ENABLE DHC

INVESTMENT PLAN

For the District Heating system in Poltava, Ukraine

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SEN	Sensitive, limited under the conditions of the Grant Agreement	☐
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R	Report, document	☒
DEM	Demonstrator, pilot, prototype, plan designs	☐
DEC	Websites, patents filing, press & media actions	☐
DATA	Datasets, microdata, etc.	☐
DMP	Data management plan	☐
ETHICS	Deliverables related to ethic issues	☐
SECURITY	Deliverables related to security issues	☐
OTHER	Software, technical diagram, algorithms, models, etc.	☐

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This template is prepared to support consortia participating in the LIFE Clean Energy Transition subprogramme in developing investment plans for existing or new district heating and/or cooling systems. The goal is to facilitate the preparation of plans that meet the "efficient district heating and cooling" criteria outlined in the Energy Efficiency Directive article 26, which is further explained in Commission Recommendation (EU) 2024/2395 [1].

[1] Commission Recommendation (EU) 2024/2395[1] of 2 September 2024 setting out guidelines for the interpretation of Article 26 of Directive (EU) 2023/1791 of the European Parliament and of the Council as regards the heating and cooling supply, available at https://eur-lex.europa.eu/eli/reco/2024/2395/oj/eng

1. Case Study Context and Transformation Objective

Poltava operates an established district-heating system that supplies residential, public and commercial consumers through a combination of heat-generation facilities and interconnected local distribution networks. Heat supply is managed by the municipal district-heating operator Poltavateploenergo, which is responsible for heat production, distribution and the continued modernisation of the system.

The existing heat supply remains predominantly based on natural gas. Although a number of efficiency improvements and infrastructure-modernisation measures have already been implemented, including network rehabilitation, pumping and control improvements, boiler-house upgrades and the introduction of more efficient equipment, the long-term transformation challenge is broader than the replacement of individual components. The system must progressively reduce its dependence on fossil fuel while maintaining affordable, reliable and secure heat supply under changing technical, economic and regulatory conditions.

Previous municipal heat-supply planning has considered several alternative heat sources and modernisation options, including renewable heat, waste-to-energy, solar thermal energy, heat pumps, cogeneration, thermal storage and improved integration of existing heat-supply areas. Some of these options represent historical planning concepts whose current technical or economic feasibility still requires confirmation. In particular, future investment decisions need to distinguish between theoretically available resource potentials and projects that are sufficiently mature for implementation.

The ENABLE DHC investment-planning process therefore focuses on identifying a technically feasible and economically credible transition pathway that can substantially reduce natural-gas consumption while increasing the contribution of renewable and low-carbon heat. Particular attention is given to large-scale heat-pump integration, renewable electricity generation, thermal energy storage and the operational flexibility required to integrate these technologies into the existing district-heating system.

A key consideration is that decarbonisation cannot be addressed solely by adding new generation capacity. The future system must coordinate heat production, network operation, electricity demand, storage and residual peak-load generation. Network integration and operational optimisation are consequently important enabling measures, as they can improve the utilisation of low-carbon heat sources and reduce the need for fossil-fuel-based production.

The investment scenarios developed for Poltava are assessed against the requirements for efficient district heating and cooling under Article 26 of Directive (EU) 2023/1791, while also considering the progressively stricter long-term requirements for renewable energy and waste heat. The objective is not only to identify a configuration that can meet the near-term regulatory threshold, but also to establish a transition pathway that remains compatible with deeper decarbonisation toward 2040, 2045 and ultimately 2050.

Within this framework, ENABLE DHC evaluates alternative technology portfolios and identifies a preferred pathway for further project development. The resulting investment concept is intended to support the next stages of feasibility confirmation, grid and infrastructure studies, permitting, financing and detailed engineering. It should therefore be understood as a strategic investment pathway, to be further validated and refined together with Poltavateploenergo, the municipality and other relevant stakeholders before implementation.

2. Solutions and Investment Scenarios Assessed

The ENABLE DHC assessment examined alternative low-carbon heat-supply configurations that could progressively reduce the dependence of the Poltava district-heating system on natural gas while maintaining reliable heat supply. The analysis focused on the interaction between large-scale heat pumps, renewable-energy generation, thermal energy storage and residual gas-fired generation, with the objective of identifying a technically credible and economically promising transition pathway.

A representative heat-supply area was used for the detailed energy-system assessment. The existing natural-gas-based configuration was first modelled as the reference case and then compared with three future investment scenarios. All scenarios were assessed against the same heat-demand basis so that the differences in performance resulted from the technology configuration rather than from changes in demand.

The three future scenarios were designed as distinct technology portfolios:

- **Scenario 1** – Large heat pump and thermal energy storage: This scenario represents the most direct electrification pathway. A large-scale heat pump provides the principal low-carbon heat supply, while thermal energy storage improves operational flexibility and reduces the need for instantaneous matching between heat production and demand. Existing gas-fired capacity is retained primarily for peak-load, backup and security-of-supply operation.
- **Scenario 2** – Large heat pump, photovoltaic generation and thermal energy storage: This scenario combines electrified heat production with local renewable electricity generation. The photovoltaic system supplies part of the electricity required by the heat pump and therefore reduces dependence on electricity imported from the grid. Thermal energy storage further increases flexibility by allowing heat production to be shifted toward periods of favourable electricity prices or higher renewable-electricity availability.
- **Scenario 3** – Large heat pump, solar thermal generation and enlarged thermal energy storage: This scenario introduces renewable heat directly into the district-heating system through a large solar-thermal collector field. The heat pump remains the dominant low-carbon heat source, while the larger thermal store is intended to increase the utilisation of variable solar-thermal production and shift daytime heat generation toward later demand periods.

The modelling shows that all three investment scenarios can substantially reduce natural-gas consumption compared with the existing reference system. In each case, the large-scale heat pump becomes the principal heat source, while gas-fired generation is progressively shifted toward a residual role for peak demand, backup and operational security.

The main distinction between the scenarios lies in the electricity balance and operational flexibility. Scenario 1 has the simplest technical configuration and the lowest investment requirement but depends most strongly on electricity imported from the grid. Scenario 2 reduces this dependency through local photovoltaic generation and achieves the strongest combined operating performance in the present assessment. Scenario 3 provides direct renewable heat but, under the current modelling assumptions, shows more limited utilisation of the solar-thermal installation and requires a larger thermal-storage volume.

The scenarios were also screened against the efficient district heating and cooling criteria of Article 26 of Directive (EU) 2023/1791. For the modelled heat-supply area, all three future configurations reach renewable-heat shares above the applicable near-term threshold, provided that the selected heat-pump technology satisfies the relevant efficiency requirements. The scenarios therefore represent a substantial step toward EED-compliant low-carbon district heating. However, further decarbonisation would still be required to meet the stricter renewable-energy requirements applicable in the longer term.

Among the three options, Scenario 2 is identified as the preferred pathway for further project development. It provides the most balanced combination of natural-gas reduction, renewable-energy integration, lower dependence on purchased electricity and operational performance. Its higher initial investment requirement is offset by a stronger operating profile compared with the other alternatives.

The preferred status of Scenario 2 should nevertheless be understood as the outcome of a strategic screening assessment rather than a final investment decision. Further development requires confirmation of the low-temperature heat source for the heat pump, sufficient electricity-grid connection capacity, suitable land for photovoltaic deployment, detailed engineering, permitting and financing conditions. Scenario 1 remains a technically credible lower-investment alternative, while Scenario 3 may become more competitive if the solar-thermal and storage configuration can be further optimised.

Overall, the scenario comparison demonstrates that the transformation of the Poltava district-heating system should be approached as an integrated energy-system transition, in which heat generation, renewable electricity, thermal storage, network operation and residual backup capacity are planned jointly rather than as independent investments.

3. Investment and Implementation Outlook

The preferred investment pathway combines a large-scale heat pump, photovoltaic generation and thermal energy storage. It is intended to substantially reduce fossil-fuel use while improving the flexibility and long-term decarbonisation readiness of the selected Poltava heat-supply area. The pathway is not considered implementation-ready at the present stage; further technical confirmation, permitting, financing and detailed engineering are required before an investment decision can be taken.

3.1. Expected Impact

The selected pathway is expected to provide substantial technical, energy and environmental benefits compared with the existing natural-gas-based reference system.

The modelling indicates that natural-gas use in the assessed heat-supply area could be reduced by approximately 72%, with the large-scale heat pump becoming the principal heat source. The remaining gas-fired generation would primarily provide peak-load, backup and security-of-supply capacity. This represents a fundamental shift from fossil-fuel-dominated heat production toward an electrified and increasingly renewable supply structure.

The integration of photovoltaic generation significantly reduces the amount of electricity that must be purchased from the grid. In the preferred scenario, local PV production supplies a substantial part of the electricity required by the heat pump, improving energy autonomy and reducing exposure to grid-electricity consumption. Thermal energy storage provides additional flexibility by allowing heat

production and electricity use to be shifted over time and better aligned with renewable generation and system demand.

For the modelled heat-supply area, the resulting heat mix contains more than 70% qualifying renewable heat, subject to confirmation that the selected heat-pump technology meets the applicable efficiency requirements under EU legislation. The scenario therefore exceeds the renewable-energy threshold applicable to efficient district heating and cooling in the near- and medium-term regulatory horizon. Further decarbonisation measures would nevertheless be required to meet the stricter requirements applicable from 2040 onward.

The main environmental impact is the substantial reduction of direct fossil-fuel use and associated combustion emissions. Additional benefits include lower dependence on natural-gas supply, improved integration of renewable energy and a more flexible operating structure.

Socio-economic benefits are expected to arise from greater energy security, reduced exposure to fossil-fuel price volatility, modernisation of local energy infrastructure and the mobilisation of investment in renewable and efficient technologies. Implementation would also require local engineering, construction, operation and maintenance capabilities, creating opportunities for technical capacity building and specialised employment.

3.2. Implementation Roadmap

Implementation is expected to proceed in successive stages over an indicative period of approximately 5–6 years. The sequence is intended to ensure that major investment commitments are made only after the key technical, regulatory and financial conditions have been confirmed.

The first phase should focus on feasibility confirmation, including verification of the low-temperature heat source for the heat pump, site availability, photovoltaic deployment area, thermal-storage location and updated heat-demand assumptions. At the same time, early studies should confirm the available electricity-grid connection capacity and identify any reinforcement requirements.

The second phase should cover permitting, environmental assessment and detailed engineering. This includes land-use requirements, construction approvals, environmental obligations, electrical and hydraulic integration, equipment sizing and development of the control concept.

In parallel, the project should progress toward financial closure, including discussions with potential international financial institutions, grant providers and municipal stakeholders. The financing package should be based on confirmed project costs, eligible expenditure and lender requirements rather than on preliminary screening assumptions.

Following technical and financial confirmation, the project can proceed to procurement and contracting, followed by construction and installation of the heat pump, photovoltaic system, thermal storage and associated infrastructure.

The final phase should cover commissioning, performance testing and operational optimisation. Monitoring during the initial years of operation will be important for verifying heat-pump efficiency, renewable-energy utilisation, storage performance and the actual reduction of residual fossil-fuel use.

The roadmap should remain adaptive. Technology sizing, project costs and implementation sequencing should be updated as more detailed information becomes available during project development.

3.3. Key Risks and Enabling Conditions

The investment pathway is subject to a number of technical, financial, regulatory and implementation risks.

A key technical uncertainty is the availability and suitability of the low-temperature heat source for the large heat pump. The source must be confirmed in terms of capacity, seasonal availability, temperature level, environmental constraints and long-term reliability before final equipment sizing.

A second important condition is electricity-grid capacity. Large-scale heat-pump operation introduces a substantial electrical load, while the photovoltaic system requires coordinated grid integration. Early engagement with the electricity-system operator is therefore essential to confirm connection capacity, reinforcement requirements, connection costs and implementation timing.

The project is also exposed to electricity-price risk. High or volatile electricity prices can materially affect operating costs. The preferred scenario partly mitigates this risk through local photovoltaic generation and thermal storage, while additional measures may include flexible operation, long-term electricity procurement and other suitable contracting arrangements.

Capital-cost escalation, financing conditions and interest-rate risk are also important because the project requires significant upfront investment. Competitive procurement, contingency allowances, diversified financing sources, concessional financing and grant support can reduce these risks.

Further risks relate to heat-pump performance, equipment reliability, control-system integration and long-term maintenance. These can be addressed through conservative design assumptions, performance guarantees, predictive maintenance, redundancy for critical components and operator training.

From a regulatory perspective, the main enabling conditions are successful permitting, confirmation of environmental requirements, compliance with electricity-market and construction rules, and verification that the heat-pump configuration qualifies for the intended renewable-energy accounting under the efficient-DHC criteria.

The risk assessment carried out within ENABLE DHC therefore confirms that successful implementation depends not on a single technology choice, but on the coordinated management of heat-source availability, grid integration, financing, regulatory compliance and operational flexibility.

3.4. Stakeholder Engagement & Endorsement

Stakeholder engagement has been an integral part of the Poltava investment-planning process. A local DHC Working Group was established within ENABLE DHC to support discussion of the transformation priorities, technical options and investment needs.

The core stakeholder group includes Poltavateploenergo, Poltava Municipality, Poltava Regional Council and City Institute, with additional stakeholders involved according to the topic under consideration.

The first Working Group meeting, held in March 2025, focused on the main decarbonisation challenges and priority measures for the district-heating system. Topics discussed included renewable heat, heat pumps, cogeneration, thermal storage, network optimisation and the need for stronger investment and financial planning.

A second Working Group meeting in July 2025 focused on identifying areas where ENABLE DHC technical support could provide the greatest added value. The discussions helped refine the technical scope of the

investment assessment and supported the selection of the measures subsequently evaluated in the scenario analysis.

The preferred pathway presented in this investment plan is therefore based on the technical assessment carried out within ENABLE DHC and on the priorities discussed with the local stakeholders. However, it should not yet be interpreted as a formally endorsed final investment decision. Final validation and endorsement by Poltavateploenergo and the relevant local stakeholders remain part of the concluding review of the investment plan.

Further stakeholder engagement during project development should include the electricity-system operator, permitting authorities, financing institutions, technology suppliers and other actors required to move from strategic investment planning toward implementation.

4. Conclusions and Key Lessons

The Poltava investment-planning process demonstrates that deep decarbonisation of an existing district-heating system requires an integrated transformation of heat generation, electricity supply, thermal storage and network operation, rather than the replacement of individual assets in isolation. The assessment confirms that large-scale electrification through heat pumps, supported by renewable electricity and thermal energy storage, can substantially reduce dependence on natural gas while preserving the operational flexibility required for reliable district-heating supply.

Among the assessed alternatives, Scenario 2 — combining a large-scale heat pump, photovoltaic generation and thermal energy storage — provides the most balanced pathway for further development. It combines a substantial reduction in fossil-fuel use with lower dependence on imported electricity and strong operational performance. For the representative heat-supply area assessed in detail, the scenario reduces natural-gas use by approximately 72% and achieves a qualifying renewable-heat share above 70%, subject to confirmation that the final heat-pump configuration satisfies the applicable efficiency requirements. It therefore provides a credible pathway toward the efficient-DHC requirements while maintaining residual gas-fired capacity for peak, backup and security-of-supply purposes.

The assessment also shows that the preferred scenario should not yet be regarded as an implementation-ready project. Several critical conditions must first be confirmed, particularly the availability and characteristics of the low-temperature heat source, electricity-grid connection capacity, suitable land for photovoltaic deployment, permitting requirements and financing conditions. These issues can materially influence equipment sizing, investment costs and the final technology configuration. The preferred pathway should therefore be advanced through detailed feasibility studies and engineering before a final investment decision is taken.

A further lesson is that long-term regulatory compatibility must be considered from the beginning of investment planning. Meeting the near-term efficient-DHC threshold alone is not sufficient. The selected pathway must retain the flexibility to further reduce residual fossil-fuel use and accommodate additional renewable or waste-heat sources as regulatory requirements become progressively stricter toward 2040, 2045 and 2050. Thermal storage, flexible heat-pump operation and continued network integration are important enabling measures in this respect.

The Poltava case also highlights the importance of distinguishing between resource potential and investment maturity. Several renewable and alternative heat sources have been identified in earlier planning studies, but not all can currently be considered sufficiently mature for investment. Robust

investment planning therefore requires confirmation of source availability, technical compatibility, economic viability and implementation status before such resources are incorporated into the final generation portfolio.

Finally, the investment-planning process confirms the importance of continuous stakeholder involvement. Collaboration between the district-heating operator, municipality, regional authorities, technical experts, financing institutions and infrastructure operators is essential for converting strategic decarbonisation objectives into implementable projects. The next stage should therefore focus on validating the preferred pathway, confirming responsibilities and financing options, and progressively developing the concept toward detailed design, procurement and implementation.

Overall, the Poltava case demonstrates a practical transition approach that may also be relevant to other fossil-fuel-dependent district-heating systems: prioritise system-level optimisation, combine electrification with renewable generation and flexibility, retain sufficient backup capacity during the transition, and preserve a clear pathway toward complete fossil-fuel phase-out.

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