Schweizerische Eidgenossenschaft
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Federal Department of the Environment, Transport, Energy and Communications DETEC

Swiss Federal Office of Energy SFOE
Energy Research and Cleantech

SWEET Call 1-2021: LANTERN

Deliverable report

Deliverable n°	7.2, v.1
Deliverable name	Inventory and Characterisation of Replicable Solutions
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Delivery date	30/09/2024

Table of contents

Summary **2**
1 Introduction and context **3**
2 Deliverable content **4**
2.1 Data Organisation 4
2.2 Data 4
3 Thoughts and Conclusion **9**
4 References **12**

sweet swiss energy research for the energy transition

Summary

This document presents the deliverable D7.2 for Project Lantern, which focuses on developing and structuring an inventory of replicable solutions for addressing sustainability, efficiency, and energy management in the scope of buildings. In total, over 80 solutions were identified, categorized and listed. The inventory explores the technical merits of each solution and asses their applicability across various building types and scales. This report concludes by exploring a range of potential domains of application of the inventory, always focussing at improving the environmental or technical performance of a building or system.

1 Introduction and context

The global energy transition towards sustainable production, transformation and use has placed increasing pressure on the housing sector to adopt innovative strategies that reduce energy consumption, minimize carbon footprints, and enhance the overall efficiency of building systems. This report presents a comprehensive inventory of replicable solutions designed to address these challenges. It offers a robust foundation for professionals across multiple sectors – engineering, architecture, energy management, and beyond – to implement practical, cost-effective, scalable, and adaptable energy sustainable practices.

In line with the scope of WP7 Affordable Energy Efficient Buildings, the solutions outlined in this report focus on improving building performance through both cost-effective technical and behavioural interventions. They range from straightforward actions like user education to more complex solutions such as advanced insulation techniques and high-efficiency window replacements. By systematically categorizing these solutions by their technical complexity, potential impact, and scalability, this report provides valuable insights for those engaged in designing, retrofitting, or managing energy-efficient buildings.

Based on a wide range of academic and industry sources, the inventory in this report aims to serve as both a reference and a guide for building development with affordability and efficiency in mind. It is tailored to the needs of professionals and researchers involved in energy management, green building design, and urban planning, while also providing educators with real-world examples for fostering the next generation of sustainability experts.

The inventory explores the technical merits of each solution and asses their applicability across various building types and scales. In the conclusions, the domains of applicability are discussed. Whether it is in research, policy formulation, or on-the-ground implementation, these solutions offer practical pathways towards affordable energy efficient buildings.

2 Deliverable content

2.1 Data Organisation

Replicable solutions addressing building efficiency have been obtained from different sources and structured in an inventory of a tabular organized as follows:

1. **Category:** category of solutions (i.e. behaviour, building envelope, building interior…);
2. **Solution name:** name of solution (i.e. user education, insulation, window replacement);
3. **Technicity:** integer numeric binary value indicating the technicity or non-technicity of each solution:
    a. 0 for non-technical;
    b. 1 and technical;
4. **Scale:** integer numeric value indicating the scalability of the solution:
    a. 0 for any scale (i.e. any number of buildings);
    b. 1 to a single building strictly;
    c. 10 to neighbourhoods strictly;
    d. 100 to cities strictly;
    e. 1000 to countries strictly;
5. **Type:** integer numeric classification of the solution by type:
    a. 1 for sharing opportunities;
    b. 2 for low-tech measures;
    c. 3 for high-tech measures;
6. **Comments:** explanatory text providing context or additional information about the solution, such as potential benefits or implementation considerations;
7. **Source:** references of the solution source.

2.2 Data

	Solution	***Technical* Scale**		**Type**	**Comment**	**Source**
Behaviour	*User education*	0	0	2	Users can be educated to a better use of energy.	
Building envelope	*Window replacement*	1	0	3		[1, 2, 3]
	Insulation of facade	1	0	3		[1, 2, 3]
	Insulation of floor	1	0	3		[1, 2, 3]
	Insulation of roof	1	0	3		[1, 2, 3]
Building interior	*Multisensoric Cooling Strategies (e.g. Colors, odor, light)*	0	0	2	Users can easily integrate the solutions according to their needs.	
Equipment	*Heat Pump (combined for space heating and hot water)*	1	0	3	Heat pumps can be used to any scale, including single home, multi-familly, neighbourhood, city or country using DHCN; These allow to reduce the energy consumption (they use free renewable environement thermal energy) furthermore, to decarbonate if electricity is renewable.	[4]
	Boiler change	1	0	3		[5]
	Furnace change	1	0	3		[5]
	Replacement of electric DHW boiler	1	0	3		

	by DHW heat pump (DHW: Domestic hot water)					
	Hot water circulator change	1	1	3		[5]
	Connection to a renewable energy sources thermal grid	1	10	3		
	Cooling through evaporation	0	0	3	The needs assessment is still ongoing. The aim is non technical solution that cools interior spaces. Planned is a product made of clay and water that cools through evaporation.	
	Water flow restrictors	1	1 and 10	3		[6, 7]
	Electric kettle	1	1 (potentially also 10)	3		[7]
	Efficient lighting (LED light bulbs etc.)	1	1 (potentially also 10)	3		[8]
	Highly efficient refrigerator	1	1 (potentially also 10)	3		[7, 9, 10]
	Highly efficient washing machine	1	1 (potentially also 10)	3		[9, 10]
	Highly efficient dish washer	1	1 (potentially also 10)	3		[9, 10]
	Highly efficient tumble dryer	1	1 (potentially also 10)	3		[9, 10]
	Power strip	1	1 (potentially also 10)	3		[7]
	Highly efficient electronic appliances	1	1 (potentially also 10)	3		[9, 10]
Control	*Burner power adjustment*	1	1 (potentially also 10)	3		[12]
	Interruption of one furnace during summer	1	1 (potentially also 10)	3		[12]
	Furnace cascade optimisation	1	1 (potentially also 10)	3		[12]
	Heating circular schedule	1	1 (potentially also 10)	3		[12]
	Heating time constant	1	1 (potentially also 10)	3		[12]
	Heating time	1	1 (potentially also 10)	3		[12]
	Heating curve slope change	1	1 (potentially also 10)	3		[12]
	Upper heating curve change	1	1 (potentially also 10)	3		[12]
	Lower heating curve modification	1	1 (potentially also 10)	3		[12]

Parallel heating curve modification	1	1 (potentially also 10)	3	[12]
Heating hysteresis modification	1	1 (potentially also 10)	3	[12]
Heating lifting temperature change	1	1 (potentially also 10)	3	[12]
Heating night lowering	1	1 (potentially also 10)	3	[12]
Heating interruption temperature	1	1 (potentially also 10)	3	[12]
Setpoint furnace temperature	1	1 (potentially also 10)	3	[12]
Maximum aerotherm temperature	1	1 (potentially also 10)	3	[12]
Maximum boiler setpoint temperature	1	1 (potentially also 10)	3	[12]
Minimum boiler setpoint temperature	1	1 (potentially also 10)	3	[12]
Hydraulic balance	*1*	1 (potentially also 10)	3	[12, 13, 14]
Hot water circulator power	1	1 (potentially also 10)	3	[12]
Hot water hysteresis change/interlocking differential	1	1 (potentially also 10)	3	[12]
Hot water circulation pumps on AUTO mode	1	1 (potentially also 10)	3	[12]
Hot water circulation schedule	1	1 (potentially also 10)	3	[12]
Hot water load schedule	1	1 (potentially also 10)	3	[12]
Hot water lifting temperature change	1	1 (potentially also 10)	3	[12]
Hot water guide temperature	1	1 (potentially also 10)	3	[12]
Hot water day guide temperature	1	1 (potentially also 10)	3	[12]
Hot water night guide temperature	1	1 (potentially also 10)	3	[12]
Hot water sensor position change	1	1 (potentially also 10)	3	[12]
Hot water heating temperature stop	1	1 (potentially also 10)	3	[12]
Hot water heating temperature start	1	1 (potentially also 10)	3	[12]

	Regulation system on AUTO mode	1	1 (potentially also 10)	3		[12]
	Day setpoint temperature	1	1 (potentially also 10)	3		[12]
	Day ECO setpoint temperature	1	1 (potentially also 10)	3		[12]
	Main setpoint temperature	1	1 (potentially also 10)	3		[12]
	Setpoint temperature	1	1 (potentially also 10)	3		[12]
	Night setpoint temperature	1	1 (potentially also 10)	3		[12]
	Night ECO setpoint temperature	1	1 (potentially also 10)	3		[12]
	Night heating interruption setpoint temperature	1	1 (potentially also 10)	3		[12]
	Night heating start setpoint temperature	1	1 (potentially also 10)	3		[12]
	Heating interruption setpoint temperature	1	1 (potentially also 10)	3		[12]
	Heat start setpoint temperature	1	1 (potentially also 10)	3		[12]
	Winter mode modification	1	1 (potentially also 10)	3		[12]
	High-speed ventilation schedule	1	1	3		[12]
	Ventilation heating curve	1	1	3		[12]
	Ventilation opening in the heating curve	1	1	3		[12]
	Low-speed ventilation schedule	1	1	3		[12]
Sharing	*Guest room*	0	1	1	Widespread sharing solution	
	Common room with kitchen	0	1	1	Widespread sharing solution in shared apartments and in cluster apartments	
	Community garden	0	1, 10	1		
	Car sharing in underground parking	0	1	1	e.g., collective agreement with Mobility Genossenschaft	
	Common fridge and cupboard	0	1, 10	1	e.g. Madame Frigo. Impact rather low, as is the implementation effort	
	Library and item cupboard	0	1, 10 (and 100)	1	Impact rather low, as is the implementation effort	
	Coworking space	0	1, 10	1	Increasing demand with increasing opportunities for working remote. Implementation effort in existing buildings mid to high, since another room/apartment would have to be converted.	

Bike sharing	0	1	1	e.g. cargo bikes, bike trailers. Low implementation effort
Common freezer with lockable compartments	0	1	1	Not yet widespread. Rather simple way to replace privately operated freezers and, hence, reduce environmental impact
Joker room	0	1	1	Flexibly usable common room without one specific purpose
Laundry room	0	1	1	Widespread sharing solution
Seminar/event room	0	1, 10, 100	1	Larger room for seminars, events etc. Typically rentable by inhabitants and non-inhabitants

Solution	***Technical* Scale**	**Type**	**Comment**	**Source**

3 Thoughts and Conclusion

This inventory offers a wide range of potential applications across various fields. These fields include, but are not restricted to:

1. **Engineering:**
   - Optimization of Building Systems: Use the technical solutions to evaluate, retrofit, or design more energy-efficient HVAC, insulation, and lighting systems for new or existing buildings;
   - Energy Modeling: Incorporate the technical solutions in simulation software to model the energy efficiency of buildings, allowing engineers to predict potential energy savings from implementing these solutions.
   - Retrofit Projects: Apply the solutions in the renovation of older buildings, focusing on reducing energy waste, improving thermal insulation, and introducing sustainable systems like smart meters and energy recovery units.
   - Product Development: Engineers could use the insights on materials (like insulation and window replacements) to develop or improve construction products that meet new environmental standards.

2. **Architecture:**
   - Sustainable Building Design: Architects can integrate the various solutions into green building designs, ensuring that projects adhere to environmental certifications like LEED or BREEAM. The inventory provides ideas on insulation, building envelopes, and material choice.
   - Passive Design Strategies: The solutions related to building envelopes, window replacement, and facade insulation can inform passive design techniques that maximize energy savings without the need for active systems.
   - Urban Planning: For larger-scale projects, the solutions can be extrapolated for planning eco-districts, incorporating shared spaces, energy-efficient building envelopes, and sustainable transportation options.
   - Lifecycle Analysis: Architects can integrate solutions with lifecycle assessment tools to evaluate the environmental impact of construction materials, focusing on carbon footprint reduction from a project's inception to demolition.

3. **Energy Management**
   - Energy Efficiency Audits: Energy managers can use this database as a checklist for conducting energy audits in buildings. Each solution provides a pathway to energy savings that can be recommended for building improvements.
   - Energy Benchmarking: Solutions like "User Education" can be part of behavioural energy-saving initiatives, while technical solutions like "Window Replacement" or "Facade Insulation" can be benchmarked for their energy reduction potential.
   - Building Management Systems (BMS): Incorporate the replicable solutions into BMS strategies, optimizing energy use across a portfolio of buildings by upgrading systems like HVAC, lighting, and water heating.
   - Carbon Footprint Reduction: These solutions can directly inform strategies to meet carbon neutrality goals by identifying building materials and methods that reduce operational and embodied carbon.

4. **Teaching**
    - Curriculum Development: The solutions can be integrated into sustainability and green engineering courses to provide students with real-world examples of energy-saving technologies and strategies.
    - Project-Based Learning: Students in architecture, civil engineering, or environmental science programs could use the solutions as the foundation for case studies or design projects focusing on sustainable construction.
    - Workshops: Organize professional development workshops or seminars for industry professionals around implementing these solutions in various fields, from building design to energy management.
    - Educational Simulations: Create interactive simulations or tools for students to experiment with how different solutions impact a building's energy performance or sustainability metrics.

5. **Research**
    - Sustainability Impact Studies: Use the listed solutions as the basis for research into the real-world impact of energy-saving measures on building performance, material sustainability, or occupant behaviour.
    - Pilot Projects: Research institutions could test these solutions in experimental settings or pilot projects to gather data on effectiveness, scalability, and cost-efficiency.
    - Life Cycle Assessment (LCA): Researchers can expand on the data to conduct LCA for various materials and building processes, optimizing for lower carbon footprints and enhanced energy efficiency.
    - Behavioural Studies: The "User Education" solutions can be used to study how behaviour affects energy consumption in buildings, with opportunities for developing tools or policies that encourage sustainable practices.

6. **Policy Development**
    - Energy Policy Formulation: Use the replicable solutions as models for energy efficiency programs and regulations, helping to guide municipal, state, or national policies on building codes and green certifications.
    - Green Building Standards: Develop or update standards like LEED, BREEAM, or local environmental certifications based on the effectiveness of these solutions in reducing energy consumption and lowering environmental impact.

7. **Sustainability Consulting**
    - Advisory Services: Consultants can leverage this data to advise clients (such as property developers, city planners, and energy managers) on implementing cost-effective, sustainable upgrades for their buildings and infrastructure.
    - Business Case Development: Use the solutions to build the financial case for investing in energy-efficient retrofits, focusing on the long-term savings and environmental benefits.

8. **Urban and Environmental Planning**
    - Smart Cities Initiatives: Many of these solutions could contribute to smart city planning, with energy-efficient building strategies integrated into larger urban systems.
    - Circular Economy: The solutions could be incorporated into urban planning policies that promote recycling and reuse of materials (like building insulation and window replacement) in alignment with circular economy principles.

9. **Innovation and Entrepreneurship**
    - Startup Development: Entrepreneurs could use this data to develop new businesses focused on innovative energy-efficient products, services, or technologies (e.g., smart windows, advanced insulation materials, or sustainable building consultancy).
    - Incubation Programs: Create incubator programs for startups focused on green technologies, using the list of solutions as inspiration for business ideas with market potential.

10. **Public Engagement and Awareness**
    - Community Education: Use the solutions to run community workshops or awareness campaigns on energy-saving measures for homeowners or property managers.
    - Municipal Initiatives: Engage municipalities in implementing the solutions at a district or city-wide scale, integrating sustainable building practices into local regulations and public projects.

Each of these areas can benefit from the data in different ways, helping to achieve sustainability goals, reduce energy consumption, and minimize environmental impact.

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