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D4.2 – IMPLEMENTATION OF PILOT CASES – BULGARIA

ENERGY AGENCY OF PLOVDIV ASSOCIATION (EAP)

The LIFE21-CET-ENERCOM-CONNECTHEAT project has received funding from the European Union's LIFE Programme under grant agreement N°101076258

D4.2 – IMPLEMENTATION OF PILOT CASES – BELGIUM

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R	Report, document	☒
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DMP	Data management plan	☐
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Summary

The EAP pilot project is being implemented in the city of Plovdiv and aims at establishing a **Renewable Heating and Cooling Energy Community**, where the residents of 6 passive houses – 4 houses x 135m2 and 2 houses x163m2 - will collectively generate, store, and share renewable energy for heating, cooling, and domestic hot water (DHW). This initiative will demonstrate a collaborative, self-sufficient, and sustainable energy model for residential buildings.

Key Features of the Pilot Project

Passive House Design – Four homes of 135m² and two of 163m², built to maximize energy efficiency and minimize consumption.

Geothermal Energy Sharing – Five or six boreholes will supply ground-source heat pumps in each house, ensuring efficient heating and cooling.

Solar Thermal System with Centralized DHW Storage – Solar collectors installed on each rooftop will generate energy for DHW, stored in a shared thermal storage tank for all six houses.

Energy Sharing Model – Residents will collaborate in managing and optimizing energy use, ensuring equitable distribution and enhancing overall efficiency.

This project will serve as a replicable model for community-based renewable energy, proving that local cooperation and shared infrastructure can significantly reduce costs, enhance energy independence, and lower environmental impact.

Main Objectives:

1. **Achieve Local Energy Independence & Sustainability:** Reduce reliance on external energy providers by covering at least 70-80% of heating, cooling, and DHW needs through on-site renewable sources, including geothermal heat pumps and rooftop solar thermal collectors. This will enhance energy security for the six participating households.
2. **Maximize Renewable Energy Utilization & Efficiency:** Optimize the use of geothermal energy from 5-6 boreholes to supply heat pumps in each home, ensuring efficient heating and cooling. Implement a shared solar thermal storage system to provide cost-effective and stable DHW supply, reducing seasonal fluctuations in energy production.
3. **Foster Community-Based Energy Management & Economic Benefits:** Establish a collaborative energy-sharing model where all six households actively participate in energy management, decision-making, and operational oversight. Residents will benefit from lower energy costs, reduced maintenance expenses, and collective financial resilience through shared infrastructure.
4. **Enhance Social Cohesion & Knowledge Exchange:** Strengthen ties among participating households by fostering a shared responsibility approach to energy management. Encourage peer learning, technical training, and knowledge exchange, positioning the community as a local pioneer in renewable heating and cooling solutions.
5. **Monitor, Evaluate & Create a Scalable Model:** Implement a real-time monitoring system to track energy production, consumption, and savings. Conduct regular assessments to optimize system performance,

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document best practices, and share insights with local policymakers, energy cooperatives, and future energy communities to support replication at regional and national levels.

The **pilot project** is spearheaded by a **Stakeholder Advisory Group (SAG)**, which brings together key actors from **energy agencies, local and national authorities, industry associations, and environmental organizations** committed to advancing **renewable energy** and **community-based energy solutions**. Each stakeholder plays a distinct role in the successful establishment and operation of the **thermal energy community**:

- **Energy Agency of Plovdiv (EAP)** – Serving as the main coordinator, EAP provides expertise in the organizational, legal, and technological aspects of the project. EAP ensures compliance with regulatory frameworks, facilitates stakeholder engagement, and oversees the integration of green technologies such as ground-source heat pumps and solar thermal systems.
- **Local and National Authorities** (Trakia Regional District within Plovdiv Municipality, Sustainable Energy Development Agency within the Ministry of Energy) – The municipality and relevant government bodies play a critical role in providing policy support, permits, and potential financial incentives. They also assist in aligning the pilot project with regional sustainability and energy transition goals.
- **Renewable Energy Companies & Contractors (**Vays Service, Re Energy, Oberon Konzeptbau**)** – Specialists in geothermal energy systems, solar thermal solutions, and energy-efficient building design are responsible for the design, installation, and long-term maintenance of the infrastructure. Their expertise ensures that the system operates efficiently and cost-effectively.
- **Industry Associations & Environmental Organizations** (Chamber of Commerce and Industry – Plovdiv, Bulgarian Energy & Mining Forum, Chamber of Energy Communities in Bulgaria) These groups support the project by advocating for regulatory improvements, raising public awareness, and promoting community engagement. They also contribute to the broader replication potential of the model by sharing best practices with other municipalities and energy communities.

By leveraging the expertise and contributions of these diverse stakeholders, the project ensures a well-structured, community-driven approach that aligns with sustainability objectives while delivering economic and environmental benefits to the participating households.

The main beneficiaries would be**:**

Residents (Community Members) that will benefit from lower energy costs, reduced carbon footprint, and improved comfort through renewable energy for heating, cooling, and DHW production. Participation strengthens community ties and fosters energy independence.

Promoters and Developers will gain experience, expertise, and recognition for implementing innovative renewable energy projects. These include energy agencies, industry associations, or companies specializing in renewable energy systems.

Local and National Authorities who will achieve climate action goals and enhance their reputation by supporting sustainable community projects.

Technology Providers who will explore innovative green technologies and good practices.

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The following technologies will be utilized in the pilot case:

1. Renewable Energy Technologies

Geothermal ground source collectors: Supply energy for heating and cooling to the GSHPs.

Ground Source Heat Pumps (GSHPs): Provides efficient heating and cooling by extracting heat from the ground in winter and dissipating it in summer.

Suitable for the passive houses in the community, ensuring year-round comfort.

Solar Thermal Collectors: Used for DHW production, reducing reliance on conventional water heating systems. High-efficiency flat plate or evacuated tube collectors will be used;

2. Energy Storage Systems

Thermal Storage Tanks. Stores excess thermal energy from the solar collectors for use during low-sunlight periods. Injects heat in the ground during summer period to increase ground source potential in the winter period. Enhances the reliability of renewable energy systems.

3. Building Energy Efficiency Interventions

High-Performance Building Envelope. Utilize the passive house design standards with superior insulation, airtight construction, and minimal thermal bridging. Triple-glazed windows and high-quality doors for thermal efficiency.

Smart Ventilation with Heat Recovery. Energy-efficient ventilation systems that recover heat from outgoing air to warm incoming fresh air.

4. Smart Energy Management Systems

Energy Monitoring and Control Systems will allow residents to track energy consumption and production in real time. Smart thermostats and zone heating systems optimize energy use.

Community Energy Sharing Platforms. Software or systems to equitably allocate energy among community members and manage surplus energy.

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1. Technical feasibility

1.1. Demand side analysis

Six households will utilize the energy for heating, cooling and DHW produced by renewable sources. Although we don't have the final design of the buildings, considering the standard for passive houses we can make the following estimates:

1. *Heating Demand* **–** 15 kWh/m²/year
2. *Cooling Demand* ~ 10 kWh/m²/year
3. *DHW Demand* **-** 25 kWh/m²/year (average)

Summary of Estimated Energy Demand

Demand Type	135 m² House (4 units)	163 m² House (2 units)	Community Total
Heating	8100 kWh/year	4890 kWh/year	**12990 kWh/year**
Cooling	5400 kWh/year	3260 kWh/year	**8660 kWh/year**
DHW	13500 kWh/year	8150 kWh/year	**21650 kWh/year**
Total	27000 kWh/year	16300 kWh/year	**43300 kWh/year**

These estimates are based on average usage patterns and passive house standards. Actual demands may vary based on occupant behavior, local climate, and system efficiency. The renewable energy systems (heat pumps and solar thermal collectors) will be designed to meet or exceed this total annual demand.

1.2. Supply side analysis

The renewable energy supply system provides heating, cooling, and domestic hot water (DHW) to six passive houses, ensuring high energy efficiency and minimal environmental impact. The system integrates geothermal energy and solar thermal collectors to maximize self-sufficiency and optimize seasonal energy utilization.

Geothermal Energy System

The geothermal system consists of five to six vertical boreholes, each approximately 50–100 meters deep, depending on local geological conditions. These boreholes extract stable underground thermal energy to supply ground-source heat pumps (GSHPs) in each house.

Geothermal Ground Source Collectors

- Closed-loop vertical borehole heat exchangers circulate a heat-transfer fluid (typically a water-glycol mixture) to absorb or dissipate heat from the ground.
- Boreholes are designed to provide sufficient thermal capacity to cover the heating and cooling loads of the six households throughout the year.

Ground Source Heat Pumps (GSHPs)

- Each house is equipped with an individual GSHP (COP ≈ 4.5–5 for heating, 3.5–4 for cooling).
- The heat pumps use the low-temperature geothermal heat for space heating in winter and reverse the cycle for cooling in summer.

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- The total annual energy demand covered by the GSHPs is estimated at 21,650 kWh/year, distributed as follows: Heating: 12,990 kWh/year, Cooling: 8,660 kWh/year
- The system ensures a balanced ground energy exchange, reducing long-term performance degradation of borehole fields.

<u>Solar Thermal Collectors for DHW Production</u>

A solar thermal system is installed on the rooftops of each house, contributing to domestic hot water (DHW) production.

- The system consists of high-efficiency flat-plate or evacuated tube solar collectors, optimized for year-round solar energy capture.
- The total solar thermal energy production is estimated at 21,650 kWh/year, covering almost 100% of the DHW demand for all six houses.
- A centralized thermal storage tank (e.g., 1,000–1,500 liters capacity) is used to store hot water for optimized energy distribution among households.

<u>Seasonal Energy Optimization</u>

- During summer, excess solar thermal energy is injected into the ground via the borehole system to regenerate the geothermal field, enhancing winter heating efficiency.
- This seasonal thermal storage approach increases the overall system efficiency and reduces the risk of ground thermal depletion.

The integrated energy system ensures year-round renewable energy utilization, optimizing the synergy between geothermal and solar thermal sources. This design enhances energy security, reduces operational costs, and serves as a scalable model for other community-based renewable energy projects.

2. Costs and Benefits

2.1. Revenue Streams and Pricing Analysis

Energy Pricing for Users

Since the 6 households produce and consume energy from shared renewable sources, revenue is generated internally through cost-sharing. This is not traditional "selling," but a structured fee system for energy use:

Pricing Structure:

- Based on actual energy production and consumption (€/kWh).
- Includes a contribution toward operational and maintenance costs (OPEX).
- Potential flat fee to cover shared infrastructure costs (e.g., boreholes, monitoring systems).

Energy Cost Per kWh:

- Estimate derived from total OPEX (e.g., €1000/year) divided by annual energy consumption (~43300 kWh/year).

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- Indicative Cost for OPEX: €0.023/kWh, significantly lower than typical market energy prices (due to no external suppliers).

Cash Flow Analysis

Revenue Collection:

- Monthly or quarterly payments by households to a community fund.
- Payments cover OPEX, system depreciation, and potentially create a reserve for future investments (e.g., equipment replacement).

Cash Flow Projections:

- Initial revenues equal the total OPEX.
- Over time, savings from avoided external energy purchases (e.g., grid electricity, gas) reduce household expenses.

Other Potential Revenues

Incentives and Subsidies: National and EU-level renewable energy subsidies could offset costs and provide additional funds.

Carbon Credits or Green Certificates: The community may qualify for these if emissions reductions meet certification criteria.

System Expansion: Future households or buildings joining the community could contribute to additional revenues.

2.2. Funding sources

To finance thermal energy community pilot project, a combination of financial resources and mechanisms will be utilized:

- Corporate and Private Investment
- The construction contractor will fund the construction of passive houses
- Energy Agency of Plovdiv will contribute to financing of the design and implementation of the geothermal and solar installations as a member of the thermal energy community.

Key economic and financial parameters will be provided as soon as the design of the geothermal and solar thermal systems is completed and we have the equipment chosen.

2.3. Expected benefits

Energy Savings

Reduction in Primary Energy Demand: The use of energy-efficient passive houses combined with renewable energy systems (solar thermal collectors and ground source heat pumps) drastically reduces energy consumption compared to conventional systems.

Estimated annual demand (~43300 kWh) is significantly lower than typical residential energy use, ensuring substantial energy savings.

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CO2 Emissions Reduction

Shift to Renewables: 100% of the energy required for heating, cooling, and domestic hot water is generated from renewable sources, leading to a nearly zero-carbon energy supply.

Assuming 0.2 kg CO2/kWh for fossil-fuel-based heating, this project avoids approximately 8.7 tons of CO2 annually.

Reduced Energy Costs

Lower Energy Bills for Residents: Residents will only pay for the operational and maintenance costs (OPEX) of the shared energy systems. Reduced reliance on external energy suppliers shields the community from volatile energy prices.

Improved Air Quality

Elimination of Fossil Fuels: The switch to renewables reduces local air pollution caused by traditional heating systems (e.g., oil or gas boilers).

Job Creation

Local Economic Stimulus: The design, installation, and maintenance of renewable energy systems create jobs in the local renewable energy and construction sectors.

Potential training programs for community members or local technicians further contribute to employment opportunities.

Community Engagement and Empowerment

Energy Autonomy: Residents actively participate in the energy management process, fostering a sense of ownership and empowerment.

Builds community resilience and educates members about renewable energy technologies.

Environmental Awareness

Promotes Sustainability: Serves as a model project, inspiring nearby communities to adopt similar solutions.

Raises awareness of the benefits of renewable energy and energy efficiency among local stakeholders.

Long-Term Economic and Environmental Benefits

Durability and Scalability: Long-lasting infrastructure ensures that benefits extend over decades.

The modular nature of the system allows for future expansion to additional households or buildings.

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3. Community Model

3.1. Project organizational and management structure

The energy community will operate in the form of a civil community of natural and legal persons (consortium) under the Obligations and Contracts Act (OCA). This form is widely used due to the following advantages:

- Citizens and business entities choose this form, mainly because of the minimal administrative and bureaucratic burden. This is primarily due to the absence of formalities and difficulties in the establishment, registration and operation of the energy consortium. No heavy registrations are required, with the existing restrictions and burdens, and only registration under BULSTAT at the Registry Agency is necessary.
- The transfer of rights and shares of the society members occurs only with the consent of the other partners;
- The society can fully carry out independent business activities and make profits.
- The registration is valid for 10 years from the date on which it was made. It may be
- extended, if the registration is renewed, before the expiration of the above period.

Energy Agency - Plovdiv is developing an Energy Community Agreement**.** The purpose of the agreement is to regulate the relations of the parties for the establishment and operation of an Energy Community.

3.2. Key Clauses for Energy Community Agreement

Purpose and Objectives

The members of the Energy Community (hereafter "the Community") agree to interact and cooperate with the shared goal of:

- Producing and using renewable energy (geothermal and solar thermal) for heating, cooling, and domestic hot water (DHW) needs;
- Reducing environmental impact and increasing home energy independence;
- Generating social and economic benefits for all members of the community.

Scope of Cooperation

The members agree to:

- Pool their efforts, expertise, administrative, and financial resources for the establishment and operation of the Community;
- Jointly manage and maintain the geothermal heating and cooling installation, the solar thermal system, and the shared energy storage tank;
- Ensure fair and transparent governance of the Community's energy systems.

Financial Contributions

- Each member shall contribute an initial investment toward the construction of the energy systems.
- Members shall also contribute ongoing expenses payment for operation and maintenance (O&M) costs. These costs will be distributed as follows:

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House	Living area	Maintenance cost	Electricity consumption	Hot water from common tank
No	m2	BGN	kW	m3
1	163	18,8%	18,8%	as per individual flow meter
2	135	15,6%	15,6%	as per individual flow meter
3	135	15,6%	15,6%	as per individual flow meter
4	135	15,6%	15,6%	as per individual flow meter
5	135	15,6%	15,6%	as per individual flow meter
6	163	18,8%	18,8%	as per individual flow meter
Total	866	100,0%	100,0%	

Energy Distribution and Benefits

- All members shall be entitled to a fair and equal share of the energy produced.
- The distribution of energy will consider household energy demands, system performance, and agreed fairness principles.
- Any surplus energy or savings resulting from the system will be handled according to decisions made by the Community Assembly.

Governance and Decision-Making

- The Community shall establish a governance structure, including a General Assembly and a Manager.
- All major decisions regarding finances, technical operations, and upgrades must be approved by a qualified majority vote.
- Regular meetings and transparent reporting will be conducted to ensure accountability and inclusion.

Duration and Exit Clause

- The Agreement shall be valid for the full operational period of the system (initially set at 20 years) and renewable thereafter.
- Members wishing to sell their property and leave the Community must notify in advance other community members, to secure transfer of rights and obligations to the new owner of the house.

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3.3. Project Roadmap

Current Status

Building Design:

- Architectural plans for the passive houses have been completed.
- Energy efficiency measures, such as insulation and passive house standards, are integrated into the design.

Technical Design Pending:

- The detailed designs for the geothermal installation (shared boreholes), individual GSHPs, and solar thermal systems are yet to be completed.

Regulatory and Administrative Progress:

- Initial stakeholder meetings have been conducted to outline the project scope.
- Preliminary discussions with local authorities indicate support for the project, but formal permits are not yet secured.

Community Engagement:

- Future community members are yet to be defined.
- Energy community Agreement is being developed, but key clauses have been defined.

Building Construction Permits (Q2–Q4 2025):

Q2 2025 (April–June):

- Prepare and submit architectural and engineering project documentation to the local authorities.
- Conduct necessary structural, energy efficiency, and fire safety assessments to comply with passive house standards.
- Address any modifications or clarifications requested by the municipality.

Q3–Q4 2025 (July–December):

- Expected issuance of construction permits by the municipal authority.
- Begin site preparation and early-stage groundwork upon permit approval.

Environmental and Technical Approvals (Q2 2025 – Q2 2026):

Q2–Q3 2025 (April–September):

Conduct an Environmental Impact Assessment (EIA) for the geothermal boreholes:
- Engage environmental consultants for impact studies.
- Submit EIA reports to the relevant environmental agencies.
- Await review and respond to regulatory feedback.

Q4 2025 – Q1 2026 (October–March):

Apply for borehole drilling permits:
- Submit hydrogeological assessments.
- Obtain approval from water resource management authorities.

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Secure thermal energy extraction permits:

- Demonstrate system sustainability and compliance with geothermal regulations.
- Finalize agreements with energy and environmental regulators.

Q2 2026 (April–June):

- Final approvals expected for drilling and water/thermal energy extraction.

Energy Community Formation:

- Legal establishment of the energy community under national or EU frameworks for renewable energy communities.

Funding Approvals:

- Applications for grants, subsidies, or loans, if available, to secure project financing.

Next Steps

Short-Term (0–8 Months)

• Commission Detailed System Designs:

- Engage engineers and consultants to design the geothermal system, including shared boreholes and individual GSHPs.
- Design solar thermal systems for DHW production.

• Secure Regulatory Approvals:

- Obtain permits for drilling, system installation, and building construction.
- Submit required documents for environmental compliance.

• Finalize Financing:

- Identify funding sources (e.g., government grants, EU programs, private loans).
- Develop a preliminary CAPEX and OPEX budget for submission to funding bodies.

Mid-Term (8–14 Months)

• Procurement and Contractor Selection:

- Tendering process for geothermal drilling contractors, GSHP suppliers, and solar collector manufacturers.
- Contract qualified installers for energy systems and monitoring technologies.

• Start Construction:

- Begin borehole drilling and passive house construction.
- Install geothermal loops and solar thermal systems.

Long-Term (14–30 Months)

• Commissioning and Testing:

- Test and optimize the geothermal and solar systems.
- Ensure all systems meet performance standards.

• Community Training and Launch:

- Educate residents on system use and energy-sharing agreements.
- Officially launch the thermal energy community.

Planned Investments

• Design Phase:

- Cost of geothermal and solar thermal system designs.

• Construction and Installation:

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- Borehole drilling and geothermal system installation.
- GSHPs for individual houses and solar thermal systems for DHW.
- Smart monitoring and control systems.

3.4. Risks

Demand Risks

Risk

Changes in the energy consumption behavior of residents (e.g., higher DHW use in winter or cooling in summer) could affect the community's energy balance and economic model.

Mitigation:

- Conduct thorough demand assessments and build in flexibility to accommodate variations.
- Use smart energy monitoring to optimize production and ensure consistent energy balance.

Technical Risks

Risk: Failure or underperformance of geothermal systems, GSHPs, or solar thermal collectors.

Mitigation:

- Use high-quality equipment from trusted suppliers.
- Include regular maintenance and monitoring in the OPEX budget.
- Conduct system tests and optimization during the commissioning phase.

Operational Risks

Risk: Higher-than-expected O&M costs or system breakdowns.

Mitigation:

- Maintenance contracts with technology providers.
- Reserve fund creation for emergency repairs.

Regulatory and Approval Risks

Risk: Delays in securing necessary permits for geothermal drilling, construction, and environmental compliance.

Mitigation:

- Engage early with local regulatory authorities and submit all necessary documentation promptly.
- Work with experienced consultants familiar with local regulatory processes to avoid compliance errors.
- Prepare contingency plans for alternative project timelines.

Legislative and Policy Changes

Risk: Changes in national or EU policies on renewable energy or community energy frameworks could affect financial incentives or legal compliance.

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Mitigation:

- Stay informed about legislative updates through active communication with policymakers and energy agencies.
- Incorporate flexible financial and operational models to adapt to changing regulations

Financial Risks

Risk:

- Insufficient user contributions or delayed payments.
- Inability to secure sufficient funding for CAPEX, leading to delays or scaling down of the project.

Mitigation:

- Transparent community agreements.
- Incremental fee increases to adjust for inflation or unforeseen costs.
- Diversify funding sources by combining grants, subsidies, and private financing.
- Build a strong business case emphasizing environmental and social benefits to attract investment.

Expertise and Resource Availability

Risk: Limited access to skilled contractors, designers, or technicians for geothermal and solar installations.

Mitigation:

- Partner with reputable firms with expertise in renewable energy system installation.
- Allocate time for training local technicians or recruiting external specialists.

Demand Risks

Risk: Changes in the energy consumption behavior of residents could affect the community's energy balance and economic model.

Mitigation:

- Conduct thorough demand assessments and build in flexibility to accommodate variations.
- Use energy management systems to monitor and adjust usage dynamically.

Political and Social Risks

Risk: Political instability (e.g., upcoming elections) or lack of community buy-in could impact support for the project.

Mitigation:

- Actively engage community members throughout the project to maintain trust and participation.
- Secure cross-party support for the project to ensure political continuity.

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Technical Risks

Risk: Failure or underperformance of geothermal systems, GSHPs, or solar thermal collectors.

Mitigation:

- Use high-quality equipment from trusted suppliers.
- Include regular maintenance and monitoring in the OPEX budget.
- Conduct system tests and optimization during the commissioning phase.

Environmental Risks

Risk: Unexpected geological issues during borehole drilling, such as unsuitable soil conditions or water contamination.

Mitigation:

- Perform detailed site assessments before drilling.
- Have backup plans for alternative borehole locations or methods.

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