



bEhaVioral Insights and Effective eNergy policy acTions

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Introduction

The EVIDENT project concentrates on understanding human behavior and determining the factors that influence household energy consumption. Its goal is to assess and recommend policies that encourage energy efficiency. To achieve this, the project utilizes field trials, surveys, and serious games to study how cognitive biases and decision-making shortcuts affect choices related to energy conservation. Furthermore, EVIDENT aims to enhance awareness, facilitate better decision-making, and establish a data hub for future research on energy efficiency behaviors through the development of a digital platform.

More information about the project, the use cases, the deliverables, and the publications can be found on the project's website (<https://evident-h2020.eu/>). Also, the project platform (<https://platform.evident-h2020.eu/>) allows users to upload serious games, create questionnaires, participate in existing questionnaires, and access available related data. The contact persons of the EVIDENT project are Prof. Panagiotis Sarigiannidis (psarigiannidis@uowm.gr) and Prof. Ioannis Pragidis (gpragkid@econ.duth.gr).

This document aims to provide several policy implications resulting from the implementation of the EVIDENT use cases, as well as to propose ideas for future research. In more detail, the document is structured as follows:

- **Section 1 - Policy Implications:** In this section, 16 new policy briefs have been included focusing on a) increasing energy efficiency through home energy reports (HERs), b) understanding consumers' financial literacy, education, and behavior, c) mitigation of present bias and rebound effects, d) understanding consumer misconceptions, e) enhancing energy efficiency through forecasting models, and f) addressing challenges associated with the open availability of energy data.
- **Section 2 - Future Research Ideas:** This section outlines potential avenues for further exploration, delving into critical energy transition and climate change adaptation. Specifically, these avenues include a) nudging prosumers for coordinating energy contributions, b) impact of climate change on Consumer behavior, and c) serious games.

1. Policy Implications

1.1 Enhancing Energy Efficiency Among Prosumers through Home Energy Reports (HERs)

This policy brief summarizes the key findings, discusses policy alternatives, and provides actionable recommendations for enhancing energy efficiency among prosumers through Home Energy Reports.

Summary

An experiment conducted in Sweden examined the impact of Home Energy Reports (HERs) on residential energy consumption among prosumers. The study revealed a 9.8% decrease in average weekly electricity usage among households receiving bi-weekly electronic HERs. However, the effects varied based on the time of day and season. This summary delves into the findings and provides recommendations for policy enhancements to improve energy efficiency and tackle seasonal consumption patterns.

Context and Importance of the Problem

Residential energy consumption is crucial in managing energy efficiency, especially among prosumers who consume and produce electricity. While traditional home energy reports (HERs) have proven effective for households solely consuming electricity, their influence on prosumers has not been extensively studied. With the increasing popularity of solar PV systems and the potential for energy rebound effects, it is important to comprehend how HERs can impact prosumer behavior to develop effective energy policies.

Policy Alternatives

1. **Implement Regular HERs for Prosumers:** Extend the frequency and reach of HERs to prosumers, providing tailored reports highlighting energy consumption and production patterns.
2. **Seasonal and Time-of-Day Adjustments:** Develop HERs that address seasonal variations and intraday patterns in energy use, emphasizing conservation during high-demand periods.
3. **Incorporate Financial Incentives:** Enhance HERs by including information on financial gains from conservation efforts, especially during peak pricing periods.

Policy Recommendations

1. **Bi-weekly HERs for Prosumers:** Continue sending bi-weekly HERs to provide frequent feedback and maintain consumer engagement. This has been shown to significantly reduce energy consumption.
2. **Customized Seasonal Reports:** Create tailored reports that address energy use and production differences across seasons. Highlight the higher financial returns of conservation during winter months when prices are higher. Given the observed seasonal variations, policies should implement season-specific strategies. For example:
 - **Mid-Spring to Mid-Fall:** Intensify peer comparison efforts and promote energy-saving behaviors when the impact is more pronounced during these months.

- **Late Fall to Early Spring:** Focus on other interventions such as promoting efficient heating solutions or insulating homes to reduce energy use during colder months.
 - **Daylight and PV Systems:** Integrate programs that consider the seasonal impact of daylight hours and the potential of rooftop PV systems to offset energy use. Encourage the adoption of PV systems in regions with high solar potential.
3. **Promote Energy Storage Utilization:** Encourage in-home battery storage systems through HERs, illustrating the benefits of storing energy during low-price periods and using it during peak times.
 4. **Educational Campaigns:** Launch campaigns to educate prosumers about the financial and environmental benefits of energy conservation, focusing on reducing misconceptions about the benefits of conservation across different seasons.

Implementation Strategies

1. **Partnerships with Energy Providers:** Collaborate with energy service providers to ensure the regular delivery of customized HERs.
2. **Leverage Technology:** Utilize advanced metering infrastructure and IT systems to provide detailed and timely consumer feedback.
3. **Monitor and Evaluate:** Establish a monitoring framework to assess the effectiveness of the HERs, adjusting based on observed consumption patterns and feedback from prosumers.
4. **Community Programs:** Foster community-based programs where neighborhoods collectively work towards energy reduction goals. Community support can enhance the impact of individual efforts.

Conclusion

When designing customized Home Energy Reports (HERs) for prosumers, it is crucial to consider their impact on energy consumption. Tailored reports that account for frequent and seasonal variations and intraday fluctuations can lead to significant reductions in energy usage. To enhance the effectiveness of HERs, policymakers should focus on increasing the visibility of financial benefits and addressing disparities in conservation efforts across different seasons. This approach can result in greater efficiency and impact in energy conservation initiatives.

1.2 Addressing Financial Literacy Gaps: Policy Recommendations from EVIDENT Survey Insights on Energy Efficiency

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings highlight the variation in financial knowledge across socio-demographic groups and emphasise the need for targeted efforts to improve financial literacy, particularly among younger age groups, low-income households, unemployed individuals, and part-time employees.

Key Findings

1. Financial Knowledge Disparities:

- Significant variation in financial knowledge exists across socio-demographic groups.
- Younger age groups, low-income households, unemployed individuals, and part-time employees exhibit lower financial knowledge compared to other groups.

2. Impact on Energy Efficiency:

- Financial knowledge is a predictor of current appliance energy rating.
- Groups with lower financial knowledge are more likely to own inefficient appliances.
- These groups hold potential as agents for change due to their current lack of efficient appliances but require targeted support to address financial knowledge gaps.

Policy Recommendations

1. Educational Initiatives:

- Develop financial literacy programs targeting younger demographics, low-income households, unemployed individuals, and part-time employees.
- Integrate financial education into school curricula and community programs to foster long-term improvements in financial knowledge.

2. Supportive Interventions:

- Provide incentives and support mechanisms to encourage the adoption of energy-efficient appliances among low financial knowledge groups.
- Implement community-based workshops and resources to bridge the financial knowledge gap and promote energy-efficient practices.

3. Customized Feedback and Interventions:

- Utilize big data analytics to design personalized feedback and interventions aimed at improving energy efficiency behaviors.
- Implement peer comparison feedback and other behavioral insights to motivate energy-saving actions among target groups.

Relevant Deliverables and Use Cases

- D4.3 'Updated econometric methodologies and robustness tests'
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Education, Social Protection)
- Local Authorities/Municipalities
- Other Stakeholders: Employment unions, student unions, advocacy groups.

EVIDENT Objectives Alignment

4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT results underscore the importance of addressing financial knowledge disparities to enhance energy efficiency. Targeted educational initiatives and supportive interventions are crucial for empowering low financial knowledge groups to adopt energy-efficient practices and contribute to sustainable energy consumption.

1.3 Bridging the Behavior-Intention Gap: Policy Recommendations from EVIDENT Survey Insights on Environmental Literacy

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings emphasise the distinct contributions of financial and environmental literacy on energy decision-making, with a particular focus on translating positive environmental attitudes into actionable behaviors.

Key Findings

1. Discrepancy in Environmental Literacy:

- Environmental literacy varies significantly across socio-demographic groups.
- High environmental attitudes and awareness are prevalent; however, there is a noticeable gap in environmental action, skills, and knowledge.
- Younger age groups score lower in knowledge, skills, awareness, and action, highlighting a need for targeted support.

2. Behaviour-Intention Gap:

- The survey underscores the behaviour-intention gap, where positive environmental attitudes do not necessarily lead to corresponding actions.
- Policies should aim to bridge this gap by fostering environmental skills and actionable knowledge.

Policy Recommendations

1. Targeted Educational Programs:

- Develop and implement educational programs focusing on environmental skills and actions, particularly for younger demographics.
- Encourage integration of environmental literacy into school curricula and community education programs.

2. Support Mechanisms for Behavioural Change:

- Introduce policies that provide incentives for environmentally friendly behaviors.
- Utilise behavioural insights to design interventions that effectively translate positive intent into action.

3. Tailored Interventions:

- Create demographic-specific interventions to address the unique needs and barriers faced by different socio-demographic groups.
- Leverage big data analytics to customise and optimise these interventions.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Energy retailers, refuse companies (if privatised), and employers.

EVIDENT Objectives Alignment

4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT results highlight critical gaps and opportunities for policy interventions aimed at enhancing environmental literacy and translating positive attitudes into meaningful actions. Tailored educational programs and targeted behavioural interventions are key to bridging the behaviour-intention gap and fostering sustainable energy consumption practices.

1.4 Encouraging Energy Efficiency in Rental Properties: Policy Recommendations from EVIDENT Survey Insights

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings highlight the willingness of landlords to invest in energy-efficient appliances when energy ratings and financial impacts are made salient, contrasting with tenants who are less willing to invest due to security of tenure concerns.

Key Findings

1. Landlord vs. Tenant Investment Willingness:

- Landlords showed an overall willingness to invest in energy-efficient appliances when provided with salient information on energy ratings and financial impacts.
- Tenants, who benefit from lower operational costs, were less willing to invest due to their poor security of tenure and the risk of not realizing financial savings over time.

2. Impact of Annual Operational Costs:

- Willingness to invest increased when annual operational costs were provided.
- As most tenancy agreements are annual, highlighting savings over this relevant time-horizon is beneficial.

3. Choice Architecture for Renters:

- Renters face uncertain long-term impacts of energy investment decisions due to the security of tenure, leading to higher discount rates.
- Choice architecture for renters should increase the salience of shorter cost horizon savings to better support engagement with efficient technologies.

4. Potential for Significant Energy Savings:

- With 30% of the European Union population residing in rented accommodation, appropriately supporting renter engagement in efficient technologies has vast potential for energy savings.

Policy Recommendations

1. Enhanced Information Provision:

- Provide clear and salient information on annual operational costs in rental properties.
- Update rental agreements to include information on potential energy savings and financial impacts of energy-efficient appliances.

2. Targeted Incentives and Support:

- Develop incentive programs for landlords to invest in energy-efficient appliances.

- Offer financial support or rebates for renters to reduce the initial cost burden of energy-efficient investments.

3. Educational Campaigns:

- Implement educational campaigns to inform both landlords and tenants about the benefits of energy-efficient appliances.
- Highlight the long-term financial and environmental benefits to encourage investment.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Mortgage providers, banks, investment companies, residence management companies, and renter associations.

EVIDENT Objectives Alignment

1. Develop a novel framework for assessing behavioral insights in energy efficiency.
4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT data highlights the importance of providing salient financial information to encourage investment in energy-efficient appliances, especially among landlords. Tailored educational initiatives and support programs are essential for promoting energy-efficient choices in rental properties, thereby achieving significant energy savings.

1.5 Enhancing Appliance Purchases with Financial Information: Policy Recommendations from EVIDENT Survey Insights

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings highlight the positive effects of increasing the salience of financial information on the willingness to purchase more efficient home appliances, particularly through the presentation of monthly costs.

Key Findings

1. Impact of Informational Frames:

- All three informational frames (energy rating, annual costs, monthly costs) effectively influenced appliance choices.
- Increasing the salience of financial information was impactful, with monthly cost information having the largest effect.
- This finding contrasts with previous research suggesting longer cost-horizons (e.g., annual costs) are more impactful.

2. Variation in Discounting Rates:

- Shorter durations (e.g., monthly costs) were found to be more impactful for smaller investments like home appliances.
- Longer cost-horizons may be more suitable for larger purchases such as cars and home heating systems.

3. Policy Implications:

- Support the inclusion of monthly operational costs at the point of sale to enhance consumer decision-making.
- Further research is necessary to determine the most effective cost horizon for different types of appliances and investments.

Policy Recommendations

1. Enhance Consumer Information:

- Mandate the display of monthly operational costs on appliance labels and at points of sale.
- Provide clear and concise financial information to help consumers make informed decisions.

2. Research Funding:

- Allocate funds for research to investigate the most effective informational frames and cost horizons for promoting energy-efficient purchases.

- Support studies that explore the behavioral impacts of different financial information presentations.

3. Educational Campaigns:

- Develop campaigns to educate consumers about the importance of considering operational costs when purchasing appliances.
- Highlight the long-term savings and environmental benefits of energy-efficient appliances.

Relevant Deliverables and Use Cases:

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Energy, Education)
- National sustainability semi-state bodies
- Local Authorities/Municipalities
- Other Stakeholders: Appliance manufacturers, appliance retailers, customer associations, and energy retailers.

EVIDENT Objectives Alignment

4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT survey data emphasises the importance of providing clear financial information, particularly monthly costs, to influence consumer decisions towards energy-efficient appliances. Tailored educational initiatives and further research are crucial for enhancing consumer decision-making and promoting sustainable energy consumption.

1.6 Enhancing Financial Literacy to Promote Sustainable Appliance Decisions: Policy Recommendations from EVIDENT Serious Game Insights

Summary

This policy brief outlines the potential policy impacts derived from the EVIDENT serious game. The findings highlight the positive association between financial knowledge and the willingness to pay (WTP) for repairs of appliances, suggesting that financial literacy can encourage more sustainable appliance decisions.

Key Findings

1. Financial Knowledge and Willingness to Pay for Repairs:

- Financial knowledge was positively associated with WTP for repair across all appliances, except washing machines.
- Although the effect was not highly significant, the data indicate that financial knowledge can help people make more sustainable decisions, such as choosing to repair rather than replace appliances.

2. Impact on Sustainable Decisions:

- Unlike pro-environmental attitudes, financial knowledge appears to have a more direct influence on sustainable appliance decisions.
- This finding suggests that enhancing financial literacy could be an effective strategy for promoting sustainable consumption behaviors.

Policy Recommendations

1. Financial Literacy Programs:

- Implement educational programs to improve financial literacy among consumers.
- Focus on practical financial skills that encourage sustainable decisions, such as the benefits of repairing rather than replacing appliances.

2. Incentives for Repair:

- Introduce incentives for repairing appliances, such as subsidies or tax credits for repair services.
- Encourage manufacturers to design products that are easier and more cost-effective to repair.

3. Public Awareness Campaigns:

- Launch campaigns to raise awareness about the environmental and financial benefits of repairing appliances.
- Collaborate with community groups, schools, and universities to spread the message.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Papers published:
 - Exploring the Use of Behavioural Techniques in Serious Games for Energy Efficiency: a Systematic Review and Content Analysis. *Behavior and Social Issues*. 31, 451–479 (2022). <https://doi.org/10.1007/s42822-022-00103-4>
 - Empowering consumers to repair: The utility and acceptability of a serious game to examine decision-making behaviour regarding home appliances in Ireland. *Energy Research & Social Science*. 109, (2024). <https://doi.org/10.1016/j.erss.2024.103428>
 - Reducing e-waste in Europe: Examining the impact of environmental and financial literacy on the premature replacement of appliances across owner-occupier and rental residential properties. *Energy Reports*. 11, 5910-5921 (2024). <https://doi.org/10.1016/j.egy.2024.05.042>
- Use Case 4: Examine the relation of energy consumption behavioral biases with consumers’ financial literacy levels.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Banks, schools, universities, community groups, governments.

EVIDENT Objectives Alignment

1. Develop a novel framework for assessing behavioral insights in energy efficiency.
4. Propose and evaluate specific policy interventions for energy efficiency.

Conclusion

The EVIDENT serious game results highlight the importance of financial knowledge in promoting sustainable appliance decisions. Policies that improve financial literacy and provide incentives for repair can help reduce waste and encourage more sustainable consumption behaviors.

1.7 Highlighting Financial Impacts to Mitigate Present Bias: Policy Recommendations from EVIDENT Survey Insights

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of more than 2000 respondents. The findings highlight the influence of present bias and the salience of financial information on consumer decisions regarding energy-efficient appliances.

Key Findings

1. Impact of Financial Cost Salience:

- Increasing the salience of financial costs for home appliances can draw attention to their limited impact, potentially increasing discount rates.
- Present bias showed mixed effects, with reduced willingness to invest in energy-efficient appliances when presented with energy ratings, but an increased willingness when presented with annual costs.

2. Present Bias and Consumer Choices:

- Individuals with higher present bias tend to choose lower-rated appliances when shown annual operating costs.
- The findings suggest that focusing solely on energy impacts is insufficient; clear financial impacts need to be highlighted to minimize present bias.

3. Recommendations for EU Energy Labels:

- The current EU energy labels, which display energy consumption in kilowatt-hours, may benefit from including clear information on financial impacts over time.
- Such changes could help those prone to higher rates of discounting make better-informed choices.

Policy Recommendations

1. Enhanced Financial Information on Labels:

- Update EU energy labels to include financial information, such as annual and monthly costs, to provide clear and impactful data.
- Ensure this information is presented in a simple and accessible manner to aid consumer decision-making.

2. Consumer Education Programs:

- Develop educational initiatives to inform consumers about the financial and environmental benefits of energy-efficient appliances.

- Target these programs towards individuals with a higher present bias to reduce discount rates and encourage energy-efficient choices.

3. Research and Development:

- Allocate funding for research on the most effective ways to present financial information on energy labels.
- Investigate the behavioral impacts of different informational frames on consumer decisions.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Governments
- Other Stakeholders: Appliance manufacturers, appliance retailers, customer associations.

EVIDENT Objectives Alignment

1. Develop a novel framework for assessing behavioral insights in energy efficiency.
4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT findings underscore the importance of presenting clear financial information to consumers to mitigate present bias and promote energy-efficient appliance choices. Enhanced labeling and targeted educational programs are crucial for informed consumer decision-making and sustainable energy consumption.

1.8 Mitigating Rebound Effects through Enhanced Environmental Literacy: Policy Recommendations from EVIDENT Survey Insights

Summary:

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings highlight high direct rebound rates and the importance of enhancing environmental literacy to mitigate these effects.

Key Findings

1. High Direct Rebound Rates:

- Almost one in ten participants reported an intention to shift from the most to the least efficient settings.
- This suggests that the potential energy and financial benefits of choosing more efficient appliances may not be fully realised.

2. Impact of Low Energy Awareness:

- The low energy awareness of the sample may have influenced the high rebound rates.
- Participants might be unaware of the impacts of their usage on energy consumption.

3. Role of Environmental Literacy:

- Environmental literacy was found to predict rebound rates.
- Enhancing environmental literacy could be beneficial in addressing high rebound rates.

Policy Recommendations

1. Educational Initiatives:

- Develop and implement educational programs focused on improving environmental literacy.
- Target these programs towards consumers to increase awareness of energy consumption impacts and the benefits of efficient appliance use.

2. Information Campaigns:

- Launch information campaigns to highlight the importance of maintaining energy-efficient settings on appliances.
- Provide clear and accessible information on how different usage settings impact energy consumption and costs.

3. Behavioral Interventions Research:

- Design and test behavioral interventions aimed at reducing rebound rates.
- Utilise insights from behavioral economics to create nudges that encourage the use of energy-efficient settings.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Banks, schools, universities.

EVIDENT Objectives Alignment

4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT results highlight the critical need to address high direct rebound rates through enhanced environmental literacy and targeted behavioral interventions. Educational initiatives and information campaigns are essential to ensure that consumers understand the full impact of their energy usage and maintain efficient appliance settings.

1.9 Tailoring Environmental Skills for Informed Choices: Policy Recommendations from EVIDENT Survey Insights

Summary

This policy brief outlines the potential policy impacts derived from an EVIDENT survey of 2000+ respondents. The findings emphasise the need for individualised environmental skills to support consumers in evaluating choice information, particularly based on age demographics.

Key Findings

1. Impact of Age on Energy and Financial Informational Frames:

- Age significantly influences how consumers respond to energy and financial informational frames.
- Those over 41 are more likely to switch to efficient appliances when shown energy ratings.
- Consumers aged 30-40 and over 51 are more likely to switch when shown annual costs.
- Consumers aged 51-60 are less likely to choose efficient appliances when shown monthly costs compared to other groups.

2. Need for Individualised Strategies:

- The discrepancies between younger and older cohorts suggest the need for tailored strategies.
- Specific efforts are needed to leverage opportunities for those under 40, who are often at a pivotal time for energy investment when purchasing their first home.

3. Environmental Literacy and Appliance Choices:

- Higher environmental skills predict the selection of less efficient appliances when shown both energy ratings and annual costs.
- This indicates that environmental literacy alone may not lead to the expected energy-efficient choices.

Policy Recommendations

1. Tailored Educational Programs:

- Develop individualised educational programs to enhance environmental skills tailored to different age groups.
- Focus on specific demographics, such as those under 40, to promote energy-efficient investments during significant life stages.

2. Information Presentation Strategies:

- Customise informational frames based on age demographics to maximise their impact.
- Consider the effectiveness of different cost-horizons (monthly vs. annual) for various age groups to improve decision-making.

3. Incentivise Environmental Skills Development:

- Provide incentives for improving environmental skills through community programs and workshops.
- Partner with mortgage providers, banks, and employers to integrate environmental literacy initiatives.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Paper submitted to Journal of Environmental Psychology: "Analysing the impact of Financial and Environmental Literacy on Energy Appliance Purchases"
- Use Case 5: Exploit energy demand curves for improved policy design.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Mortgage providers, banks, and employers.

EVIDENT Objectives Alignment:

1. Develop a novel framework for assessing behavioral insights in energy efficiency.
2. Create a platform to raise energy efficiency awareness and support better decision-making.
4. Propose and evaluate specific policy interventions for energy efficiency.
5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT results highlight the importance of individualised strategies to enhance environmental skills and support informed consumer decision-making. Tailored educational initiatives and customised informational frames are essential for promoting energy-efficient choices across different age demographics.

1.10 Tailoring Financial Education to Influence Sustainable Appliance Choices: Policy Recommendations from EVIDENT Serious Game Insights

Summary

This policy brief outlines the potential policy impacts derived from the EVIDENT serious game. The findings highlight the decision-making patterns of different demographic groups when choosing to repair or replace broken appliances, emphasising the need for tailored financial knowledge to influence more sustainable choices.

Key Findings

1. Decision Patterns in Appliance Replacement:

- Most participants elected to replace the appliance with a more efficient A-rated appliance (53.5%; n=480) or repair their appliance (41.4%; n=371).
- However, those aged 41-50 or 65+ were significantly more likely to select a less efficient replacement.
- Homeowners who were also landlords or tenants, as well as those in part-time work, job-seeking, and unemployed, also tended to choose less efficient replacements.

2. Need for Tailored Financial Knowledge:

- Individuals in part-time work, job-seeking, or unemployed could benefit from tailored knowledge about the financial impacts of their behavior.
- Providing targeted financial education could leverage change towards more efficient appliance choices.

Policy Recommendations

1. Targeted Financial Education:

- Develop educational programs specifically aimed at part-time workers, job-seekers, and the unemployed.
- Focus on the financial benefits of choosing more efficient appliances and the long-term cost savings.

2. Incentives for Efficient Choices:

- Introduce incentives for choosing more efficient appliances, such as subsidies, rebates, or tax credits.
- Encourage landlords to invest in energy-efficient appliances for their rental properties.

3. Public Awareness Campaigns:

- Launch campaigns to raise awareness about the environmental and financial benefits of energy-efficient appliances.

- Collaborate with local authorities, unemployment agencies, and employers to reach target demographics.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Papers published:
 - Exploring the Use of Behavioural Techniques in Serious Games for Energy Efficiency: a Systematic Review and Content Analysis. *Behavior and Social Issues*. 31, 451–479 (2022). <https://doi.org/10.1007/s42822-022-00103-4>
 - Empowering consumers to repair: The utility and acceptability of a serious game to examine decision-making behaviour regarding home appliances in Ireland. *Energy Research & Social Science*. 109, (2024). <https://doi.org/10.1016/j.erss.2024.103428>
 - Reducing e-waste in Europe: Examining the impact of environmental and financial literacy on the premature replacement of appliances across owner-occupier and rental residential properties. *Energy Reports*. 11, 5910-5921 (2024). <https://doi.org/10.1016/j.egyr.2024.05.042>
- Use Case 4: Examine the relation of energy consumption behavioral biases with consumers’ financial literacy levels.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Banks, schools, universities, local authorities, unemployment agencies, employers.

EVIDENT Objectives Alignment

4. Propose and evaluate specific policy interventions for energy efficiency.

Conclusion

The EVIDENT serious game highlights the importance of providing tailored financial knowledge to influence sustainable appliance decisions. Policies that improve financial literacy and offer incentives for efficient choices can help reduce energy consumption and promote sustainability.

1.11 Turning Attitudes into Actions: Practical Policy Recommendations from EVIDENT Serious Game Insights

Summary

This policy brief outlines the potential policy impacts derived from the EVIDENT serious game. The findings highlight that pro-environmental attitudes alone are insufficient to motivate change, emphasising the need for policies that focus on actual pro-environmental behaviors rather than attitudes in isolation.

Key Findings

1. Pro-Environmental Attitudes vs. Behaviors:

- The serious game results indicate that pro-environmental attitudes alone do not significantly motivate behavioral change.
- This supports the literature on the behavior-attitude gap, demonstrating the limited efficacy of increasing environmental attitudes to influence actual behaviors.

2. Variation Across Appliances:

- The data showed some variation across appliances, with ovens being an exception where attitudes had a different impact on behavior.

3. Policy Focus:

- Policies should prioritise promoting actual pro-environmental behaviors rather than solely focusing on increasing pro-environmental attitudes.

Policy Recommendations

1. Behavioral Interventions:

- Develop and implement behavioral interventions that directly encourage pro-environmental actions.
- Utilise techniques from behavioral economics, such as nudges and incentives, to promote sustainable behaviors.

2. Education and Awareness Programs:

- Create educational programs that go beyond raising awareness and focus on practical actions that individuals can take to reduce their environmental impact.
- Partner with schools and universities to integrate these programs into curricula.

3. Feedback Mechanisms:

- Provide consumers with regular feedback on their energy consumption to encourage more efficient use of appliances.
- Implement peer comparison feedback to leverage social norms and motivate behavioral change.

Relevant Deliverables and Use Cases

- D4.3 “Updated econometric methodologies and robustness tests”
- Papers published:
 - Exploring the Use of Behavioural Techniques in Serious Games for Energy Efficiency: a Systematic Review and Content Analysis. *Behavior and Social Issues*. 31, 451–479 (2022). <https://doi.org/10.1007/s42822-022-00103-4>
 - Empowering consumers to repair: The utility and acceptability of a serious game to examine decision-making behaviour regarding home appliances in Ireland. *Energy Research & Social Science*. 109, (2024). <https://doi.org/10.1016/j.erss.2024.103428>
 - Reducing e-waste in Europe: Examining the impact of environmental and financial literacy on the premature replacement of appliances across owner-occupier and rental residential properties. *Energy Reports*. 11, 5910-5921 (2024). <https://doi.org/10.1016/j.egy.2024.05.042>
- Use Case 4: Examine the relation of energy consumption behavioral biases with consumers’ financial literacy levels.

Policy Maker/Stakeholder Levels

- Commission DG
- National Ministries (Housing, Education)
- Local Authorities/Municipalities
- Other Stakeholders: Schools, universities.

EVIDENT Objectives Alignment

5. Communicate innovative results to industry, citizens, energy communities, and policy actors.

Conclusion

The EVIDENT results from the serious game highlight the importance of focusing on actual pro-environmental behaviors rather than attitudes alone. Behavioral interventions, education, and feedback mechanisms are essential to effectively promote sustainable actions and close the behavior-attitude gap.

1.12 Understanding Consumer Misperceptions and Suboptimal Electricity Contract Choices

Summary

This policy brief explores consumer behavior in electricity contract selection, specifically examining data from a Greek utility. The number of consumers involved in this analysis is approximately 22,000. The analysis reveals that consumers frequently choose suboptimal contracts, increasing costs and decreasing loyalty. Additionally, consumer inertia exacerbates the issue, as most customers stick with their initial contract despite better alternatives. These findings align with patterns observed in other markets and suggest a need for policies that encourage informed and efficient decision-making among consumers.

Key Findings

1. Suboptimal Contract Choices:

- **Prevalence:** Approximately 70% of consumers fail to sign an optimal contract based on their past electricity consumption experience. This is consistent with findings from Hortaçsu et al. (2017) and Ito et al. (2017), who highlight consumers' difficulty choosing cost-effective electricity tariffs.
- **Impact:** Consumers frequently overestimate or underestimate their future electricity consumption, leading to higher costs. For instance, those on Tier-1 contracts pay 17.06% more per kWh on average than those on a regular tariff contract.

2. Consumer Inertia:

- **Extent:** About 93% of consumers on suboptimal contracts do not switch despite the quick and cost-free process. This inertia is mirrored in other sectors, such as health insurance (Handel, 2013) and retirement investments (Madrian & Shea, 2001).
- **Switching Costs:** Even minimal switching costs or the hassle of changing contracts deter consumers from optimizing their choices (Ito et al., 2017; Dressler & Weiergraeber, 2023).

3. Loyalty and Contract Duration:

- **Loyalty:** Customers on suboptimal contracts exhibit lower loyalty, often switching providers more frequently. This effect is pronounced among those whose consumption exceeds their contracted kWh limits.
- **Duration:** Tier-type contracts have shorter durations (516-532 days) than regular tariff contracts (734 days), suggesting that higher costs lead to reduced contract adherence.

4. Fixed Consumption vs. Regular Tariff Contracts:

- **Cost-Effectiveness:** The regular tariff contract is the most cost-effective for low annual consumption (<2,500kWh).
- **Consumption Asymmetry:** Significant asymmetry in cost-effectiveness around consumption limits contributes to suboptimal choices, as customers misestimate their future consumption.

Policy Implications

1. Enhancing Consumer Awareness

- **Information Provision:**
 - **Transparent Billing:** Require utilities to provide detailed and clear breakdowns of electricity consumption and bill costs, highlighting potential savings from alternative contracts.
 - **Comparative Tools:** Develop and mandate online tools that allow consumers to compare different electricity plans based on their past consumption patterns. These tools should be easy to use and accessible.
 - **Educational Materials:** Distribute educational materials that explain how different contracts work, the factors affecting electricity costs, and the benefits of choosing an optimal contract.
- **Education Campaigns:**
 - **Public Outreach:** Launch nationwide campaigns to educate consumers about the importance of selecting the right electricity contract. Utilize multiple channels, including social media, traditional media, and community events.
 - **Workshops and Seminars:** Organize workshops and seminars in collaboration with consumer protection agencies and local governments to teach consumers how to assess their energy needs and make informed decisions.

2. Reducing Consumer Inertia

- **Simplified Switching:**
 - **Streamlined Processes:** Simplify the process for switching contracts by reducing paperwork and providing clear, step-by-step instructions. Ensure that the switching process can be completed online.
 - **Automated Switching:** Implement systems that automatically switch consumers to the most cost-effective contract based on their consumption history, with an option to opt out if they prefer to stay with their current plan.
- **Incentives for Switching:**
 - **Financial Incentives:** Offer financial incentives to consumers who switch to a more suitable contract, such as discounts or rebates.
 - **Loyalty Rewards:** Introduce loyalty programs that reward consumers for periodically reviewing and optimizing their electricity contracts.

3. Behavioral Interventions

Default Options:

- **Smart Defaults:** Design default contract options that are likely optimal for most consumers, leveraging data on average consumption patterns. For instance, new

customers could be automatically enrolled in the contract that offers the best value based on typical consumption levels, with the option to switch if needed.

4. Nudges

- a. **Reminders:** Send periodic reminders to consumers encouraging them to review their contract and consider switching if they can find a better deal. Use email, SMS, and app notifications to deliver these reminders.
- b. **Simplified Comparison Reports:** Provide consumers with personalized comparison reports that show how their current contract compares to other available options in terms of cost and benefits.
- c. **Trial Periods:** Offer trial periods for different contracts, allowing consumers to test a new plan with the option to revert to their original plan if unsatisfied.

5. Regular Reviews of Contract Offerings

Utility Practices:

- **Contract Reviews:** Require utilities to regularly review and adjust their contract offerings to reflect changes in consumption patterns, market prices, and consumer feedback.
- **Consumer Feedback:** Encourage utilities to solicit and incorporate consumer feedback into their contract design and customer service practices.

6. Personalized Recommendations

Advanced Analytics:

- **Data Utilization:** Advanced data analytics will provide personalized contract recommendations based on individual consumption histories and projected future usage. This can help consumers make more informed choices.
- **Customer Portals:** Develop customer portals that offer personalized insights and suggestions, making it easy for consumers to understand their options and the potential benefits of switching contracts.

7. Regulatory Oversight

Transparency and Fairness:

- **Regulatory Frameworks:** Strengthen regulatory frameworks to ensure transparency and fairness in electricity contract terms. Regulators should monitor utilities to ensure they comply with best practices in customer communication and contract design.
- **Consumer Protection:** Enhance consumer protection laws to safeguard against misleading marketing practices and ensure consumers have access to clear and accurate information about their electricity options.

Implementation Strategy

To effectively implement these policy implications, a coordinated approach involving multiple stakeholders is essential:

- **Government and Regulators:** Lead the development of regulations and frameworks, ensuring compliance and enforcement. Provide funding and support for educational campaigns and comparative tools.
- **Utilities:** Collaborate with regulators to simplify contract offerings, enhance transparency, and implement automated switching systems. Engage with consumers to gather feedback and improve service delivery.
- **Consumer Advocacy Groups:** Advocate for consumer rights, participate in educational campaigns, and aid consumers navigating their contract options.
- **Technology Providers:** Develop and maintain online tools and platforms for contract comparison and personalized recommendations. Ensure these tools are user-friendly and accessible to a broad audience.

Conclusion

Consumers frequently underestimate their electricity usage and make less-than-ideal contract choices, resulting in higher costs and diminished contract loyalty. Dealing with these challenges necessitates a comprehensive strategy encompassing improved information dissemination, incentives for optimal contract selection, and behavioral interventions. By implementing these measures, policymakers can empower consumers to make better-informed decisions, ultimately boosting energy efficiency and cutting costs universally.

Related literature

1. Dressler, L. and Weiergraeber, S., (2023). Alert the inert? Switching costs and limited awareness in retail electricity markets. *American Economic Journal: Microeconomics*, 15(1), pp.74-116.
2. Handel, B. R., (2013). Adverse selection and inertia in health insurance markets: When nudging hurts. *American Economic Review*, 103(7), 2643-2682.
3. Hortaçsu, Ali, Seyed Ali Madanizadeh, and Steven L. Puller, (2017). "Power to Choose? An Analysis of Consumer Inertia in the Residential Electricity Market." *American Economic Journal: Economic Policy*, 9 (4): 192-226.
4. Ito, K., Ida, T., & Tanaka, M., (2017). Information Frictions, Inertia, and Selection on Elasticity: A Field Experiment on Electricity Tariff Choice. Working Paper.
5. Madrian, B. C., & Shea, D. F., (2001). The power of suggestion: Inertia in 401 (k) participation and savings behavior. *The Quarterly journal of economics*, 116(4), 1149–1187.

1.13 Enhancing Energy Efficiency Through Advanced Forecasting Models

Summary

Energy consumption and production forecasting tools are essential for energy metering and billing systems. They are crucial in promoting energy efficiency, conservation, and sustainable energy management for customers and energy providers. Furthermore, advanced predictive models and data-driven insights empower policymakers to proactively address energy demands, optimize resource allocation, and promote the development of a more resilient and efficient energy infrastructure.

This brief examines the role of advanced forecasting models, particularly Artificial Neural Networks (ANNs) and Long Short-Term Memory (LSTM) models, in predicting energy consumption and production. Utilising data from customers with photovoltaic (PV) systems, these models demonstrate superior accuracy compared to traditional methods, offering valuable insights for energy efficiency, conservation, and sustainable energy management.

Key Findings

1. Diverse Methodologies for Energy Forecasting

- **Engineering Models:** Based on physics and thermodynamics, these models provide precise descriptions of building components and occupant behavior but require extensive data and incur high operational costs.
- **Statistical Regression:** These methods correlate energy consumption with historical parameters and occupant behavior, enhancing accuracy while offering flexibility.
- **Artificial Intelligence (AI):** ANNs, especially LSTM models, excel in non-linear settings, providing accurate predictions for heating/cooling loads, electricity consumption, and component optimization.

2. Data Utilization

- The study analyzed data from January 2017 to November 2022 for 300 customers with installed PV systems.
- The dataset included daily records of energy consumption, grid electricity purchases, unused energy sold to the grid, and PV energy production, supplemented with demographic data and weather conditions.

3. Performance of Forecasting Models

- LSTM models outperformed other models in terms of out-sample forecasting error, capturing data complexity and patterns effectively.
- For energy consumption forecasting, the best LSTM model presented around 14% deviation from the mean value.
- The best LSTM model showed around 29% deviation from the mean value for energy production forecasting.

Policy Implications

1. **Energy Efficiency and Conservation:** Advanced forecasting tools are crucial for energy metering and billing systems, aiding customers and energy providers in achieving energy efficiency and conservation goals.
2. **Resource Allocation and Sustainable Management:** Accurate predictive models enable policymakers to proactively address energy demands, optimize resource allocation, and foster a resilient and efficient energy infrastructure.
3. **Financial Incentives and Support:** Policymakers should consider providing financial incentives for adopting advanced forecasting tools and supporting AI and machine learning research to enhance energy prediction capabilities.

Recommendations

1. **Adopt Advanced Forecasting Models:** Encourage the integration of AI-based models, particularly LSTM models, in energy management systems to improve accuracy in predicting energy consumption and production.
2. **Promote Data Collection and Sharing:** Facilitate comprehensive data collection, including demographic and weather data, and promote data sharing among stakeholders to enhance the performance of predictive models.
3. **Invest in Smart Technologies:** Support investment in smart technologies and infrastructure to enable real-time monitoring and management of energy consumption and production. This will increase data availability and quality, contributing to more accurate forecasting outputs.
4. **Educate Stakeholders:** To promote widespread adoption, provide training and resources for energy providers and consumers on the benefits and usage of advanced forecasting tools.

Conclusion

Utilizing advanced forecasting models, particularly AI-based methods like LSTM, presents a substantial opportunity to enhance energy efficiency and sustainability. By harnessing comprehensive data and state-of-the-art technologies, stakeholders can streamline energy usage, reduce CO₂ emissions, and play a pivotal role in forging a more sustainable future. To realize these objectives, it will be crucial to incorporate these models and advocate for policies that promote their widespread adoption.

1.14 Impact of Financial and Environmental Literacy on Consumer Energy Pricing Responses

Summary

Household energy billing often utilizes nonlinear pricing schedules to encourage consumers to consume less energy. However, consumer behavior doesn't always align with traditional economic predictions due to psychological and behavioral biases, leading to potential welfare loss. This study investigates the impact of financial and environmental literacy on consumers' reactions to energy pricing.

Key Points

1. *Nonlinear Pricing Challenges:*

- **Rational Behavior Assumptions:** Traditional economic theory assumes that consumers act rationally based on perfect information. However, consumers often exhibit behavioral biases.
- **Behavioral Biases:** Biases such as loss aversion, overconfidence, present bias, and price misperception can lead to suboptimal responses to energy pricing and result in welfare loss.

2. *Consumer Response to Pricing:*

- **Complex Pricing Structures:** Consumers often struggle to understand complex nonlinear pricing structures, leading to average price bias, where they focus on average rather than marginal prices.
- **Usage Sensitivity:** High-usage consumers are more responsive to average prices, while low-usage consumers are more sensitive to marginal prices.

3. *Empirical Evidence:*

- **Response Patterns:** Empirical studies indicate that consumers frequently respond to average prices rather than marginal prices, even in controlled experimental settings.
- **Literacy Influence:** Financial and environmental literacy significantly influence consumers' ability to choose cost-effective energy tariffs under nonlinear pricing schedules.

Findings from the Study

1. *Financial and Environmental Literacy:*

- **Correlated Literacies:** Financially literate individuals often exhibit greater environmental literacy.
- **Optimal Choices:** Those with higher financial and environmental literacy levels are more likely to choose optimal energy tariffs.

2. *Average Price Bias:*

- **Literacy Rates:** 70.9% of highly financially literate respondents are also highly environmentally literate.
- **Tariff Selection:** Financially literate individuals (69.8%) and environmentally literate individuals (60.3%) are likelier to choose the most efficient electricity tariffs.

3. Data Insights:

- Participant Demographics: The study involved 1,313 participants from 40 countries, focusing on Greece, Ireland, the USA, and the UK. Most participants were 25-34, with significant representation from low-income households and renters.

4. Experiment and Results:

- Hypothetical Scenarios: Participants were given scenarios to choose the most cost-effective energy tariff based on their annual consumption.
- Literacy Impact: Correct answers increased with financial and environmental literacy, especially as the price difference between average and marginal prices widened.
- Demographic Trends: Older individuals and those with higher incomes showed higher environmental literacy scores.

Recommendations

1. Enhance Literacy Programs:

- Educational Programs: Develop and promote programs to improve financial and environmental literacy among consumers.
- Targeted Outreach: To bridge literacy gaps, focus on young adults, low-income households, and renters.

2. Simplify Pricing Structures:

- Simplified Pricing: Simplify nonlinear pricing schedules to make them more understandable for consumers.
- Clear Information: Provide accessible information about how pricing works and the benefits of optimal energy usage.

3. Behavioral Interventions:

- Nudges: Implement behavioral nudges and information campaigns to address average price bias and misperception of marginal prices.
- Interactive Education: Use tools like serious games and interactive platforms to educate consumers on effective energy consumption strategies.

4. Policy Development:

- Behavioral Consideration: Design pricing policies considering consumer behavior and biases to promote sustainable and efficient energy use.
- Collaborative Efforts: Encourage collaboration between policymakers, energy providers, and educational institutions to support comprehensive literacy initiatives.

5. Incentives for Participation:

- Consumer Incentives: Offer incentives such as vouchers or discounts to encourage participation in literacy programs and energy-saving initiatives.

Conclusion

Improving financial and environmental literacy is crucial for enabling consumers to make optimal choices in energy consumption under nonlinear pricing schedules. By addressing behavioural biases and simplifying pricing structures, policymakers can enhance energy efficiency, reduce consumption, and contribute to sustainability goals. These efforts can bring significant economic and environmental benefits, ultimately contributing to a more informed and responsible consumer base.

1.15 Main Constitutive Elements of an Effective Home Energy Report

Summary

The EVIDENT Use Cases conducted in Greece examined the impact of Home Energy Reports (HERs) on residential energy consumption. The study revealed a 6.9% decrease in electricity usage among households receiving electronic HERs reinforcing their importance in promoting energy efficiency.

Bare minimum information for an effective HER

1. Current energy consumption metering

- **Historic data:** the information needs to be presented in a clear and concise manner (e.g., bar chart).
- **Energy saving tips:** the most salient part of a HER. Even though our HERs provided users with different types of feedback, tips proved to be the most effective across age groups and household sizes. Effective tips need to be short, clear, concise, actionable and illustrate the benefit for the user, such as:

Washing at 30 ° C uses about 40% less energy than washing at a higher temperature.

- 2. **Disaggregated consumption:** The information needs to be clearly illustrated (e.g., pie chart). The effects of disaggregated consumption information are amplified when combined with energy-saving targets.
- 3. **Peer comparison:** A clear and easy-to-grasp representation of what the user's current consumption is and how it relates to that of their neighbours. Even though other studies, as well as the EVIDENT Use Cases run in Sweden, attest to the importance of peer comparison, in the Greek Use Case its impact is yet to be determined.
- 4. **Financial information on energy investments required:** Information about the cost and benefits of replacing appliances or upgrading infrastructure. Information includes yearly savings in KWh, EUR, and kgs of CO₂, alongside the expected payback period.

Recommendations

- 1. **Expand the use of HERs to all consumers:**
 - Sponsor campaigns to incentivize consumers to use online energy monitoring tools (e.g., financial incentives for reducing energy consumption)
 - Incorporate the main constitutive elements of an effective HER (consumption history & energy saving tips) in monthly print bills to reach residential users with limited connectivity or digital literacy.
- 2. **Implement real-time HERs** leveraging smart metering infrastructure to allow users real-time information on their energy consumption and behavior.
- 3. **Integrate more interactive elements in online HERs to boost engagement and produce personalised HERs.** Integrating gamification approaches, online competitions, or other

simulations will allow users to experiment with different energy usage scenarios (e.g., replacement of a device, change in usage frequency) and provide the utility suppliers with invaluable data on their customers' energy behavior fostering production of more personalised HERs

4. Use HERs as a tool to promote environmental and financial literacy:

- Provide easy-to-understand information for the return of investment (ROI) and payback time on energy upgrades and investments.
- Use targeted tips to promote environmental literacy.
- Train users on how to read and use a HER through education initiatives (e.g., phone energy consultations for elderly consumers, and training modules within the energy management platform).

Conclusion

As the energy landscape changes, utility providers need to embrace their expanded role as energy consultants, helping their customers navigate the areas of home sustainability, energy saving, and energy management. To this end, HERs are invaluable tools. Efficient reports at their bare minimum should combine basic energy metrics (consumption and consumption history) with actionable energy saving tips. IT technologies allow for more elaborate online HERs that can incorporate various add-ons, such as financial information on energy investments or gamification approaches. To enhance the effectiveness of HERs, policymakers should focus on expanding their accessibility to all residential users, promoting education initiatives to support users in reading and understanding their HER, and increasing user engagement.

1.16 Availability of Open-Access Energy-Related Data

Summary

The availability of energy-related data has a critical impact on the energy sector, as it can enhance decision-making, leading to increased energy efficiency. Analyzing energy-related data can equip researchers and stakeholders with the necessary insights into energy consumption patterns. Nevertheless, several challenges need to be addressed, including privacy concerns and obsolete or incomplete data.

Key Challenges

The following challenges arose concerning the availability of open data:

1. **Incomplete demographic, social, and economic data:** The consortium attempted to collect demographic, social, or economic data through questionnaires or online platforms. Nevertheless, users' participation in such questionnaires of their own volition led to inconsistent completion rates, rendering the link between these two sets of data (energy usage and demographic and socio-economic) a difficult task.
2. **Obsolete demographic, social, and economic data:** The users were required to update their demographic, social, and economic data. Very few users, however, updated their data at all, making it challenging for the consortium to determine which demographic and socio-economic data was valid for a user throughout the experiment.
3. **Few energy consumption data points:** In the Greek experiment, the delay in the rollout of the installation of smart meters in residential consumers has limited the amount of data points available with regard to energy consumption measurements. In addition, up until very recently, electricity meters in Greece were read three times a year. This resulted in a dearth of data points, that posed a challenge to the consortium.

Recommendations and Insights

In view of the aforementioned challenges, the following relevant recommendations and insights are outlined:

1. **Promote data interconnectivity and interoperability in a GDPR-compliant manner:** Establishing a framework for GDPR-compliant demographic and socio-economic data from third parties is essential for minimising the user's effort and ensuring that data stays updated. Government initiatives such as "Know Your Customer", which runs currently in the banking sector in Greece and where, with the explicit consent of the customer, a bank may have access to said customer's choice of demographic and economic data may be worthy of further exploration.
2. **Educational Initiatives for Residential Customers:** some residential users may be reluctant to share their demographic or financial data with their utility providers. Hence, initiatives and campaigns that communicate transparently to citizens how their data is being and educate them on the importance of said data for generating efficient interventions are necessary. Through information

campaigns and educational initiatives, customers will better understand the value generated for themselves in sharing their demographic data with their energy utility providers and keeping this data updated.

3. Financial initiatives for installing smart meters in regions where coverage is still low: demographic and financial data aside, a wealth of energy consumption data points is important for better understanding the current and forecasting the future consumption patterns of residential consumers. Informing residential users on the benefits of smart meters, while simultaneously instituting financial incentives for installing them, is expected to speed up the installation of smart meters in residential consumers.

2. Future Research Ideas

The following subsections outline some potential avenues for further exploration, delving into critical energy transition and climate change adaptation. These research topics offer interdisciplinary opportunities, integrating insights from behavioural science, economics, energy systems engineering, computer science, environmental psychology, and public policy.

2.1 Nudging Prosumers for Coordinating Energy Contributions

- **Behavioral Experiments:** Conduct controlled experiments to understand how behavioral nudges influence prosumers' willingness to participate in energy flexibility services. For example, one experiment could offer financial incentives to households that adjust their energy consumption patterns during peak demand hours, while another could test the effectiveness of social norm messaging in encouraging prosumer cooperation.
- **Smart Technology Integration:** Investigate the integration of smart home technologies, such as smart meters, energy management systems, and home automation devices, to facilitate energy sharing among consumers. This could involve developing simulation models to optimize energy distribution within a local energy community based on real-time energy generation, consumption, and grid demand data.
- **Regulatory and Market Analysis:** Analyze existing regulatory frameworks and market structures to identify barriers and enablers for prosumer participation in energy markets. This could involve assessing the impact of regulatory incentives, grid tariffs, and market mechanisms (such as peer-to-peer energy trading platforms) on prosumer engagement and the scalability of energy flexibility services.

2.2 Impact of Climate Change on Consumer Behavior

- **Longitudinal Studies:** Conduct longitudinal studies to track changes in consumer attitudes, preferences, and behaviors in response to climate-induced reliability issues in the energy sector. This could involve surveying households regularly to measure shifts in perceptions of energy reliability, willingness to invest in renewable energy technologies, and support for climate mitigation policies.
- **Communication Strategies:** Explore the effectiveness of different communication strategies in shaping consumer perceptions of climate-related risks and reliability concerns in electricity supply. This could involve conducting focus groups or online surveys to assess the impact of informational campaigns, risk communication messages, and public outreach initiatives on consumer awareness and preparedness.
- **Socioeconomic Analysis:** Investigate the interaction between socioeconomic factors, geographic location, and consumer vulnerability to climate-induced energy disruptions. This could involve analysing demographic data, income levels, housing characteristics, and access to energy

infrastructure to identify vulnerable populations and design targeted interventions to enhance resilience and adaptive capacity.

2.3 Serious Games

There are many options for expanding EVIDENT's Serious Game by adding more games and scenarios to the platform. The EVIDENT Serious Game was created so that the advice provided to the player could be altered. For example, based on the same design, a serious game with advice on better energy management can be developed using the same devices. This advice can include not using the washing machine during the day and only at night, turning off the heat at night, etc.

Furthermore, leveraging the EVIDENT platform, users can design and upload a variety of serious games and scenarios. Such games involve scenarios for fire protection in the home, with devices that can cause fires and the actions the user can take to prevent them, serious games with real-time data from a smart house, and serious games about new parents and how to create a home that is suitable for children, with child protection in the sockets, locked kitchen cabinets, and other things parents must consider when designing a house for a child.