

DEDALUS

Toolkit for incentives scheme design

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This project has received funding from European Union's Horizon Europe Research and Innovation programme under the Grant Agreement No 101103998

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Table of contents

1. Introduction.....	5
1.1 What are Incentives and why they are important	5
1.2 Financial and non-financial incentives' principles	6
1.2.1 Financial Incentives.....	7
1.2.2 Non-Financial Incentives.....	9
2. How to plan successful incentives.....	12
2.1 Intervention frequency: How often incentives are delivered matters	12
2.2 Timing & Duration: Reinforcement must be immediate enough and long enough	13
2.2.1 Timing: Immediate consequences are more powerful.....	13
2.2.2 Duration: Behaviour change requires sustained exposure	13
2.3 The social-cultural dimension: Aligning incentives with people, norms, and meaning	14
3. What are the most effective incentives according to target group	15
3.1 Barriers and Drivers	15
3.2 Clustering of DEDALUS target groups and its correlation with the selection of incentives.	17
3.3 How to effectively choose and combine Financial and Non-Financial Incentives.....	21
4. Conclusions.....	23

Table of Figures

1 - Examples of Financial Incentives.....	8
2 - Examples of Non-Financial Incentives	11
3 - Table Personas, characteristics and levers	19
4 - Incentives rated by Persona's type	20

1. Introduction

The **DEDALUS Toolkit for Incentives** has been designed in the framework of the project to support public and private actors, such as energy providers, policymakers, community organisations and programme managers, in creating and implementing effective, user-centric incentives programmes for residential energy consumers. Leveraging the studies and the work carried out in the context of DEDALUS project, the present toolkit intends to provide actionable guidance on how to motivate and keep engaged diverse end-user groups, including young and older people, migrants, to participate in Demand Response (DR) programmes.

Demand Response is a critical strategy to balance energy supply and demand, in order to reduce peak loads and promote a sustainable use of energy. However, its success is strongly connected to active participation from residential consumers, who often have varying motivations, preferences and barriers. Thus, the aim of this toolkit is to bridge the gap between technical DR solutions and social acceptance, offering tailored strategies for the design and implementation of incentives that resonate with different user groups.

The present Toolkit for Incentives is structured to guide through:

- Understanding what incentives are and why they are essential in Demand Response.
- Exploring financial and non-financial incentives
- Discovering how to tailor and adapt incentives to diverse user groups.
- Designing and planning effective incentives programmes

1.1 What are Incentives and why they are important

An incentive is introduced to motivate an individual or a certain group of people to change their behaviour in a way that is intended by the part posing the incentive, by offering rewards or removing barriers.

In the framework of the energy sector and specifically that of Demand Response, incentives encourage residential energy consumers to shift, reduce or optimise their energy use in response to grid conditions, prices or environmental goals.

In this process, it is important to consider socio-economic enablers, for engaging residential energy consumers in services, such as DR at building-level or at district level.

Incentives can be broadly categorised into two types:

1. **Financial Incentives:** tangible rewards that provide direct economic benefits, such as discounts, rebates, or dynamic pricing.
2. **Non-Financial Incentives:** psychological or social motivators, such as recognition, gamification, or community engagement, which appeal to intrinsic values like environmental consciousness or social belonging.

Both types play a critical role in overcoming barriers to participation and fostering long-term engagement in DR programmes. But why they are so important?

The human side of Demand Response

The effectiveness of Demand Response (DR) programs fundamentally depends on the active and sustained participation of residential energy consumers. However, achieving widespread engagement is not without its challenges. Many consumers remain unaware of the existence or benefits of DR initiatives, a phenomenon well-documented in studies such as those conducted by Allcott and Mullainathan (2010). Furthermore, even when consumers are informed about DR, the **perceived complexity of energy management** systems can act as a deterrent. Terms like "load shifting," "dynamic pricing," and "peak demand events" are not part of the everyday lexicon for most people, and the technical nature of these concepts can make participation seem daunting (Schultz et al., 2007).

Beyond awareness and complexity, another critical challenge is **behavioural inertia**. Humans are inherently creatures of habit, and established routines, such as running appliances at specific times or maintaining consistent indoor temperatures, are difficult to alter. Even when consumers recognise the potential benefits of modifying their energy consumption patterns, they often fail to maintain themselves engaged without an external motivator. This inertia is a well-studied phenomenon in behavioural economics, where Thaler and Sunstein (2008) emphasise that individuals tend to stick to familiar behaviors unless prompted by a compelling reason to change. In this context, another important aspect must be considered: **motivations driving consumer behaviour are highly diverse**. Different demographic groups respond to distinct types of incentives, and what appeals to one segment may not resonate with another. This diversity in motivations necessitates a tailored approach to incentive design, ensuring that programs are inclusive and appealing to a broad range of participants.

In conclusion, actual Demand Response often requires changes to set routines and habits that happen mostly unconsciously (Verplanken & Whitmarsh, 2021). Similarly, many consumers have a low awareness of the electricity tariff in which they are enrolled (Layer et al., 2017). Nevertheless, certain general motivations can act as drivers of DR behaviours. Specifically, many people are motivated to protect the environment and strive to behave consistently with their pro-environmental motivation (e.g., Van der Werff et al., 2013). Such intrinsic motivations are important because they can promote behaviour change despite certain efforts or costs (Dietz, 2015). Moreover, individuals engaging in DR behaviour based on their intrinsic pro-environmental motivation are more likely to consistently engage in a set of related behaviours, such as using new DR technologies in appropriate ways (Peters et al., 2018).

Other personal motivations may play a role too. For example, consumers who see themselves as more innovative may adopt new technologies or participate in novel DR programs more readily (Wolske et al., 2017). Finally, consumers are influenced by others around them, especially by people or groups who are important to them (Jans et al., 2018). Research has shown that consumers are more likely to adopt new technologies (e.g., photovoltaic systems) in areas with a visible adoption rate (Bollinger & Gillingham, 2012).

1.2 Financial and non-financial incentives' principles

As previously mentioned, there are two main categories of incentives: financial and non-financial incentives.

Financial incentives typically involve direct monetary benefits, for example time-varying tariffs, bill credits, or payments for reducing or shifting consumption during peak periods, which reward participants based on measurable actions within demand-response programmes. On the other hand, **non-financial incentives** rely on forms of value that do not involve direct payments: these



may include improved comfort, access to enhanced energy services, recognition for participating in sustainability initiatives, or the provision of smart-energy tools that simplify everyday energy decisions.

1.2.1 Financial Incentives

Financial incentives are often the first tool in the toolbox because they offer immediate, concrete benefits, appealing to rational, cost-driven decision-making. These incentives can effectively raise awareness by drawing attention to the economic advantages of participation, thereby overcoming the initial barrier of unfamiliarity. Additionally, financial rewards simplify the decision-making process for consumers, as the prospect of saving money or earning credits offers a clear and compelling reason to engage.

Examples of financial incentives

❖ Time-of-Use (TOU) Pricing

TOU pricing structures vary electricity rates based on the time of day, with higher costs during peak demand periods (e.g., late afternoon to early evening) and lower rates during off-peak hours (e.g., overnight or early morning). This pricing model incentivises consumers to shift their energy consumption to times when electricity is cheaper and less strain is placed on the grid.

- **Effectiveness:** research has shown that TOU pricing can lead to significant reductions in peak demand. For example, a study conducted in the UK found that households under TOU pricing reduced their peak energy consumption by 12% simply by adjusting the timing of appliance usage (Bradley et al., 2016).
- **Considerations:** while TOU pricing is effective, it requires clear communication to ensure consumers understand the rate structures and how to optimize their energy use accordingly.

❖ Rebates and Bill Credits

Rebates and bill credits provide consumers with direct financial rewards for reducing their energy consumption during critical periods. These incentives are typically offered as a one-time payment or credit applied to the consumer's electricity bill, making them highly visible and immediately beneficial.

- **Effectiveness:** pilot programs have demonstrated the power of rebates in driving participation. In California, a program offering participants \$50 for reducing their peak energy consumption by 20% resulted in a 15% decrease in demand during critical periods (Faruqui & George, 2005).
- **Considerations:** rebates and bill credits are particularly effective for short-term engagement but may require supplementary incentives to sustain long-term participation.

❖ Dynamic Pricing

Dynamic pricing takes the concept of TOU pricing a step further by adjusting electricity rates in real time based on grid conditions. Unlike TOU pricing, which follows a predetermined schedule, dynamic pricing reflects current supply and demand, offering consumers the opportunity to save money by responding to real-time price signals.

- **Effectiveness:** dynamic pricing can be highly effective in reducing peak demand and balancing grid load, particularly when consumers have access to tools that provide real-time pricing information. However, its success depends on transparent communication and user-friendly tools that help consumers understand and respond to price fluctuations (Allcott, 2011).
- **Considerations:** while dynamic pricing offers flexibility, it can also introduce bill volatility, which may be a concern for some consumers. As such, it is often most effective when paired with educational campaigns and automated tools that simplify participation.

❖ Subscription-Based Incentives

Some DR programs offer consumers the option to subscribe to a service that provides financial rewards for participation in demand response events. For example, consumers might receive a monthly payment or discount in exchange for allowing their energy provider to adjust their thermostat or other connected devices during peak periods.

- **Effectiveness:** subscription models provide predictable rewards for consumers, which can enhance long-term engagement. They are particularly appealing to consumers who value convenience and automation.
- **Considerations:** these programs require trust in the energy provider and reliable technology to ensure that adjustments to energy use do not compromise consumer comfort or convenience.

Effectiveness and considerations of Financial Incentives

Financial incentives are powerful tools for driving participation in DR programs. Their immediate and tangible nature makes them highly effective in initially engaging consumers and reducing peak demand. However, their long-term effectiveness can diminish if consumers perceive the rewards as insufficient or if the incentives are not complemented by other motivators. Research by Abrahamse et al. (2005) suggests that while financial incentives can initiate behavioural change, their impact may fade over time unless reinforced by non-financial incentives or ongoing engagement strategies.

1 - Examples of Financial Incentives

FINANCIAL INCENTIVES			
INCENTIVES TYPE	SHORT DESCRIPTION	EFFECTIVENESS	CONSIDERATIONS
Time-of-Use (TOU) Pricing	Electricity prices vary by time of day to encourage shifting usage toward off-peak hours	Reduces peak demand (~12% reduction observed in UK trials)	Requires clear communication so users understand rate schedules and how to respond.
Rebates & Bill Credits	Direct financial rewards or bill reductions for meeting DR targets	Strong short-term impact pilots show ~15% peak reduction	May not sustain long-term engagement unless paired with other motivators
Dynamic Pricing	Real-time prices adjust based on actual grid conditions	Highly effective when consumers have access to real-time information tools	May introduce bill volatility; best combined with educational support or automation
Subscription-Based Incentives	Fixed monthly payments/discounts for allowing automated adjustments during peak periods	Predictable rewards encourage long-term participation	Requires user trust and reliable technology to maintain comfort

1.2.2 Non-Financial Incentives

Non-financial incentives tap into deeper psychological and emotional motivators. These incentives are designed to resonate with intrinsic values, such as personal satisfaction, social recognition, environmental consciousness, or a sense of community. Unlike financial rewards, which often focus on immediate economic gains, non-financial incentives foster long-term engagement by aligning with the values, beliefs, and social identities of consumers. Non-financial incentives are particularly effective in contexts where financial rewards alone may not suffice to sustain participation. For example, consumers who are already motivated by environmental concerns or that do not manage directly their energy bill, may respond more strongly to non-financial incentives than to monetary rewards. Additionally, these incentives can enhance the perceived value of participating in Demand Response (DR) programs, making them more appealing to a broader range of individuals.

Examples of non-financial incentives

❖ Social Recognition

Social recognition leverages the human desire for approval and status within a community. By publicly acknowledging participants for their contributions to energy savings, these incentive programmes can create a sense of pride and belonging and encourage others to follow suit.

- **Implementation:** recognition can take various forms, such as featuring "Top Energy Savers" in community newsletters, displaying leaderboards in mobile applications, or awarding digital badges for achieving energy-saving milestones.
- **Considerations:** for social recognition to be effective, it must be visible and meaningful to the target audience. It works best in communities where individuals value social approval or collective achievements.

❖ Gamification

Gamification transforms energy conservation into an interactive and engaging experience through the incorporation of elements typically found in games, such as points, levels, challenges, and rewards. This approach is particularly effective among younger demographics or tech-savvy consumers who are accustomed to digital engagement.

- **Implementation:** gamification can be integrated into mobile applications or online platforms, where users earn points for reducing energy consumption, complete challenges to unlock rewards, or compete with neighbours in energy-saving competitions.
- **Considerations:** to sustain engagement, gamification strategies should be dynamic and evolving, with new challenges or rewards introduced regularly to maintain interest.

❖ Community Engagement

Community engagement fosters a sense of collective effort and shared responsibility, motivating individuals to participate in DR programs as part of a larger group. This approach is particularly effective in close-knit communities or among consumers who value social cohesion and collaboration.



- **Implementation:** community-based incentives can include neighbourhood challenges, where households compete to achieve the highest energy savings, or shared goals, such as reducing the community's overall energy consumption by a certain percentage.
- **Considerations:** community engagement works best when participants feel a strong sense of belonging and when the program fosters collaboration rather than competition.

❖ Educational Incentives

Educational incentives focus on increasing consumers' knowledge and awareness of energy conservation and Demand Response. By providing information about the environmental, economic, and social impacts of their energy use, these incentives empower consumers to make informed decisions.

- **Implementation:** educational incentives can take the form of workshops, webinars, informational campaigns, or interactive tools that help consumers understand their energy consumption patterns and the benefits of DR participation.
- **Considerations:** educational incentives are most effective when they are accessible, engaging, and actionable, providing consumers with clear steps to modify their behaviour.

❖ Environmental and Social Impact Reporting

For consumers motivated by environmental or social responsibility, providing detailed reports on the impact of their energy-saving actions can be a compelling incentive. These reports can highlight the environmental benefits of reduced energy consumption, such as lower carbon emissions, or the social benefits, such as contributing to community resilience.

- **Implementation:** impact reports can be integrated into energy bills, mobile applications, or community platforms, showing consumers how their participation in DR contributes to broader sustainability goals.
- **Considerations:** to maximise effectiveness, impact reporting should be specific, visual, and emotionally resonant, helping consumers connect their individual actions to larger outcomes.

Effectiveness and Considerations of Non-Financial Incentives

Non-financial incentives are a critical complement to financial rewards, particularly in fostering long-term engagement and broader participation in DR programmes. As mentioned above, while financial incentives may initially attract consumers, non-financial incentives help sustain their involvement by appealing to intrinsic motivations, such as personal values, social identity, and a sense of purpose. However, the success of non-financial incentives depends on several factors:

- **Alignment with consumer values:** incentives must resonate with the motivations and priorities of the target audience. For example, environmentally conscious consumers may respond strongly to impact reporting, while socially oriented individuals may be more motivated by community engagement.
- **Visibility and accessibility:** non-financial incentives should be easily understood and accessible to all participants. Clear communication and user-friendly platforms are essential for ensuring that consumers can engage with and benefit from these incentives.

- **Integration with financial incentives:** the most effective DR programs often combine financial and non-financial incentives to create a holistic approach that appeals to a wide range of motivations. For instance, a program might offer bill credits for reducing energy use while also providing social recognition for top performers.

In summary, non-financial incentives play a vital role in the success of DR programmes, as they address the psychological and social dimensions of consumer behaviour. When thoughtfully designed and implemented, these incentives can enhance participation, foster long-term engagement, and contribute to the overall effectiveness of Demand Response initiatives.

2 - Examples of Non-Financial Incentives

NON-FINANCIAL INCENTIVES			
INCENTIVES TYPE	SHORT DESCRIPTION	EFFECTIVENESS	CONSIDERATIONS
Social Recognition	Public or visible acknowledgement of participants' energy-saving contributions	Highly effective where social approval or community belonging is valued	Must be visible, meaningful, and relevant to the target audience
Gamification	Uses points, levels, badges, or challenges to make DR engaging and interactive	Very effective with younger or tech-savvy users; boosts ongoing engagement	Needs regular updates and new challenges to avoid loss of interest
Community Engagement	Frames DR as a collective effort through group challenges or shared goals	Strong impact in cohesive communities with social identity	Works best when emphasising collaboration rather than competition
Educational Incentives	Tools or activities that increase awareness of energy use and DR impacts	Enhances long-term behavioural change through better understanding	Must be accessible, engaging, and offer practical guidance
Environmental & Social Impact Reporting	Shows participants the CO ₂ , environmental, or community benefits of their actions	Highly effective for environmentally conscious or socially motivated users	Should be specific, visual, and emotionally resonant to reinforce impact

2. How to plan successful incentives

As explained in the ABC framework of incentives, three major components determine whether an incentive mechanism produces reliable behavioural change: A = antecedent, B = behaviour, and C = consequence (Meredith et al., 2014). To successfully implement an incentive mechanism, the way consequences (incentives) are timed, repeated, and sustained over time is crucial. Evidence from behavioural science, energy research and demonstration projects shows that **intervention frequency, duration and timing**, and the **social-cultural dimension** shape the extent to which incentives support stable, repeatable energy behaviours in residential settings.

Below you will find guidelines for planning incentive schemes, structured according to these three components.

2.1 Intervention frequency: How often incentives are delivered matters

Incentives operate as consequences within an ABC contingency. The more frequently a consequence follows a target behaviour, the stronger and more predictable the learning effect. Behavioural analyses show that frequent, contingent reinforcement accelerates skill acquisition and habit formation (Meredith et al., 2014). This mechanism generalises across domains: whether the behaviour is medication adherence, daily steps, recycling, or load-shifting, frequent reinforcement strengthens the link between behaviour and consequence.

In energy contexts, households engage in repetitive, low-salience behaviours (heating use, laundry timing, appliance use). Frequent reinforcement helps maintain attention and supports experimentation.

Guidelines for practice

- **For simple one-off actions**, such as signing up for an energy service or responding to an occasional peak alert, *low-frequency incentives* (e.g., end-of-event bonuses) can be sufficient
- **For recurring or complex behaviours**, such as repeated load shifting or sustained conservation:
 - Prefer higher-frequency incentives (e.g., daily or event-based feedback or points), which maintain salience and reduce behavioural “drift”
 - Small but frequent incentives often outperform large, infrequent ones, because they keep the behaviour present in daily routines (Abrahamse et al., 2005)
- **Combine frequency with feedback**: frequent incentives are most effective when paired with immediate informational feedback, even if the financial reward is delivered weekly or monthly (Andor & Fels, 2018; S3C Guideline)
- **Avoid long reinforcement gaps**: when incentives are delivered too infrequently (e.g., only via billing cycles), users struggle to identify which actions produced the reward

In short: match frequency to behavioural complexity, the more sustained and routine-based the behaviour, the more frequent the reinforcement should be.

2.2 Timing & Duration: Reinforcement must be immediate enough and long enough

Designing an effective incentive scheme requires not only choosing the right type of reward, but also defining when and for how long incentives are delivered. Duration and timing determine whether users can clearly connect their actions to consequences, develop new routines, and maintain behaviour over time. Getting these elements right is essential for moving from short-term reactions to stable, repeatable energy practices.

2.2.1 Timing: Immediate consequences are more powerful

Research into operant learning consistently shows that the shorter the interval between the behaviour (B) and the consequence (C), the stronger the behavioural effect (Meredith et al. 2014; Locke & Latham 2002). Delayed rewards hinder behavioural learning because users are unable to clearly associate the action with the outcome.

Guidelines for timing

- Try to **minimise the delay between action and acknowledgement** (e.g., instant app notifications, points earned during the day, real-time dashboards)
- If financial transfers cannot be immediate (billing cycles, regulatory constraints), use **immediate symbolic reinforcement** (e.g., “You earned €X today” notifications) to maintain perceived immediacy
- **Avoid back-loaded incentives** (e.g., annual rebates) for actions requiring behavioural persistence, they are less motivating and less effective (Qin et al., 2024; Andor & Fels, 2018)

2.2.2 Duration: Behaviour change requires sustained exposure

Energy behaviours are strongly habit driven, and changing entrenched routines requires repeated performance over time, opportunities for users to try out alternative ways of doing things, and stable reinforcement that helps anchor new patterns. Short projects or brief incentive windows rarely lead to durable change (Abrahamse et al., 2005), because sustained exposure is needed to build trust in the system, allow users to learn when and how flexibility is required, and gradually integrate new actions into their everyday routines.

Guidelines for duration

- **Ensure incentive exposure lasts long enough** to allow routines to stabilise (weeks to months depending on behaviour)
- **Avoid short pilot windows** if the goal is habit formation
- **Plan for maintenance phases**, where reinforcement frequency can be gradually reduced while feedback continues (Meredith et al., 2014)
- **Monitor behavioural decay when incentives are paused and compensate with low-cost social or feedback incentives**

Duration and timing shape the “strength” of the C in the ABC contingency: when consequences are timely and sustained, behaviour becomes more stable and less reliant on large rewards.

2.3 The social-cultural dimension: Aligning incentives with people, norms, and meaning

The ABC contingency does not operate in a vacuum: antecedents (A) include rules, expectations, shared norms, personal values and the ways communication frames a behaviour. These socio-cultural factors shape whether incentives are perceived as fair, meaningful, intrusive, or aligned with one's identity. Behavioural dynamics in Demand Response (DR) are shaped by the interplay between antecedents (rules, expectations, norms), behaviour (the action required), and consequences (rewards, signals). However, these ABC contingencies only work when they resonate with the cultural identity, socio-economic conditions, cognitive preferences, and motivations of distinct user groups. In short, behavioural levers are effective only when they resonate with the cultural values and lived realities of each user persona.

Guidelines for practice

- **Match incentives to user profiles:** design rewards based on a clear understanding of your end-user segments and their dominant motivations
- **Blend monetary and non-monetary levers:** combine financial benefits with recognition, comfort reassurance, or social meaning to address both extrinsic and intrinsic drivers
- **Communicate purpose, not just reward:** ensure antecedents (A) explain why the behaviour matters and how it contributes to personal or collective goals
- **Keep interventions supportive, not punitive:** avoid heavy-handed penalties, which risk backlash, distrust, and disengagement
- **Leverage social and community narratives:** use collective goals, community identity, or shared environmental purpose when engaging Smart Citizen-type personas
- **Ensure fairness and transparency:** make rules, calculations, and expected impacts clear to strengthen trust and perceived legitimacy

THE DEDALUS CASE - Behavioural & Cultural Levers by Persona Type

Evidence from the DEDALUS customer segmentation confirms that user responses to DR incentives vary substantially across demographic groups, motivational profiles, and technological familiarity. Seniors in cohousing environments, for example, value comfort, clarity and trust, while younger digitally skilled users, such as university students, are more responsive to gamified, technology-driven incentives and environmental framings. Social housing residents show strong eco- and tech attitudes but low DR awareness, making clear communication pivotal; meanwhile, civic-minded citizens display moderate literacy and willingness but benefit from recognition and community-based motivations. The DEDALUS segmentation also confirms that personas, not locations, are the most reliable predictors of how people interpret incentives, trust systems, or adopt flexibility behaviours.

3. What are the most effective incentives according to target group

As discussed in the socio-cultural dimension of incentives, users do not interpret or respond to incentives in a uniform way. Their values, capabilities, expectations, and identities shape how antecedents are perceived, how behaviours are carried out, and how consequences are interpreted. Understanding which incentives work best therefore requires analysing both broad behavioural patterns and the specific characteristics of each target group.

3.1 Barriers and Drivers

Participating in a Demand Response programme requires households to make a fundamental shift from being passive consumers of electricity to becoming active agents who must deliberately adjust when and how they use energy. This shift is not primarily technical in nature, but is thoroughly behavioural.

Residential energy consumption is intertwined with everyday life through habits and implicit norms: people cook, do their laundry, and heat or cool their homes according to rhythms they perceive as natural, convenient and often comforting. Because these behaviours are automatic rather than reflective, asking people to actively adapt them, even slightly, requires them to break established habits that have been reinforced over years or decades. This is one of the deepest behavioural barriers documented in the literature on energy consumption (see Abrahamse et al., 2005; Andor & Fels, 2018).

A second core barrier is that household energy use is intrinsically low in salience (Abrahamse et al., 2005; Sloot et al., 2023). Unlike water, mobility or waste, which are accompanied by visible cues and direct sensory experiences, electricity is invisible and instantly available. Most consumers never consciously “decide to consume electricity”; they decide to perform daily-life activities that happen to require electricity. As a result, the behavioural link between action and energy outcome is weak, and the idea of “timing” energy use feels abstract or irrelevant. Participation in DR requires a greater awareness of energy consumption as a behaviour that can be controlled – an aspect that many users have never been asked to consider.

Another important barrier is cognitive load. DR actions often need to be taken during already busy periods of the day (evenings, mornings, family routines) causing friction precisely at the moments when people prefer convenience over optimisation. Even when the required action is simple, it still represents an additional decision, and decision-making research consistently shows that small cognitive burdens can undermine behaviour adoption (see Andor & Fels, 2018; Sloot et al., 2023). When users anticipate inconvenience, effort, or disruption to family routines, participation declines substantially.

Comfort concerns form another major obstacle. Many users fear that engaging in DR will result in temperature discomfort, delayed access to appliances, or disruptions that affect their wellbeing or their family’s daily rhythm. These concerns, even when unfounded, strongly influence perceived acceptability. Comfort concerns are especially pronounced among older adults, families with small children, people with health conditions, or anyone who views the home

as a place where predictability and stability take priority over experimentation (Chen et al., 2023; Abrahamse et al., 2005).

The lack of established social norms around energy flexibility further contributes to the challenge. While activities such as recycling or water conservation benefit from decades of public messaging and widespread cultural consensus, DR is still a novel concept for most households. Without shared norms indicating that “people like me participate in DR” or that “adjusting my energy use is socially responsible”, the behaviour lacks a framework of social meaning (the absence of established descriptive and injunctive norms for DR participation has been noted in several behavioural energy studies; Andor & Fels, 2018; Chen et al., 2023). This absence of social anchoring often leaves users unsure about whether their engagement matters, whether others are doing the same, or whether their effort is valued.

Trust also plays a crucial role. DR programmes typically rely on smart meters, automated control systems, or digital interfaces. When households feel uncertain about how much control they retain, how their data are used, or whether the system will function reliably, trust becomes a barrier to engagement. Lack of trust can stem from privacy worries, previous negative experiences with utility providers, unfamiliarity with digital tools, or concerns about hidden costs and fears of loss of control (Sloot et al., 2023; Chen et al., 2023). When trust is low, no incentive (financial or otherwise) is sufficiently persuasive.

Fairness concerns add another layer of complexity. Not all households have the same ability to shift load: working families with rigid schedules, renters with limited appliance control, individuals in poorly insulated homes, or people with low digital literacy cannot contribute to DR in the same way. If incentive schemes do not visibly account for these structural differences, users may perceive them as unfair or exclusionary, leading to disengagement (Andor & Fels, 2018; Sloot et al., 2023). A well-designed incentive structure must therefore recognise asymmetries in flexibility potential and ensure that participation opportunities feel equitable.

Finally, technological barriers remain significant for many user groups. Some households are uncomfortable navigating apps, adjusting digital settings, or interpreting graphs and notifications. Others may have unreliable connectivity or outdated appliances that limit the effectiveness of DR signals. Even minor usability problems can inhibit participation when users already feel uncertain or overwhelmed.

Despite these challenges, there are also powerful behavioural drivers that support engagement when properly activated. Households respond positively to clear and immediate rewards, whether financial or symbolic; to meaningful feedback that makes invisible behaviours visible; to social or environmental messages that resonate with personal values; and to clear communication that demonstrates that comfort and autonomy will be protected. Automation, personalisation, and trust building strategies can significantly reduce the cognitive burden of participation and help users integrate new practices into their routines.

To sum up, the following are the major barriers and drivers documented:

❖ MAJOR BARRIERS

- **Habitual routines:** Energy use is embedded in stable daily practices that are difficult to disrupt



- **Low salience of energy consumption:** Electricity remains largely invisible and abstract to end users
- **Cognitive load and effort:** DR requires attention and decisions at moments of low cognitive availability
- **Comfort and risk aversion:** Fear of discomfort or loss of control discourages engagement
- **Lack of social norms:** Energy flexibility lacks established behavioural and normative references
- **Trust and privacy concerns:** Uncertainty about control, data use, and automation reduces acceptance
- **Perceived unfairness:** Unequal flexibility potential across households undermines legitimacy
- **Technological barriers:** Limited digital skills, usability issues, and system complexity inhibit uptake

❖ KEY DRIVERS

- **Clear and immediate incentives:** Financial or symbolic rewards that are easy to perceive
- **Meaningful feedback:** Visibility of impact, progress, or contribution
- **Alignment with values:** Environmental, community, or civic motivations
- **Protection of comfort and autonomy:** Clear assurances reduce perceived risk
- **Automation and simplicity:** Reduced effort increases participation
- **Recognition and social meaning:** Especially effective for community-oriented users

Understanding these general barriers and drivers provides the foundation for analysing how different target groups experience DR differently. While the obstacles described above apply widely across user populations, each DEDALUS persona - seniors, students, digital optimisers, prosumers, financially constrained residents and civic-minded citizens - encounters them in specific ways shaped by their capacities, motivations, and living conditions. The next section examines how these differences inform the tailoring of incentive schemes to each target group.

3.2 Clustering of DEDALUS target groups and its correlation with the selection of incentives

DEDALUS used a combination of segmentation techniques (i.e., demographic profiling, psychographic factors, technological literacy, environmental attitudes, and behavioural intentions) to create distinct user clusters. These clusters are not merely descriptive; they function as design inputs for shaping effective incentive schemes. Profiling users is the first and most crucial step: without a clear understanding of who the end-users are, how they live, and what matters to them, incentives risk being misaligned or ineffective.

A structured profiling process generally involves three phases:

1. **Identify the characteristics of your user base:** digital skills, comfort expectations, financial sensitivity, social motivations, environmental attitudes, flexibility potential, and trust levels.

2. **Group users by similarities that predict behaviour:** e.g., seniors prioritising comfort, young adults motivated by fun and competition, prosumers seeking autonomy and optimisation, or financially constrained residents valuing fairness and savings.
3. **Translate cluster characteristics into incentive strategies:** determine which mix of financial, non-financial, normative, or gamified incentives best aligns with the motivations and capacities of each group.

In practice, the correlation between clusters and incentive selection operates through two mechanisms:

1. Matching motivations to the right incentive form, for example:

- Financially sensitive households respond best to transparent economic incentives and immediate savings.
- Environmentally motivated groups respond more to eco-impact information and social recognition.
- Tech-savvy users engage more with automated optimisation, personalised dashboards, and feedback-rich incentives.

2. Matching capability levels to the right incentive complexity

- Low digital literacy segments require simple, low-effort incentives and clear instructions.
- High digital literacy segments can handle dynamic pricing, gamification, and multi-layered feedback.
- Time-constrained working adults benefit most from automation-supported incentives requiring minimal active input.

The DEDALUS segmentation ultimately enables project teams to build persona-centred incentive schemes, ensuring that the A–B–C contingency structure is experienced as meaningful, fair, and feasible for each group. By starting with robust end-user profiling and aligning incentives with real behavioural drivers, projects can increase engagement, reduce friction, and enhance the long-term effectiveness of DR participation.

Below, each persona is linked to tailored leverage points for communication, incentives, and nudging.

3 - Table Personas, characteristics and levers

PERSONAS	KEY CHARACTERISTICS	WHAT WORKS	EFFECTIVE LEVERS
Comfort First Seniors	• Low Digital Literacy • High Eco & Social Attitudes • Value comfort, safety, stability • Prefer face-to-face reassurance and human presence • Strong eco and community orientation • Low familiarity with DR concepts and apps	Antecedents: Clear rules, repetition, reassurance; printed materials; trusted intermediaries Behaviour: Low-effort, comfort-preserving tasks Consequences: Non-monetary recognition, community acknowledgement, small predictable savings	✓ Clarity & trust ✓ Comfort guarantees ✓ Social belonging ✓ Environmental meaning
The Savings-Oriented Residents	• Financial Pressure • middle-high/high Eco & Tech Attitudes • High financial sensitivity • Often low awareness of DR • Strong environmental values and openness to technology	Antecedents: Transparent rules, simple financial dashboards, fairness cues Behaviour: Actions with visible cost impact (e.g., shifting heating or laundry times) Consequences: Direct monetary feedback, savings visualisations, eco-impact metrics	✓ Cost savings ✓ Fairness framing ✓ Local social norms ✓ Eco incentives
The Digital Optimisers	• Tech Savvy • Working Age • High Literacy • High education and strong financial&tech motivation • Want control, optimisation, and autonomy • Value efficiency and personalised data	Antecedents: Personalisation, detailed data, real-time dashboards Behaviour: Automated optimisation, flexible scheduling Consequences: Gamified elements, dynamic financial rewards, carbon metrics	✓ Personalisation ✓ Automation ✓ High-resolution feedback ✓ Gamified financial incentives
The Playful Achievers	• Digital natives (Students and young adults) • Motivated by novelty, fun, and social recognition • Responsive to competitions, badges, and challenges • Mild but present financial sensitivity	Antecedents: Challenge framing ("Try to beat yesterday"), playful tone Behaviour: Quick, low-effort actions that generate tokens/points Consequences: Achievements, leaderboards, badges, NFT-like visual assets	✓ Gamification ✓ Social comparison ✓ Digital tokens ✓ Instant gratification
The Civic Stewards	• Community Employees & Engagement-Minded Citizens • Motivated by collective benefit and public service • Moderate digital competence, mid level literacy • Social responsibility is a dominant driver	Antecedents: Connect DR to community goals ("help reduce emissions for our region") Behaviour: Simple shifts aligned with daily routines Consequences: Group recognition, collective milestones, environmental impact feedback	✓ Community identity ✓ Group goals ✓ Public recognition ✓ Transparent environmental metrics
The Eco Tech Prosumers	• Community Energy Participants • Highly knowledgeable and motivated • Strong eco values and strong tech identity • Already involved in collective energy assets (PV, batteries, etc.)	Antecedents: Detailed energy forecasts, rich data, autonomy Behaviour: Strategic optimisation of loads, EV/PV alignment Consequences: Dynamic incentives, peer coordination, carbon-based rewards	✓ High-detail dashboards ✓ Solar-forecast nudges ✓ Control + autonomy ✓ Community optimization goals



4 - Incentives rated by Persona's type

	PERSONA TYPES					
Lever Type	Comfort First Seniors	Savings-Oriented Residents	Digital Optimisers	Playful Achievers	Civic-Minded Citizens	Eco Tech Prosumers
Financial Incentives	★★ Limited	★★★★★ Very Strong	★★★ Moderate	★★ Limited	★★ Limited	★★★ Moderate
Gamification	★ Weak	★★ Limited	★★★ Moderate	★★★★★ Very Strong	★★ Limited	★★ Limited
Social Norms	★★★ Strong	★★★ Strong	★★ Limited	★★★ Strong	★★★★★ Very Strong	★★ Limited
Environmental Framing	★★★★ Strong	★★★ Strong	★★★ Moderate	★★★★ Strong	★★★ Strong	★★★★★ Very Strong
Automation	★★ Limited	★★★ Moderate	★★★★★ Very Strong	★★ Limited	★★ Limited	★★★★ Strong
Personalisation	★ Limited	★★ Limited	★★★★★ Very Strong	★★ Limited	★★ Limited	★★★★★ Very Strong
Trust & Transparency	★★★★★ Very Strong	★★★★★ Very Strong	★★★ Moderate	★★ Limited	★★★★ Strong	★★★★★ Very Strong



3.3 How to effectively choose and combine Financial and Non-Financial Incentives

Many experimentations in Demand Response (DR) programs recognise that **no single type of incentive can universally motivate all consumers**. Indeed, as mentioned in the previous chapter, financial incentives provide immediate and tangible rewards, but their effectiveness can diminish over time if not reinforced by deeper, more intrinsic motivators. Conversely, non-financial incentives are more likely to foster long-term behavioural change by aligning with personal values and social identities. However, these incentives may not always be sufficient to initiate participation, particularly among consumers who are primarily driven by economic considerations. Therefore, the optimal strategy for DR programs lies in the thoughtful integration of financial and non-financial incentives, creating a holistic and adaptive approach that appeals to a broad spectrum of motivations.

The integration of financial and non-financial incentives offers significant benefits, but their successful implementation requires careful planning and execution. Below are critical considerations for designing an effective integrated incentive program:

- **Consumer-Centric design:** at the heart of any successful incentive program lies a deep understanding of the target audience. Consumers are not a monolithic group, as they vary widely in their values, preferences, behaviours, and technological proficiency. Therefore, the first step in designing an integrated incentive program is to segment the consumer base and tailor incentives to the unique motivations of each group. In particular:
 - incentives should be aligned with the values, preferences, and behaviours of the target audience. Conduct **surveys, focus groups, or pilot tests** to understand what motivates your consumers;
 - avoid assumptions about consumer motivations; instead, **use data-driven insights** to tailor incentives effectively.
- **Clear communication:** even the most well-designed incentive programme can fail if consumers do not understand how to participate. Clear, accessible, and engaging communication is essential to bridge the awareness gap and ensure that consumers are informed, motivated, and capable of taking action. It is essential that:
 - consumers easily understand how to participate, what rewards they can earn, and how their actions contribute to broader goals;
 - use **simple, jargon-free language** and **visual aids** (e.g., infographics, videos) to explain the program.
- **Transparency and trust:**
 - build trust by being transparent about how incentives are calculated and distributed;
 - ensure that **rewards are delivered promptly** and accurately to maintain consumer confidence.
- **Technology and accessibility:**
 - leverage smart meters, mobile applications, and online platforms to provide real-time feedback and rewards;
 - ensure that the **technology is user-friendly** and accessible to all consumers, including those with limited digital literacy.



- **Monitoring and Adaptation:**
 - continuously monitor participation rates and consumer feedback to identify what is working and what needs improvement;
 - be prepared to **adjust incentives based on evolving consumer preferences** or external factors (e.g., changes in energy prices or regulations).
- **Regulatory and Ethical Compliance:**
 - ensure that incentive programmes comply with local regulations and ethical standards, particularly regarding data privacy and consumer protection;
 - **avoid manipulative practices**; incentives should empower consumers rather than exploit their behaviours.



4. Conclusions

The success of Demand Response ultimately hinges on one decisive factor: people. Although DR is often presented as a technical or economic mechanism, its real impact depends on households who must be willing, motivated, and able to adapt deeply ingrained routines. This toolkit has highlighted that DR is, before anything else, a behavioural practice: it requires attention in moments of cognitive overload, a disruption of comfort, and the willingness to engage with concepts that are often unfamiliar or invisible in everyday life.

Because of this, the thoughtful design of financial and non-financial incentives is indispensable. Incentives are not merely add-ons, they are the bridge that connects grid needs with the lived realities of residential users. When designed with users in mind - their motivations, capabilities, identities, and constraints - incentives can transform DR from a technical request into a meaningful, feasible action. When misaligned, there is a risk of confusion, disengagement, or even resistance.

The work carried out in DEDALUS demonstrates that there is no “average user”. The elderly resident concerned with comfort, the student motivated by playfulness and recognition, the digitally skilled worker seeking optimisation, or the eco-driven prosumer, each responds to different incentives, communicated in different ways. Effective DR programmes therefore depend on precise user profiling, segmentation, and the careful matching of behavioural levers with the right incentive mix.

Ultimately, delivering a fair, inclusive, and effective DR programme requires recognising that energy flexibility does not happen in the abstract. It happens in homes, in routines, in lives that differ widely. Incentives that respect this human dimension - balancing financial benefits with recognition, clarity, social belonging, and environmental meaning - have the power to support long-term engagement and make consumers active partners in the energy transition.

As Europe accelerates towards a smarter and more flexible energy system, putting people at the centre of DR design is not optional, it is essential. Incentives, when grounded in behavioural insight and tailored to real user experiences, are one of the most powerful tools we have to achieve that.



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