring situations to nudge people as efficiently as possible (...or keep it simple!)

Energy consumers highly differ in their motivation to save energy or even to deal with the topic. In addition, for most people it is hard to find time in their day-to-day life to approach new topics. Therefore, it is important to deliver nudges in as low-threshold, easy, and time-saving manner as possible [4].

This can be done by using naturally occurring situations (energy bills, heating maintenance, etc.) or already existing channels to implement nudges instead of preparing additional new channels [5]. Also default nudges with easy opt-out/opt-in options (see ethical aspects) are a potentially efficient way to approach this issue [6]. An important tool to implement efficient default nudges is the digital infrastructure. Especially smart meters and other smart sensors would be able to implement energy saving settings as a default (opt-out) or easy opt-in option and to deliver low-threshold just-in-time interventions as reminder for certain energy saving behaviour based on the respective energy consumption behaviour. However, this approach also relies on hardware such as smart meters, further underlining their importance.

[3] Within the framework of the project, this was implemented by installing smart meters and providing corresponding apps and dashboards for data analysis. The user data showed that the acceptance/use of this information provision was highly dependent on the user-friendliness of the corresponding platforms.

[4] Usage of the tools typically spikes at the beginning of the interventions, but then levels off quickly. Those users who only open the app once at this intitial point could be treated more effectively with a default nudge (which is also effective if they don't use the tools frequently), because the window of opportunity for catching their attention is very short.

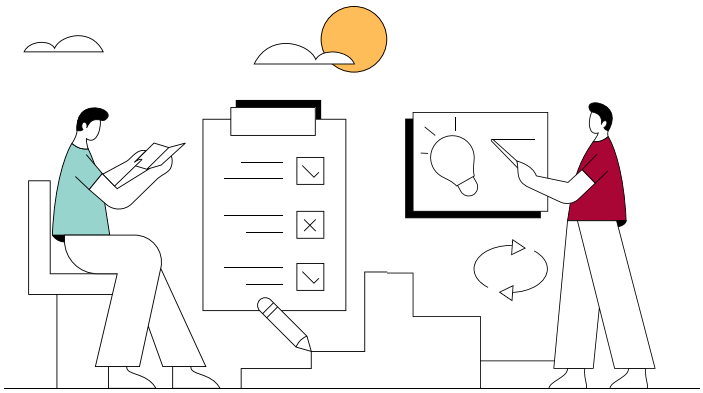
[5] Not all pilot participants were eager to interact with the mobile apps that were used to deliver the nudges. Instead,part of the pilot participants ranging from 5% up to 25% (in the Greek pilot) did not interact at all with the mobile app, despite downloading it and installing it on their smartphones. In the same pilot, several pilot participants counterintuitively preferred to manually set the thermostat temperature rather than use the app to tune it.

[6] 75% of the eligible users activated the opt-in feature in the German pilot, which is higher than the overall usage of the nudge tools on average. This could be even increased by the use of a by default activated opt-in option (but with easily accessible opt-out actions)

Nudges are more effective when new behaviours are formed instead of improving existing ones (...or the early bird gets the worm!)

Behavioural interventions, as integral components of energy policy, should not remain static but evolve in tandem with the emerging technological landscape. This adaptability is crucial for ensuring that these interventions retain their relevance and effectiveness over time. Thus, it is important that policy makers take responsibility for anticipating and proactively preparing for these changes. This forward-looking approach requires a comprehensive understanding of **new technologies, market dynamics and consumer behaviour**. Such insight enables policymakers to formulate policies that are not only effective today, but also resilient and adaptable for the future.

More specifically, this suggests e.g., implementing nudges while EVs and other electrified residential technologies are still emerging and new routines are created around them [7]. As these emerging technologies already have a digital interface, nudges could also be integrated at low cost.



Consider ethical aspects (...or don't act paternalistic!)

Ethical considerations, consumer protection and data protection are of paramount importance and include issues such as informed consent, transparency and respect for autonomy. These principles are essential to ensure that individuals are fully informed about the interventions, their purpose and the data collection procedures involved, and to avoid possible negative reactions, e.g., due to interventions that may be perceived as too paternalistic.

How to monitor the impact of nudges

Strong link between nudge and energy-saving rationale (...or keep it simple again!)

The project results show that, due to the often small effect sizes, it is important to ensure a strong and direct link between the intervention and the observed (energy-saving) behaviour. When considering more indirect effects or longer chains of intervention effects, a clear attribution of the identified effect on the monitored parameter to the intervention will most likely not be possible (due to (too) small effect sizes and (too) many other, external influencing factors). It is therefore important to be aware of realistically achievable effect sizes and to select accordingly the appropriate KPIs to be monitored [8].

[7] In the German field experiment, we could measure energy savings in the order of 11-13% thanks to higher use of self-generated energy for EV charging, with a default nudge that was oriented to EV owners. This is substantially higher than the increase of self-generated consumption we achieved in the general case.
[8] Evidence for the importance,of appropriate saving rationals and KPI's is given by the Belgium and Portugese pilots. See also: D2.3

Use of digital infrastructure to allow long-term monitoring (...or stay interested, even in the long run!)

Continuous long-term monitoring of energy consumption behaviour is essential to better understand different behaviour patterns and their possible adaption towards nudging (including possible rebound effects)[9] and other (external) circumstances (e.g., regulatory conditions, prices) [10], but also to find the best timing to deliver different nudges to different target groups [11].

Smart meters are a key building block here and are also essential for many other aspects of nudging (see above). It is therefore important to promote the roll-out of smart meters, but also other relevant digital devices or applications. For smart meters, recent data show an annual increase of 24% between 2014 and 2020. A continuation of this trend would mean that the EU would not reach 100% penetration until close to 2030, which would be far too slow to enable timely grid digitisation and effective implementation of behavioural interventions [12].

Collaboration and knowledge sharing (...or combine your efforts and utilise synergies!)

Collaboration and knowledge sharing between government bodies, energy providers, technology firms, and consumer associations are essential components of successful behavioural interventions in complex and fast evolving regulatory and external conditions. Especially (anonymized) data sharing between different stakeholders is essential to understand consumer behaviour and its interplay with nudging and external/regulatory conditions.

Monitor not only positive but also possible negative effects (..or be critical!)

In order to understand all dimensions of the impact of different nudges, it is important to monitor not only positive but also possible negative effects. This is particularly relevant in the case of potentially conflicting objectives (e.g., energy saving ovs. comfort) [13], to avoid unexpected negative consequences and to increase the acceptance and effectiveness of the nudges by adjusting them if necessary.

[9] Whether rebounds in energy consumption are environmentally detrimental is not clear and needs more research. For example, in the Croatian pilot, households increased their energy consumption either by using air-conditioning for heating (i.e., through ineffficient energy use), or by investing in heat pumps (climate-friendly electrification).
[10] The energy consumption patterns in the pilots are highly volatile in the short-run and driven by a seasonal pattern throughout the year. To get credible estimates that allow for a deeper exploration of these patterns, multi-year designs would be needed. For example, in the Greek and Portuguese pilots, even with a 1.5 year project, only 2 heating seasons are covered, of which the 2nd one was affected by the energy crisis.
[11] Depending on the chosen nudges and target groups, the different pilots in the project showed a clear dependency of the nudging effects on the time frame studied (e.g. effects of holiday seasons, effects of weather conditions, ...).
[12] Electricity | ECNO (climateobservatory.eu)
[13] Examples of such conflicting objectives are investigated in the Portugese pilot (energy saving vs. healthy homes).

How to consider external conditions such as regulatory frameworks

Nudges are effective in reinforcing policy-based incentives but not reversing disincentives (...or don't go/nudge against the flow!)

If the external incentives (e.g., financial incentives through energy prices or regulatory aspects) and the nudging incentives are aligned, positive, reinforcing effects can be observed. However, misaligned regulatory conditions or comparable external aspects can offset nudging effects. As a result, it is important to....

... Align behavioural interventions / nudges with external conditions. Therefore, it is essential to understand the impact of the regulatory framework and other external conditions (e.g., prices) on energy saving behaviour (...or know your setting!)

Due to the effect size of nudging interventions and the fact that they can be easily shallowed up by external influences it is essential to understand the interplay between these different aspects and to identify possible negative [14] as well as positive interactions.

Only with this understanding can nudges be designed that are effective in targeting otherwise hard-to-reach energy saving or flexibility potentials, and that allow for positive spill-over effects between the behavioural intervention and external conditions by making sure that they are aligned and push for the same objective [15].

Accompanying regulatory frameworks with digital tools and information can have a positive impact (...or explore co-benefits!)

As nudges are effective in reinforcing policy-based incentives, they can be used to deliver to consumers information on important regulatory conditions with regard to energy consumption [16]. As a result, it could be shown, that people changed their respective behaviour. An important example could be to e.g., communicate information about the regulatory conditions with regard to energy consumption and self-consumption/production through smart meter apps or energy management systems.

[14] Both behavioural interventions and regulatory frameworks - or even their interplay - can have unexpected negative impacts on the energy consumption behaviour. As a result, it is important to identify such unexpected negative aspects with the aim to remove them either by adapting the respective framework or the relevant behaviour.

[15] Using the Croatian pilot, the interplay between regulatory conditions and behavioural interventions could be investigated. In Croatia, the regulatory framework (which has since been changed) led to financial disadvantages when PV electricity production was higher than electricity consumption. This had a significant impact on user behaviour and the effect of the nudges. In concrete terms, this led either to higher consumption or to a shutdown of the PV system (lower production). As a consequence, there were both positive (e.g. investments in heat pumps to increase electricity consumption and to be able to use the self-produced electricity more efficiently) and negative effects (increased (inefficient) energy consumption, limitations in the potential for generating renewable energy).

[16] The information delivered in the nudge project (e.g., in the Croation pilot) created a new level of transparency and easier control over the regulatory status for each participant. Therefore, nudging and similar information schemes can have a positive co-benefit: transparency.

Conclusion and key findings

Behavioural interventions should be viewed as **integral components within broader energy policy frameworks**, as this approach enables a comprehensive and synergistic approach to energy conservation.

Here it is important to make sure that the **enabling conditions are set right to deliver and monitor behaviour change** (smart meters, channels to distribute energy knowledge and potential nudges, availability of data and knowledge about energy consumption behaviour).

By seamlessly **integrating behavioural insights with technological advancements**, policymakers can harness the full spectrum of tools at their disposal **to drive substantial and enduring energy savings**.

However, subtle interventions **require supporting regulatory, technical, and digital conditions**.

The other way around, restrictive self-consumption regulation, unappealing digital interfaces, and mal-functioning flexible technologies can easily overrule the small, positive nudging effects.

At the same time, if nudges are thoughtfully aligned to these conditions, they can **unlock hard-to-reach efficiency and flexibility potentials** [17].

Further reading/ Literature

Knowledge-hub • Nudge (nudgeproject.eu)

[17] Orchestrating a grid-friendly operation of large consumption technologies, such as EVs and heat pumps, is a promising future case for nudges in light of emerging flexibility markets, digitalization and other grid regulations.

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