MINISTRY OF FOREIGN AFFAIRS
OF DENMARK

Mykolaiv
city on the wave

Assistance to the Development of the Mykolaiv Masterplan

Energy
Priority Investment Programme (PIP)
Annex No.2 to the Roadmap
Final

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Contents

1 Introduction

This annex provides the PIP for Energy prepared as part of the contribution of COWI to the Mykolaiv Masterplan. The PIP is broken down by investment projects and enabling projects, as well as by short-term, mid-term and long-term projects. Figure 1 below provides the definitions of the terms used.

Figure 1 Definitions

A Priority Investment Programme (PIP) comprises several projects, categorized into investment projects and enabling projects. These projects vary in duration, with some being short-term, others mid-term, and yet others long-term.

Investment projects (IP) – these are municipal investment projects aimed at improving and maybe enlarging current infrastructure and, hence, improving municipal services provided to the population.

Enabling projects (EP) – these are projects aimed at ensuring that infrastructure investments may be implemented and operated successfully, not only in the short- to mid- term but also in the long-term.

Short-term projects (ST) – these are projects to be launched and finalised before 2030.

Mid-term projects (MT) – these are projects to be launched and finalised before 2040.

Long-term projects (LT) - these are projects to be launched before 2050.

The Table 1-1 presents an overview of the PIP in the sector of energy and includes investment and enabling short-, mid- and long-term projects.

Table 1-1 PIP for energy sector, Overview[1]

Project # & type	Title	Costs	Beneficiary
Investment projects			
Short-term projects. Consumption.			
1-STIP	Building new Individual Heating Substations (IHS) and piping system inside the buildings for existing consumers	MEUR 1,6-2,7	MOTE, MCHPP
2-STIP	Thermal modernization of the buildings	MEUR 80-120	MOTE+MCHPP
Short-term projects. Distribution.			
3-STIP	Rehabilitation and reconstruction of distribution electrical grids of Distribution System Operator “MykolaivOblEnergo”	MEUR 60-65	MOE
4-STIP	Replacement of the distribution pipes of Mykolaiv CHPP and MOTE	MEUR 35-40	MCHPP
5-STIP	Building new interconnecting pipelines	MEUR 18-22	MOTE, MCHPP
Short-term projects. Production.			
6-STIP	Construction of biomethane plant at agricultural company «Promin» (Pervomaiskyi district)	MEUR 9	Agricultural company

			"Promin" Ltd, MOTE, MCHPP
7-STIP	Complete reconstruction and rehabilitation of Mykolaiv CHPP	MEUR 9-11	MCHPP
8-STIP	Construction of new biomass-waste incineration CHP	TBD	MOTE+MCHPP
9-STIP	Installation of gas cogeneration units (gas engines)	MEUR 25-30	MOTE+MCHPP
10-STIP	Installation of flue gas recovery heat pumps at biomass-waste CHP	TBD	MOTE+MCHPP
11-STIP	Installation of heat pumps on Bug River	TBD	MOTE+MCHPP
12-STIP	Installation of electrode boilers	TBD	MOTE+MCHPP
13-STIP	Building heat storage accumulator	TBD	MOTE+MCHPP
14-STIP	Installation of multiple local network-connected PV installations	MEUR 4-4,5	MOTE+MCHPP
15-STIP	Installation of wind turbine for small business or utility	MEUR 0,15	MVK or private small business facility
16-STIP	Wind power for Mykolaiv innovative industrial park, Mykolaiv Sea Port or MykolaivVodoKanal	MEUR 1,6-1,8	Mykolaiv innovative industrial park, MVK
17-STIP	Wind Power for Community	MEUR 1,6-1,8	Mykolaiv community
18-STIP	Hybrid Street Lighting	TBD	Mykolaiv community
19-STIP	Small wind turbine for private household	MEUR 0,01	Mykolaiv community
20-STIP	Rooftop small wind turbine for multistorey building	MEUR 0,003	Mykolaiv community
Short-term projects. Monitoring and management.			
21-STIP	Implementation of an automated control system for technological processes	MUAH 12	MCHPP
22-STIP	Implementation of an automatic consumption metering and dispatching system	MUAH 11	MCHPP
Mid-term projects. Consumption.			
1-MTIP	Building new substations (IHS) and piping system inside the buildings for existing consumers and for new consumers	TBD	MOTE+MCHP
2-MTIP	Thermal modernization of the buildings	TBD	MOTE+MCHP
Mid-term projects. Distribution.			
3-MTIP	Replacement of the distribution pipes due to thermal modernization	TBD	MOTE+MCHP
4-MTIP	Building new distribution pipes due to connecting new consumers	TBD	MOTE+MCHP
5-MTIP	Building new interconnecting pipelines	TBD	MOTE+MCHP
Mid-term projects. Production.			
6-MTIP	Installation of energy storage at MCHPP	MEUR 1,1- 1,4	MCHPP
7-MTIP	Installation of gas cogeneration units (gas engines)	TBD	MCHPP
8-MTIP	Installation of additional heat pumps on Bug river	TBD	MCHPP
9-MTIP	Installation of sewage water heat pumps	TBD	MOTE+MCHP

10-MTIP	Heat recovery from excess heat sources	TBD	MOTE+MCHP
11-MTIP	Installation of additional electrode boilers	TBD	MOTE+MCHP
12-MTIP	Hydrogen/hydrogen compounds fuel cells and engines	TBD	MOTE+MCHP
13-MTIP	Building heat storage accumulator	TBD	MOTE+MCHP
Long-term projects. Consumption.			
1-LTIP	Building new Individual Heating Substations (IHS) and piping system inside the buildings for existing and new consumers	TBD	MOTE+MCHP
2-LTIP	Thermal modernization of the buildings	TBD	MOTE+MCHP
Long-term projects. Distribution.			
3-LTIP	Replacement of the distribution pipes due to thermal modernization	TBD	MOTE+MCHP
4-LTIP	Building new distribution pipes due to connecting new consumers	TBD	MOTE+MCHP
5-LTIP	Building new interconnecting pipelines	TBD	MOTE+MCHP
Long-term projects. Production.			
6-LTIP	Installation of gas cogeneration units (gas engines)	TBD	MOTE+MCHP
7-LTIP	Installation of addtional air to water heat pumps	TBD	MOTE+MCHP
8-LTIP	Installation of additional sewage water heat pumps		
9-LTIP	Installation of addtional heat pumps on Bug river		
10-LTIP	Heat recovery from excess heat sources	TBD	MOTE+MCHP
11-LTIP	Installation of additional electrode boilers	TBD	MOTE+MCHP
12-LTIP	Hydrogen/hydrogen compounds fuel cells and engines	TBD	MOTE+MCHP
13-LTIP	Building geothermal plant	TBD	MOTE+MCHP
Enabling projects			
Short-term projects			
1-STEP	Comprehensive hydraulic modelling and energy planning tools	TBD	MOTE+MCHPP
2-STEP	Establishment of a Decarbonisation Office	TBD	MOTE+MCHPP
3-STEP	Heat Supply Scheme Development	TBD	MOTE+MCHPP
4-STEP	Enhancing Public Awareness for Sustainable Solutions	TBD	MOTE+MCHPP
5-STEP	Geothermal Potential Research	TBD	MOTE+MCHPP
6-STEP	Prefeasibility study for defining preconditions for construction of new biomass-waste incineration CHP	TBD	MOTE+MCHPP
7-STEP	Reintroduction of the Domestic Hot Water	TBD	MOTE+MCHPP
8-STEP	Restructuring of DH production facilities	TBD	MOTE+MCHPP

2 Investment projects

This chapter presents investment projects in energy sector.

2.1 Short term projects

For a more comprehensive presentation, all projects were further divided into those related to energy consumption, distribution or production and those related to monitoring and management systems.

1-STIP. CONSUMPTION

Title	**Building new Individual Heating Substations (IHS) and piping system inside the buildings for existing consumers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The primary objectives are: 1. To restore centralized domestic hot water supply system, which will enable the consumption of thermal energy in the summer period, thus allowing the generation of electrical energy in cogeneration plants. Additionally, this will enable the operation of systems using renewable energy, such as solar collectors, which provide peak heat production specifically in the summer period. 2. The implementation of individual heating points will primarily reduce the consumption of thermal energy, especially in thermomodernized houses, provide weather regulation, allow residents to influence their consumption and bills, increase comfort and reliability of heat supply. Two pilot projects should be considered as a first priority: 1- Installation of 107 IHSs in residential buildings supplied from the rehabilitated boiler house located at 42 Samoilovicha st.; 2- Installation of 84 IHSs in residential buildings supplied from the rehabilitated boiler house located at 71 Bila st.
Key outputs	Individual heating substations; Domestic hot water installation
Key tasks	1. Centralized hot water has not been provided to consumers since 2018, leading to reliance on individual electric boilers in apartments. These boilers are preferred for their lower cost and quality, influenced by the disparity in electricity pricing for residents and industries. The engineering infrastructure inside buildings has likely deteriorated due to disuse. The primary task is evaluating the condition of these internal networks and planning their restoration.

	2. Reinstating in-house networks will probably necessitate replacing pipes within residents' apartments, which calls for a planned repair program or compensation for the residents. 3. There are no legal requirements forcing residents to permit the reinstallation of hot water pipes or to use the centralized system again, so educating the public about the benefits of this system is crucial. 4. Pilot projects could focus on municipal buildings like hospitals or kindergartens, located near CHP plants or boiler houses, as these locations are more conducive to network restoration. By 2030, it's estimated that about 5% of consumers, or roughly 4400, will have new installations, including households, service industries, and public consumers.
Expected timeline of project	2024-2027
Estimated investment cost (CAPEX)	Pilot Project 1 - MEUR 2.1-2.7; Pilot Project 2 - MEUR 1.6-2.1. The cost of an individual heating point depends on its power, network characteristics, and additional features. However, a typical installation for a nine-story building can be estimated at 20-25 thousand euros.
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: 4.31 Production of heat/cool from fossil gaseous fuels in an efficient district heating and cooling system
Critical observation points	*Design parameters of IHS and internal building pipe network should consider future low temperature operation and centralised domestic hot water production. To achieve the best results in terms of energy savings and the potential to utilize the energy efficiency of equipment, IHS should be installed for 100% of consumers. The use of renewable energy sources is essential for ensuring a low tariff on hot water, which is the main, if not the only driver, that will help convince the population to use centralized hot water supply again.
Related studies, projects and programmes	Mykolaivoblteploenergo (hereafter MOTE) is a participant in the Ukraine District Heating Energy Efficiency Project (UDHEEP), which is financed by loans from the International Bank for Reconstruction and Development (IBRD) and the Clean Technology Fund (CTF). In the framework of the Project MOTE implemented Contract No. UDHEE-MYK-ICB-06 dated

	December 18, 2017, "Installation of Individual Heat Points in Mykolaiv" for the design, manufacture, testing, delivery, installation, commissioning, and commissioning of individual heating substations points in Mykolaiv. According to the contract, 92 IHSs have been installed.
Readiness of project documents, including design documents	Design documentation for the selected buildings has not been prepared. However, as already mentioned above, MOTE has extensive experience in installing IHS under Contract No. UDHEE-MYK-ICB-06. This experience, technical specifications, and developed tender documentation can be used as a reference, although they do not presuppose the use of centralized hot water supply.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The project in Mykolaiv represents a detailed plan to address the persistent lack of a centralized hot water supply, as well as a dependency on an outdated and inefficient district heating system. The goal is to restore a dependable and resourceful hot water system by building new Individual Heating Substations (IHS) and renovating the worn internal piping systems. This initiative will guide the city toward adopting more sustainable and energy-efficient heating methods, granting inhabitants increased control over heating levels and energy usage, thereby enhancing their living standards. Furthermore, it aims to rectify the current heating system's hydraulic inefficiencies. This endeavour is in line with extensive strategies to update the urban infrastructure and incorporate renewable energy sources.
Beneficiary	MOTE
Other stakeholders	District heating

2-STIP. CONSUMPTION

Title	**Thermal modernization of the buildings**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the efficiency of heat consumption
Key outputs	Improved building insulation, resulting in lower heat consumption
Key tasks	20% of the buildings connected to the DH network should undergo thermal modernization. The MCA prioritises the following buildings: 1. Mykolaiv Secondary School of I-III degrees No. 23 at 10, Garnizonna st., Mykolaiv (priority)

	2. The building of the Communal Institution "City Geriatric House of Mercy named after Saint Nicholas" at 2 Naberezhna st., 1-d, 3. Mykolaiv Secondary School of I-III Grades No. 45 at.4 Longitudinal st.,58 4. Mykolaiv Secondary School of Grades I-III No. 56 at the Cosmonautiv st., 138-A. (1 start-up construction complex) 5. Mykolaiv secondary school of grades 1-III No. 1 named after O. Olzhycha at 8, Aivazovsky st. 6. The building of No. 111 "Buratino" preschool educational institution (DNZ) at 4A Korabeliv Ave. 7. The building of No 144 preschool educational institution at 42 Okeanivska st. 8. the building of No 106 preschool educational institution at 297, Bogoyavlenskyi Ave. 9. Mykolaiv Secondary School of Grades I-III No. 4 at M. Morska st.,78 10. The building of preschool educational institution No. 52 at 7-B Parusny Ave. 11. Mykolayiv secondary school of grades I-III No. 20 at 70, Cosmonauts st. 12. Mykolaiv No 44 Secondary School of Grades I-III at 2/6 Znamenska st. 13. Mykolaiv No 6 Secondary School I-III grades of the Mykolaiv City Council of the Mykolaiv Region at the address: Mykolaiv, 2-A Kurortna st. 14. The building of gymnasium No. 4 at 48, Lazurna st., Mykolaiv (1-launch construction complex)
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	MEUR 80-120
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation Key activities according to the EU Taxonomy Compass: (9.3.) Professional services related to energy performance of buildings Reduced heat consumption leading to a reduction in CO_2 emissions.
Critical observation points	The priority should be given to public facilities such as hospitals or kindergartens, which will also help reduce budget spending on utility bills. Alternatively, it could be directed to residential buildings that are already equipped with individual heating units (IHUs) and receive heat from recently reconstructed boiler houses. This approach will enable us to achieve maximum energy resource savings.

	Analysis of the current situation regarding building insulation should be carried out. Subsequently, estimates should be made to determine if thermal modernization on this scale is possible within the suggested time period.
Related studies, projects and programmes	As of 2024, Ukraine offers several programs for thermal modernization of residential buildings: 1. Government Program for Thermal Modernization: Targets buildings built before the 1990s, planning to retrofit 5,000 multi-family buildings. Managed by UKRFINZHYTLO (UFZhK), it provides long-term loans to local governments at 3-5% interest. Local governments select buildings for upgrade and offer grants covering up to 30% of costs 2. Energy Independence Program by President Zelenskyy: Aims to reduce imported energy consumption, expected to lower heating costs for over 1.5 million citizens and create about 170,000 jobs. 3. Program of Assistance to Communities in Thermal Modernization: Offers energy consulting, supports thermal modernization projects, and includes measures like energy audits, insulation, and installation of energy-saving windows and renewable energy sources. 4. IQ Energy Project by European Bank for Reconstruction and Development (EBRD): Provides compensation of up to 20% for the cost of thermo-modernization in houses and flats. Participants can purchase energy-efficient equipment on hire purchase terms and apply for compensation via the IQ Energy website.
Readiness of project documents, including design documents	Currently there is no design documentation or tender documentation available.
Funding opportunities	Government Program for Thermal Modernization, Energy Independence Program by President Zelenskyy, IQ Energy Project by EBRD
Interested local companies	To be identified
Background	In recent years, Ukraine has identified energy efficiency and the reduction of imported gas consumption as its foremost national priorities. This shift reflects a strategic move towards sustainable development and energy independence. The support for this priority is evident in the enactment of several key laws, such as the Law of Ukraine "On Energy Saving." This legislative framework underscores Ukraine's commitment to a greener and more energy-resilient future. A significant focus of Ukraine's energy efficiency drive is the residential building sector. In cities like Mykolaiv, as well as across Ukraine, the majority of residential buildings were constructed according to Soviet

	norms, which did not prioritize energy efficiency. These buildings, characterized by their high energy consumption and inefficiency, present a major challenge and an opportunity for Ukraine's energy policy. The process of thermal modernization of buildings is pivotal in addressing this challenge. Supported by laws such as the Law of Ukraine "On Energy Efficiency of Buildings" and the Law of Ukraine "On the Energy Efficiency Fund," this process is not just a mere regulatory compliance but a transformative step towards significantly reducing heat consumption in District Heating (DH) systems. The implications of such reductions are profound: they lead to decreased capacity requirements for heat supply sources and enable the transition to a low-temperature heating system. This transition plays a crucial role in enhancing the efficiency of heat transfer and opens up new possibilities for the use of renewable and efficient heat sources, such as heat pumps. By retrofitting buildings to be more energy-efficient, Ukraine not only reduces its reliance on imported gas but also lays the groundwork for a more sustainable energy system. These efforts are complemented by the introduction of renewable energy sources, which further diversifies Ukraine's energy mix and reduces its carbon footprint. The thermal modernization of buildings in Ukraine, especially in Soviet-era constructions, is therefore not just an energy policy measure but a fundamental reshaping of the urban landscape towards sustainability. It represents a critical step in Ukraine's journey towards energy independence and a sustainable future. By prioritizing energy efficiency and reducing reliance on imported gas, Ukraine is not only addressing its immediate energy security concerns but also setting a precedent for future generations on the importance of sustainable living and proactive environmental stewardship. According to the available data, the municipal housing stock includes 3.008 buildings with a total area of approx. 6.233 million square meters.
Beneficiary	MOTE+MCHPP
Other stakeholders	

3-STIP. DISTRIBUTION

Title	**Rehabilitation and reconstruction of distribution electrical grids of Distribution System Operator "MykolaivOblEnergo"**
Sector	Electricity distribution and supply
COWI comment	Municipal project in line with COWI Masterplan
Objective(s)	The project's objectives include constructing, modernizing, and reconstructing power grids and equipment under the Mykolayiv Oblast Distribution System Operator (MOE). It introduces the unique use of 20 kV networks in the region, which will enhance the reliability and capacity of the power distribution system.

	The project is aimed at strengthening the region's power supply by updating old structures and integrating advanced technologies for efficient energy distribution. In addition, project includes upgrade of the electrical distribution network with automated control technology. This will improve the speed and reliability of network operations. The system will collect and process data in real time, allowing for immediate adjustments and better network management. The upgrade is essential for enhancing the efficiency of the regional power distribution system.
Key outputs	1. Construction, modernization, and reconstruction of electrical networks and equipment. 2. Measures to reduce non-technical electricity consumption. 3. Implementation and development of automated dispatch and technological control systems (ADTCS). 4. Implementation and development of information technologies and communication systems. 5. Modernization and procurement of wheeled vehicles.
Key tasks	MOE actively collaborates with various donors and conducts a significant amount of work independently, so the current situation is constantly changing. This means that the first task in cooperation with MOE is to update the current status and priorities. As of the beginning of 2024, a number of key tasks have been identified, aimed at improving the reliability of the city's energy supply, as well as reconstructing the infrastructure to connect cogeneration plants, which are currently actively being acquired by donors for MOTE and are one of the main priorities: • Constructing a 150 kV cable line of approximately 6.5 km to enhance city-wide electrical communication. • Developing an automated dispatch control system for electrical networks. • Reconstructing the 150 kV external electrical networks, including integration of wind farm generation from Ochakiv district to the "Lisky" substation. • Upgrading the distribution network voltage from 6 kV to 20 kV.
Expected timeline of project	2024-2026

Estimated investment cost (CAPEX)	MEUR 60-65 for the full investment Programme
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) climate change mitigation, Key activities according to the EU Taxonomy Compass: (4.9) Transmission and distribution of electricity
Critical observation points	JSC 'Mykolaivoblenergo', responsible for key infrastructure, faced targeted attacks during the 2022-2023 winter. Consequently, detailed information regarding the infrastructure's condition and the company's development plans is classified. Additionally, it should be noted that the investment program envisages the reconstruction of networks throughout the Mykolaiv region, whereas the volume of investments required for the city of Mykolaiv itself is significantly lower.
Related studies, projects and programmes	The joint-stock company "Mykolaivoblenergo", which operates the distribution system in Mykolaiv and Mykolaiv region, has developed a detailed development plan and investment program for the enterprise for the years 2022-2026. This plan is based on the resolution of the National Commission for State Regulation in Energy and Utilities dated 04.09.2018 № 955 "On the Approval of the Procedure for the Development and Submission for Approval of Development Plans and Programs of Distribution System Operators". This development plan contains a very detailed description and planning of financing for all technical measures.
Readiness of project documents, including design documents	The Development Plan features detailed reconstruction plans, although obtaining more information is currently difficult due to its classified status.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	JSC "Mykolayivoblenergo" is a distribution system operator that conducts licensed activities in the territory of the Mykolayiv region, covering an area of 24.6 thousand km^2 and serving a population of over 1,093.4 thousand people. The company is comprised of 20 separate structural divisions (branches) and the management. As of January 1, 2021, AT "Mykolayivoblenergo" has 4 971,138 km of overhead lines and 33,523 km of cable lines with nominal voltages of 35-150 kV, including 4 590,555 km of overhead lines 35-150 kV and 1,482 km of cable lines 35 kV, whose service life exceeds 30 years, and

	822,446 km of overhead lines 35-150 kV, which require reconstruction and replacement. The total number of installed transformers in the networks is 6-150 kV is 6412 units (3 555,579 MVA), including 47 transformers at 150 kV (1 358 MVA) and 281 at 35 kV (986,8 MVA). The main years of commissioning of substations with 35-150 kV voltage levels occurred between the 1960s and 1990s. Therefore, the service life of most substations ranges from 25 to 55 years. From 2018 to 2022, a large number of renewable energy sources, primarily solar and wind stations, were commissioned in the region. Although the introduction of new capacities slowed down with the onset of the full-scale war, currently, there are plans to build or commission a large number of powerful wind and solar stations in the area. This is partly because the sea coasts offer the best wind potential, and all coasts except for the Mykolaiv region are temporarily occupied, making the Mykolaiv region the best place in Ukraine for building such wind stations.
Beneficiary	MOE
Other stakeholders	

4-STIP. DISTRIBUTION

Title	**Replacement of the distribution pipes of Mykolaiv CHPP and MOTE**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The reconstruction of the most worn-out sections of the heating network with the replacement of pipes. Increasing the efficiency of the heat distribution, adjusting existing pipes for future low temperature operation, removing local bottlenecks. Priority: The replacement of emergency network sections with diameters ranging from 250 to 720 mm aims to reconstruct 14.7 km of main network sections out of a total length of 50.7 km.
Key outputs	New pipes, distribution network
Key tasks	Replacement of approx. 50 km of existing pipes for highly insulated pipes, adjusted for low temperature operation for MCHPP and MOTE DH networks.
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	MEUR 35-40
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation, Key activities according to the EU Taxonomy Compass:

	(4.15) District heating/cooling distribution Increased efficiency will allow reducing heat production, and thereby decreasing CO_2 emissions.
Critical observation points	The current approach for pipeline renovation in the Mykolaiv Thermal Power Plant involves replacing pipes using the same sizes and dimensions as the existing ones. Simultaneously, the Masterplan suggests shutting down some of the smaller, local boiler houses within the MOTE operational area and rerouting their consumers to MCHPP. It is recommended to first develop a comprehensive plan for this subscriber transition and perform hydraulic modeling. This ensures that during pipe replacement, the new pipes are fitted with optimized diameters suitable for the updated network layout and requirements.
Related studies, projects and programmes	Replacement of 720 mm pipe section in 2023 financed by IOM
Readiness of project documents, including design documents	There is a detailed scheme and description of priority of pipes section to be replaced available at Mykolaiv CHPP. Regarding MOTE DH networks, decision making process require further investigation (supported with hydraulic analysis).
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The Mykolaiv CHPP controls around 50.7 km of heating networks. Most of these networks, extending over 41 km, have been in use for over 25 years, resulting in significant energy losses and a high incidence of system failures. Complications escalated during the 2022-2023 heating season when station personnel resorted to using saline water from the Buzkyi Liman for network water supply, leading to severe pipe damage. Despite substantial repairs in summer 2023, funded by donors like IOM, including replacing major 720 mm diameter pipe sections, the condition of these networks remains dire. This has led to extended heating interruptions for several customers at the onset of the heating season. Presently, maintenance teams are almost continuously engaged in fixing recurring local breakdowns across the city.
Beneficiary	MOTE+MCHPP
Other stakeholders	

5-STIP. DISTRIBUTION

Title	**Building new interconnecting pipelines**
Sector	District heating
COWI comment	COWI Proposal

Objective(s)	The objective is to merge several distributed district heating networks into one large system using a set of interconnecting pipes. These interconnecting pipelines will be separated from distribution pipelines by heat exchangers or shunting stations, as operation temperatures may vary for each network. Heat sources will primarily feed into the interconnecting pipelines.
Key outputs	New pipes, transmission network
Key tasks	Building approx.15 km of new interconnecting pipelines. (Possibly starting from connecting new built CHP with the location of the well-developed DH network).
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	MEUR 18-22
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation, Key activities according to the EU Taxonomy Compass: (4.15) District heating/cooling distribution By utilizing more efficient technologies and incorporating renewable energy, centralized district heating systems can contribute to lower emissions of greenhouse gases and pollutants compared to decentralized heating systems.
Critical observation points	The suggested reinforcements would require the installation of approximately 70 km of new pipes, including both distribution and transmission, by 2030—an enormous undertaking in a relatively short time. Drawing on experience from the Danish and Polish markets where the average length of new pipelines built by a district heating company is approximately 6 km per year, it is apparent that the limiting factors include financial resources, the availability of manufacturing for the required components, and executive teams. To meet this goal, Mykolaiv city will need substantial financing and resources for labour and materials. As many cities in Ukraine are expected to undergo reconstruction during this time, securing these requirements might be challenging, though not impossible.
Related studies, projects and programmes	Not available
Readiness of project documents,	To precisely determine the loads, diameters, and lengths of the pipelines, a heating supply scheme needs to be developed. This scheme will

including design documents	include an analysis of all heat sources and consumers, as well as a hydraulic calculation of the network.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The roadmap includes a significant reduction in the number of heat sources within the city from the current count of over 95. The projected strategy involves concentrating heat production in large cogeneration plants operating on biofuel located outside residential areas. The individual networks, currently served by separate boiler houses, are to be interconnected with main networks that distribute the heat carrier from centralized sources.
Beneficiary	MOTE+MCHPP
Other stakeholders	

6-STIP. PRODUCTION

Title	**Construction of biomethane plant at agricultural company «Promin» (Pervomaiskyi district)**
Sector	District heating and power (Combined heat and power)
COWI comment	Municipal project in line with the COWI Masterplan
Objective(s)	• To provide consumption of biomethane in Mykolaiv city • To decarbonize the Mykolaiv city gas sector through increased biomethane consumption
Key outputs	• Initiate operation of the biomethane plant at agricultural company 'Promin' Ltd. • Produce 4 mln m3/yr of biomethane. • Enable actual or virtual supply of biomethane for gas boiler plants/CHP plant in Mykolaiv city. Most likely, it will be virtual providing based on mutual accounting of biomethane supplied into a gas pipeline and consumed in Mykolaiv city. • Reduce consumption of natural gas by boiler plants/CHP plant in Mykolaiv city.
Key tasks	• To perform a feasibility study for the construction of a biomethane plant at agricultural company «Promin» Ltd. • To study the possibility and feasibility of supplying the produced biomethane into existing nearby GTS/GDS pipelines.
Expected timeline of project	2025-2028
Estimated investment cost (CAPEX)	CAPEX for a plant of 4 mln m^3/yr biomethane production is about 353 MUAH (9 MEUR), including:

	• Cost of Equipment: 272 MUAH (6.9 MEUR) • Cost of Civil Works: 81 MUAH (2.1 MEUR)
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) climate change mitigation, (5) pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.24) Production of heat/cool from bioenergy (4.19) Cogeneration of heat/cool and power from renewable non-fossil gaseous and liquid fuels
Critical observation points	• The current situation related to the war. • Agricultural company “Promin” Ltd. (the biggest farm in the Mykolaiv oblast) is located in Pervomaiskyi district, approximately 160 km from Mykolaiv city. There appear to be no Gas Transmission System (GTS) pipelines close to “Promin”, the nearest zone of transmission pipelines being at a distance of roughly 35-40 km. If “Promin” begins producing biomethane, the question of how it will be supplied to a gas pipeline arises. This issue requires exploration of two points: (1) whether it is possible and feasible to lay a new pipeline towards the nearest existing GTS pipelines (35-40 km), and (2) whether a local Gas Distribution System (GDS) pipeline, which might be much closer to “Promin”, exists and we are not aware of it. Should the connection to the nearest GTS/GDS pipelines be impossible or infeasible, the project may need to be redesigned for power production from biogas.
Related studies, projects and programmes	• The National Recovery Plan. • The Program of complex modernization of Combine Heat and Power (CHP) plants and heating plants of Naftogaz Group. • Denmark and the Mykolaiv oblast signed a memorandum on reconstruction in March 2023. Danish Government provides financial support for the reconstruction of heating system in Mykolaiv city.
Readiness of project documents, including design documents	Agricultural company “Promin” Ltd. is planning to construct a biogas plant to cover its electricity needs and to sell the surplus biogas. Before the Russian invasion in 2022, “Promin” had planned to commence construction of the biogas plant in 2024. Consequently, some design documents related to the biogas plant might already be available. However, further clarification with the company is needed.
Funding opportunities	To be identified
Interested local companies	To be identified

Background	The problem addressed is the need in decarbonization of Mykolaiv city gas sector. This is important because it is in line with general Ukraine's energy policy aimed at climate change mitigation, green transition and strengthening of energy security.
Beneficiary	Agricultural company "Promin" Ltd, MOTE, MCHPP
Other stakeholders	City of Mykolaiv, NSC "Naftogas Ukraine".

7-STIP. PRODUCTION

Title	**Complete reconstruction and rehabilitation of Mykolaiv CHPP**
Sector	District heating
COWI comment	Municipal project, variant A for main production unit
Objective(s)	The project's goal is to completely reconstruct the existing Mykolaiv CHPP to increase plant efficiency and enhance the plant's maneuverability. It aims to utilize renewable resources to enable the station to balance the production of thermal and electrical energy efficiently, allowing it to operate effectively in the current electricity market by quickly adjusting its output according to demand.
Key outputs	1. A new turbine for efficient electricity generation. 2. 80 MW gas piston generators with heat recovery for flexible power output and market participation. 3. Condensing heat utilizers for boilers to enhance energy efficiency and reduce gas usage. 4. Upgraded boiler-turbine department with energy-efficient burners to improve efficiency and lower emissions. 5. Frequency converters on exhaust fans for optimized fuel combustion and energy savings. 6. An industrial energy storage system for emergency power and balance of thermal and electrical output. 7. A heat pump system using the low potential heat from the Bug estuary to increase overall system efficiency
Key tasks	• Replace the existing inefficient turbine that has exhausted its operational lifespan with a new 15 MW capacity turbine to provide a reliable base source of electricity with high energy efficiency. • Install a set of 80 MW gas piston generators with heat recovery boilers to equip the station with flexible and responsive units. These generators can swiftly adjust their power output, allowing the station to effectively participate in the electricity market. • Install condensing heat utilizers for each steam boiler to increase energy efficiency and lower gas consumption. • Reconstruct the boiler-turbine department by replacing existing burners on steam boilers TKP-2 No. 1 and No. 2 with energy-efficient burners to improve efficiency and significantly reduce emissions.

	• Install frequency converters on the motors of smoke exhaust fans and ventilators for more precise control of the combustion process, reducing gas and electricity usage. • Install an industrial electrical energy storage system for emergency disconnection reserve and regulation of the thermal and electrical energy balance. • Build heat pumps on the Bug river to utilize the thermal energy of the waters of the Buzkyi estuary, with the plant's own generators as a power source.
Expected timeline of project	2024-2027
Estimated investment cost (CAPEX)	MEUR 15-20
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) climate change mitigation, (5) pollution prevention and control, Key activities according to the EU Taxonomy Compass: (4.29) Electricity generation from fossil gaseous fuels (4.31) Production of heat/cool from fossil gaseous fuels in an efficient district heating and cooling system
Critical observation points	Developing a hydraulic model and determining the number of consumers and loads are critical steps in developing the overall reconstruction plan.
Related studies, projects and programmes	In 2021-2022, Wärtsilä developed the concept of a Dynamic Thermal Power Plant, which includes all the technical solutions described in this project and models the thermal power plant's operation within Ukraine's energy system.
Readiness of project documents, including design documents	One of the highest priorities is reconstructing two boilers, as the existing emissions permit expires in 2026 and a new permit is unattainable without measures to reduce NOx emissions. MCHPP has financed the development of detailed project documentation, which has already undergone expert evaluation.
Funding opportunities	Swedfund
Interested local companies	To be identified
Background	The Public Joint-Stock Company "Mykolaiv CHP" supplies thermal and electrical loads to Mykolaiv, providing about 40% of multi-story residential buildings with thermal energy and becoming the sole source of electrical generation for the city during power outages.

	The CHP's main equipment includes four power boilers, three water heating boilers, and three turbines, with installed thermal capacity of 410 Gcal/h (477 MW) and a connected load of 177 Gcal/h (206 MW). The consumers include 777 multi-apartment buildings, 87 schools and kindergartens, and 19 hospitals, mainly in the industrial district. The main equipment has been in operation for 30 to 60 years and requires reconstruction or replacement.
Beneficiary	MCHPP
Other stakeholders	

8-STIP. PRODUCTION

Title	**Construction of new biomass-waste incineration CHP**
Sector	District heating
COWI comment	COWI Proposal, variant B for main production unit
Objective(s)	To increase the share of renewable energy sources in the overall heat production mix. To build a reliable baseload unit that operates year-round and will partially replace gas operations. To utilize waste without the need for preparing a new landfill.
Key outputs	Biomass-waste CHP plant, baseload unit
Key tasks	Develop a feasibility study to find the optimal location and capacity for a biomass-based CHP (alternatively biomass-waste). Develop project documentation, including the preparation of an Environmental Impact Assessment (EIA) and conducting public hearings.
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	Not available without feasibility study
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.20) Cogeneration of heat/cool and power from bioenergy Reduced emission of CO_2 Reduction in the amount of waste landfilled
Critical observation points	The limited amount of waste and strict environmental regulations necessitate a careful approach to the selection of the waste-to-energy plant's location and the coordination of the plant's capacity with existing and future strategic documents. This includes alignment with the city's

	Sanitation Scheme, adopted in 2023, and the "Technical and Economic Feasibility Study for the Object: New Construction of MW Treatment Complex in Mykolaiv City," which is currently under development.
Related studies, projects and programmes	It is an alternative to the rehabilitation of the existing CHP, as presented by MCHP. According to a report from the REA, there is sufficient reason and biomass potential in the region to build such a plant.
Readiness of project documents, including design documents	The Mykolaiv City ordered implementation of “A technical and economic feasibility study for the object: New construction of MW treatment complex in Mykolaiv City” with the SE "Scientific-research and design-technological institute of urban economy". According to the ToR the FS will analyse different technical options for MW treatment facility and assess the costs of various options. The FS should be finalised in March 2024.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The construction of a facility for processing and incinerating solid household waste is a priority project, as requested by all partners collaborating with COWI in the Masterplan development, including the city administration, MOTE, and MCHPP. While the improvement of the waste collection and transportation systems, the construction of a Mechanical Biological Treatment (MBT) facility with Refuse-Derived Fuel (RDF) production, and the construction of a sorting line for recyclables are well-documented in the Priority Investment Program for Solid Waste Management, the construction of a waste incineration plant post sorting, and recycling requires additional explanation. The residual solid household waste post sorting and recycling is an excellent energy source, and the construction of a waste-to-energy plant is considered essential. This facility offers several benefits, such as waste disposal without the need for new landfills and a significant reduction in natural gas usage, providing a source of heat and electricity. According to available data, Mykolaiv city produces approximately 100,000 tons of waste per year, and the Mykolaiv region produces a similar amount. Building several such stations (e.g., one for the city and another for the MCHPP) is impractical, as the waste volume post sorting, and processing would be reduced by about 30-40%. This volume would only suffice to supply heat and hot water to approximately 80-100 apartment buildings. Considering the low and unstable calorific value of waste combustion, it is suggested to explore the possibility of co-firing solid household waste with solid biofuel to maintain the necessary combustion temperature for ecological safety and facilitate the plant’s operation. A final decision must be supported by a detailed techno-economic analysis.

Beneficiary	MOTE+MCHP
Other stakeholders	

9-STIP. PRODUCTION

Title	**Installation of gas cogeneration units (gas engines)**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The project's objective is to enhance the reliability and efficiency of the heating system in Mykolaiv by reconstructing and modernizing existing boiler houses and introducing cogeneration units, with a focus on transitioning to renewable energy sources like biomethane.
Key outputs	• Modernized and reconstructed boiler houses • Installation of cogeneration units for improved efficiency and reliability • Reduced number of heat sources
Key tasks	• Develop a hydraulic model of the network to determine specific locations and capacities for installations. • Coordinate network reconstruction to align with diameters and layout schemes. • Coordinate with Mykolaiv Combined Heat and Power Plant (MCHPP), given that some boiler houses proposed for reconstruction lie within the MCHPP heating supply zone, and their consumers could be connected to MCHPP, significantly reducing necessary investment sizes.
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	MEUR 25-30
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.20) Cogeneration of heat/cool and power from bioenergy Reduced emission of CO_2 Reduction in the amount of waste landfilled
Critical observation points	The main challenge lies in the uncertainty of initial data, particularly in the number and capacity of the installations. This uncertainty arises from various factors, such as the feasibility of connecting consumers to MCHPP networks, the electrical grid's capability to handle such capacity, and the technical possibility of integrating different boiler networks into a

	single system. In the short term, it is recommended to prioritize the development of 7 cogeneration stations, as this is a key project for MOTE with detailed planning already in place. For these cogeneration units, the locations have been selected, their capacities determined, and an agreement has been reached with an electric power distribution company for their connection. A list of critical infrastructure facilities to be powered by these units, including centralized water supply systems, has also been established
Related studies, projects and programmes	MOTE reports that an agreement has already been reached for the supply of several cogeneration units with USAID and IOM
Readiness of project documents, including design documents	MOTE undertakes the responsibility to finance the preparation of detailed design documentation, as well as to ensure the acquisition of all necessary permits and agreements with all stakeholders.
Funding opportunities	USAID, IOM
Interested local companies	To be identified
Background	During the development of the Masterplan and in collaboration with MOTE, the latter provided plans for reconstructing existing boiler houses, specifically: 1. Reconstructing 27 low-capacity boiler houses, primarily fitted with inefficient NIISTU-5 boilers. 2. Constructing 7 Combined Heat and Power plants with a capacity of 2-4 MW each. 3. Reconstruction of the boiler room at Mykolaiv School of I-III degrees No. 23. 4. Reconstruction of the boiler house at 11, Kurortna st, Mykolaiv providing heat supply for 2 schools, 2 preschool educational institutions, and 74 residential buildings, 10MW 5. Reconstruction of the boiler house at 51, Karpenko st, Mykolaiv providing heat supply for 1 school, 1 preschool educational institution, and 48 residential buildings, 5MW The highest priority is given to the installation of cogeneration units to enhance system reliability, especially vital during wartime, by providing backup power. This vision involves reducing the total number of boiler houses. Mobile engines/boilers are introduced to partially replace old gas boiler houses, of which there are approximately 94, with fewer, larger mobile units, connected by transmission pipelines. The locations of the mentioned 27 boiler plants, as well as 7 cogeneration units, are shown on the map in Figure 2 below.

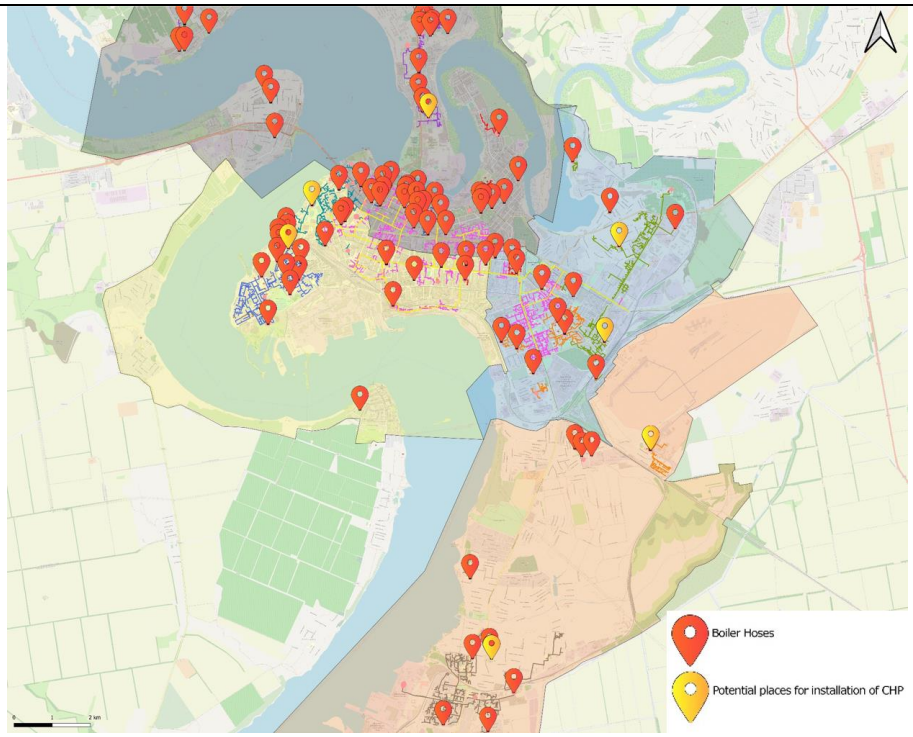

Figure 2 Places of location of 27 BHs and 7 cogeneration units

By March 2024 MOTE has performed certain amount of work on the installation of the following cogeneration units:

- 2 cogeneration units (3MW) at 42, Samoilovycha st. Remaining work includes telemechanics and electricity supply.
- 2 cogeneration units (1MW) at 71, Bila st. Remaining work includes telemechanics, gas and electricity supply.
- 5 cogeneration units (11MW) at 36, Vodopiyna st. Dismantling and site preparation are currently underway.

It is important to note that the cogeneration units can initially operate on natural gas and may later switch to biomethane from a planned plant. In the long term, these units could be relocated and consolidated. The definitive number of units, their locations, and capacities will require separate, detailed analysis.

Beneficiary	MOTE
Other stakeholders	

10-STIP. PRODUCTION

Title	**Installation of flue gas recovery heat pumps at biomass-waste CHP**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the operation efficiency of CHP plant + the share of renewable energy sources in overall heat production mix

Key outputs	Heat pumps at CHP, base load unit
Key tasks	Flue gas recovery heat pumps may operate as the initial stage for preheating district heating water, which could then be reheated at the CHP plant.
Expected timeline of project	2028-2029
Estimated investment cost (CAPEX)	Will be delivered later
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.16) Installation and operation of electric heat pumps (4.20) Cogeneration of heat/cool and power from bioenergy
Critical observation points	No critical observation points.
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	Combining heat pumps with cogeneration units represents a powerful approach to enhancing the efficiency of energy systems. It is a strategy that can improve economics and reduce environmental impacts by: 1. Increasing overall energy efficiency with cogeneration units that simultaneously produce electricity and heat, achieving higher efficiency compared to separate generation systems. Heat pumps complement this by utilizing low-grade heat to further increase system efficiency. 2. Offering flexibility in load management as heat pumps can help balance the disparity between energy production and consumption, particularly during peak periods. This leads to more flexible energy resource distribution and greater system reliability. 3. Improving economic efficiency through the integration of heat pumps that leverage waste heat from cogeneration units. This

	reduces the consumption of primary energy resources and energy costs. 4. Reducing carbon dioxide emissions as the integration contributes to efficient energy use and diminishes greenhouse gas emissions by curbing fossil fuel use and promoting renewable energy.
Beneficiary	MOTE+MCHP
Other stakeholders	

11-STIP. PRODUCTION

Title	**Installation of heat pumps on Bug River**
Sector	District heating
COWI comment	COWI proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix. Building reliable base load unit working whole year long that will partially replace gas operation.
Key outputs	River water heat pumps, base load unit
Key tasks	Finding optimal location for placing of heat pump on Bug River
Expected timeline of project	2028-2029
Estimated investment cost (CAPEX)	Not available without feasibility study
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.16) Installation and operation of electric heat pumps
Critical observation points	To effectively use heat pumps, which mainly produce heat up to 60-65 ℃, a comprehensive strategy is necessary, particularly for heating systems originally designed for higher temperatures of 95 ℃. The plan involves creating mixed heating systems that combine heat pumps with traditional heating for colder days, underlining the need for building improvements and better insulation to reduce heat requirements. It also includes the use of intelligent controls to improve efficiency, applying large-scale heat pumps for community heating in updated areas, and highlighting the importance of training for those installing and maintaining these systems, as well as educating the public about their benefits
Related studies, projects and programmes	Not available

Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The installation of water/water type heat pumps using low-potential heat from the Southern Bug River is planned in the development plans of MCHPP and is listed as part of the work in project 7-STIP "Complete reconstruction and rehabilitation of Mykolaiv CHPP". However, the installation of heat pumps is envisioned by the roadmap as an independent project to significantly increase the efficiency of heat supply in Mykolaiv, and it makes sense especially considering that in recent years, the Mykolaiv region has had an electricity surplus due to a significant volume of its production from renewable sources. Therefore, installing heat pumps, like other equipment producing heat using electricity, makes sense for balancing the energy system. In this context, a natural and sensible choice is to use Mykolaiv's location and utilize the heat of the Southern Bug River, on which the city is situated.
Beneficiary	MCHPP
Other stakeholders	

12-STIP. PRODUCTION

Title	**Installation of electrode boilers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increase the share of renewable energy sources in the overall heat production mix
Key outputs	Electrode boiler as a peak-load unit
Key tasks	Determine the installation location; potential sites may include existing boiler house areas or adjacent to heat pumps, to reheat water from the heat pumps to the desired temperature.
Expected timeline of project	2024-2026
Estimated investment cost (CAPEX)	Not available without feasibility study
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass:

	(4.23) Production of heat/cool from renewable non-fossil gaseous and liquid fuels
Critical observation points	The primary barrier and limiting factor is the transmission capacity and the condition of the electrical networks. Thus, any such project must be developed in direct collaboration with the MOE.
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	There is currently no design documentation. However, given the technical simplicity of implementing such boilers, this documentation can be developed rapidly.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	Ukraine ranks second in the world for installed capacity of nuclear power plants and the amount of electricity they produce. In 2021-2022, nuclear power plants generated approximately 40% of all Ukraine's electricity. Additionally, the Minister of Energy of Ukraine announced plans to start construction of four new nuclear power units in 2024. In the Mykolaiv region, a significant number of major electricity sources produced from renewable resources, such as wind and solar energy, have been established. This region has been characterized by an electricity surplus for several years. A common attribute of renewable and nuclear energy is their base-load nature; they provide a consistent output and cannot quickly alter power generation to match fluctuating consumer demand. The availability of large quantities of inexpensive electricity from base-load sources suggests that, to balance the consumption of surplus electricity (e.g., during low nighttime demand), robust consumers are needed. Electric boilers, which utilize cheap electricity during off-peak hours to heat water—potentially stored in large tanks—can fulfill this role. The accumulated heat can then be deployed during peak demand periods. Another viable approach is using these boilers as peaking units or for direct heating of low-temperature heat carriers in homes, for example, those supplied from heat pumps.
Beneficiary	MOTE+MCHP
Other stakeholders	

13-STIP. PRODUCTION

Title	**Building heat storage accumulator**
Sector	District heating

COWI comment	COWI Proposal
Objective(s)	Increasing the flexibility of the system
Key outputs	Heat storage accumulator
Key tasks	Determine the location – it should be situated close to the base load unit (biomass-waste Combined Heat and Power (CHP) plant)
Expected timeline of project	2027-2030
Estimated investment cost (CAPEX)	Not available without feasibility study
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (4.11) Storage of thermal energy
Critical observation points	Further analysis regarding the time horizon of storage and storage size can be conducted once the location for the CHP is determined.
Related studies, projects and programmes	The necessity for constructing a heat storage accumulator for the Municipal Combined Heat and Power Plant (MCHPP) was discussed in the concept of a Dynamic Thermal Power Plant developed in 2021-2022 by Wärtsilä. This concept encompasses all the technical solutions described in this project, as well as modeling the operation of the thermal power plant within Ukraine's energy system.
Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The necessity of building a large heat storage accumulator for a District Heating (DH) system and cogeneration units is driven by several factors: 1. Energy Efficiency: Heat storage accumulators allow for the storage of excess heat during periods of low demand and its release during high demand, improving heat utilization and reducing waste.

	2. Load Balancing: These systems enhance load balancing by storing excess heat during off-peak hours, reducing the need for additional heat generation during peak times. 3. Resilience: Heat storage contributes to the resilience of the DH system, providing a backup heat supply in the event of generation interruptions. 4. Integration with Renewable Energy: Accumulators can integrate with renewable energy sources, storing excess heat for consistent supply despite intermittent generation. 5. Reduced Fuel Consumption: With storage, cogeneration units can operate at optimal capacity, storing excess heat instead of wasting it, which can lead to lower primary fuel consumption. 6. Environmental Benefits: By optimizing heat production and minimizing the need for additional heat sources, heat storage accumulators can reduce greenhouse gas emissions and enhance environmental outcomes.
Beneficiary	MOTE+MCHP
Other stakeholders	

14-STIP. PRODUCTION

Title	**Installation of multiple local network-connected PV installations**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	PV installations will generate electricity for the consumer's network. If electricity consumption exceeds PV generation, additional electricity is drawn from the supplier's network. The benefits are: 1. The hospital will achieve cost savings from reduced electricity consumption. 2. Mykolayivoblenergo PJSC will benefit from reduced electric line load, allowing for redistribution to sites with higher demand. 3. The deployment of renewable energy sources will contribute to environmental protection by reducing the level of greenhouse gas emissions and mitigating the effects of climate change.
Key outputs	• Installation of photovoltaic solar systems • Reduction in electricity consumption • Decrease in greenhouse gas (GHG) emissions
Key tasks	Develop a design documentation
Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	Total CAPEX is approximately 4 to 4.5 MEUR with individual project investments as follows (in Ukrainian hryvnia (UAH)): 1. 4.5 MUAH; 2. 5.4 MUAH; 3. 7.3 MUAH; 4. 6.2 MUAH; 5. 0.8 MUAH; 6. 0.8 MUAH; 7. 0.8 MUAH; 8. 0.8 MUAH; 9. 0.8 MUAH; 10. 39.0 MUAH; 11. 93.0 MUAH; 12. 12.0 MUAH

Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.1) Electricity generation using solar photovoltaic technology
Critical observation points	N/A
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The city administration has proposed several priority installations for solar stations: 1. City Children's Hospital No. 2, st. Ryumina 5, 95 kW 2. City Hospital No. 1 at the address of st. 2a Ekipazhna 4, 150 kW 3. City Hospital No. 3 at the address of st. Cosmonavtiv 97, 210 kW 4. City Hospital No. 5 at 336 Bogoyavlenskyi Ave., 160 kW 5. Preschool educational institution No. 140 at the address of st. Hlinky, 7A, 20 kW 6. Preschool educational institution No. 144 at the address of st. Okeanivska, 42, 20 kW 7. Preschool educational institution No. 20 at the address of st. Korabeliv 6, 20 kW 8. Preschool educational institution No. 68 at the address of st. 1st Ekipazhna 4, 20kW 9. Preschool educational institution No. 143 at the address of st. Ozerna 5V, 20 kW 10. Mykolaivvodokanal MCP Water treatment st. Yantarna 324, 1050 kW 11. Mykolaivvodokanal MCP of the TsVDN, 2508 kW 12. MKP "Mykolaivvodokanal" Pumping station III lift,st. Mykolaivska 14, 321 kW 13. CPMSD No. 6 at the address: Mykolaiv, Velyka Korenikha township, st. Garrison, 1st, 30 kW 14. "City Geriatric House of Mercy named after Saint Nicholas" at the address: Mykolaiv, str. 2 Naberezhna, 1-d, 25 kW

	15. PV installation on the territory of MCHPP (0,8 MW) to prevent potential power outage resulting from the energy system destruction
Beneficiary	Department of energy, energy saving and introduction of innovative technologies
Other stakeholders	

15-STIP. PRODUCTION

Title	**Installation of wind turbine for small business or utility**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	Installation of 45-50 kW wind turbine at small business production facility or water utility (Vodokanal) or water treatment utility
Key outputs	• Establish an individual Renewable Energy Source (RES) electricity-generating facility • Green the power supply by incorporating renewable energy • Strengthen the power supply with a backup system option • Reduce electricity bills and fossil fuel consumption
Key tasks	• Determine the specific purpose/application (stand-alone system, reduced consumption, self-generation, uninterrupted operation). • Ascertain the wind potential of the site. • Assess site compliance with Ukraine's sanitary standards (setback distance). • Calculate the required generation capacity/output. • Select appropriate wind equipment / Wind Turbine (WT). • Procure necessary equipment. • Construct foundation. • Install WT and complete system setup.
Expected timeline of project	Approximately 90 days, targeted for 2025
Estimated investment cost (CAPEX)	Estimated investment cost (CAPEX): EUR 0.15 MEUR (Prices are as of 2023 and should be verified at the time of purchase) Including: • WT cost (including 40 m mast, 50 kWh accumulator, cables, 50 kW off-grid inverter etc) – 0.12 MEUR • Construction cost (logistics excluded) 0.03 MEUR
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems

	Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power
Critical observation points	Wind potential and noise impact should be considered
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	Project documents to be developed
Funding opportunities	To be identified
Interested local companies	To be identified
Background	Currently, Mykolaiv and the Mykolaiv region boast the highest wind potential in Ukraine. Therefore, the utilization of wind turbines presents the most promising opportunity for enterprises to reduce their electricity costs and enhance the reliability of their power supply.
Beneficiary	• Mykolaiv Water Treatment Facility • Mykolaiv Water Utility • Private Small Business Facility
Other stakeholders	

16-STIP. PRODUCTION

Title	**Wind power for Mykolaiv innovative industrial park, Mykolaiv Sea Port or MykolaivVodoKanal**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	To install a 4 MW or 5 MW wind turbine within the territories of Mykolaiv Innovative Industrial Park, Mykoliv Sea Port, or the Zhovtneve water reservoir, set for reconstruction under the UMIP and financed by the EIB. Estimated electricity generation – 12,260 MWh to 15,330 MWh, respectively.
Key outputs	• Installation of an individual RES electricity-generating facility • Greening the energy supply • Strengthening power supply systems (adding a backup system) • Reducing electricity bills • Reducing fossil fuel consumption • Capacity building for renewable energy implementation
Key tasks	• Conduct a wind potential assessment

	• Assess site compliance with Ukrainian sanitary standards (700 m setback distance) • Determine the required generation capacity/output • Select a wind turbine/equipment and prepare tender documents • Conduct the procurement process • Construct the foundation • Install wind turbine (WT) • Perform system setting and adjustments
Expected timeline of project	2028-2030
Estimated investment cost (CAPEX)	Estimated investment cost (CAPEX): 1.6 – 1.8 MEUR per MW installed and grid-connected, including: • WT cost – appr. 1.0 MEUR per MW (with potential cost decreases due to raw material/commodity price reductions) • Construction cost 0.6 – 0.8 MEUR per MW (varies based on logistics, site conditions, etc.) **Prices are as of 2023 and should be verified*
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (4) transition to a circular economy (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power • No CO_2 emissions during operation, resulting in minimal carbon footprint among RES (around 11 g CO_2/kWh) • Waterless operation/cooling • High recyclability (currently, up to 94% of a wind turbine can be recycled) • No fuel combustion or related pollution • An ornithological study will be conducted as needed
Critical observation points	• A 700 m setback distance is mandatory for selecting the site for installing the wind turbine • The area's wind potential needs assessment • Conducting an ornithological study, if required
Related studies, projects and programmes	N/A
Readiness of project documents, including design documents	Project documentation should be developed

Funding opportunities	To be identified
Interested local companies	To be identified
Background	The European Investment Bank is supporting the Mykolaiv VodoKanal (MVK) to formulate and implement a sustainable, long-term strategy for a reliable water supply system, spurred by the Russian invasion of Ukraine. Restoring the Zhovtneve reservoir, inactive since 2011 and in close proximity to a water treatment plant, is among the most promising independent drinking water solutions for the city. The integration of wind power turbines will decrease operational costs for MVK and improve the reliability of the city's water supply.
Beneficiary	• Mykolaiv innovative industrial park • Mykolaiv Sea Port • Mykolaivvodokanal (MVK)
Other stakeholders	

17-STIP. PRODUCTION

Title	**Wind Power for Community**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	To install one or several 2-3 MW wind turbines in the locality neighboring Mykolaiv City to reduce energy costs. Refurbished wind turbines may be considered as a cost-saving option.
Key outputs	• Creation of an individual RES electricity-generating facility • Greening of the power supply • Strengthening of the power supply with a backup system • Reduction in electricity bills • Reduction in fossil fuel consumption • Capacity building in renewable energy
Key tasks	• Determine the applications (stand-alone system, reduced consumption, self-generation, uninterrupted operation) • Assess wind potential • Calculate required generation capacity • Select wind equipment or Wind Turbines (WT) • Conduct an Initial Site Environmental Assessment (ISEA) • Procure equipment • Construct foundation • Install WT • Configure the system
Expected timeline of project	2028-2030

Estimated investment cost (CAPEX)	Estimated investment cost (CAPEX)*: For new WTs: 1.6 – 1.8 MEUR per MW installed and grid-connected including: • WT cost – appr. 1 MEUR per MW • Construction cost 0.6 – 0.8 MEUR per MW (aries based on logistics, site conditions, etc.) For renovated WT: CAPEX: 1.15 MEUR: • WT cost - 0.15 – 0.25 MEUR per MW • Construction cost - 0.20 MEUR per MW installed Prices are as of 2023 and should be revisited closer to the time of implementation.
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (4) transition to a circular economy (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power
Critical observation points	• A 700 m setback distance is required when selecting the site for the wind turbine installation • Wind potential should be properly assessed • An Initial Site Environmental Assessment (ISEA) must be conducted
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	Project documentations to be developed
Funding opportunities	To be identified
Interested local companies	To be identified
Background	Currently, Mykolaiv and the Mykolaiv region boast the highest wind potential in Ukraine. Therefore, the utilization of wind turbines presents the most promising opportunity for communities to reduce their electricity costs and enhance the reliability of their power supply.
Beneficiary	Mykolaiv community
Other stakeholders	

18-STIP. PRODUCTION

Title	**Hybrid Street Lighting**

Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	To install hybrid wind-solar systems (e.g., SHLP 8M-40/400/400-EKO) for street lighting. The system is designed to operate for 8-10 hours a day using the full power of the LED modules, with battery reserves for up to 4 consecutive cloudy, rainy, or windless days.
Key outputs	• Uninterrupted operation of streetlights, irrespective of solar and wind conditions • The significant advantage of hybrid LED street lamps is their complete autonomy, enabling installation in locations without access to grid electricity • Enhancement of the power supply with renewable energy sources • Reduction in fossil fuel consumption • Development of renewable energy capacities in urban areas
Key tasks	• Procure equipment • Install the hybrid system • Configure the system for optimal performance
Expected timeline of project	2028-2029
Estimated investment cost (CAPEX)	Total CAPEX to be estimated The estimated unit cost is USD 4,123, inclusive of: • A 24 V 400 W wind generator. • Two 200 W photovoltaic (PV) panels. • A 400 W LED module. • System controller. • Necessary battery storage, etc. For more information, visit: (https://stolb.com.ua/en/komplekt-gibridnogo-vulichnogo-osvitlennya-na-vitrogeneratori-ta-sonyachniy-paneli-shlp-8m-40-400-400-eko/) Prices are as of 2023 and should be reviewed. Bulk discounts might apply depending on order quantity..
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (4) transition to a circular economy (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power
Critical observation points	No critical observation points
Related studies, projects and programmes	Not available

Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	TBD
Beneficiary	Mykolaiv Sea Port
Other stakeholders	

19-STIP. PRODUCTION

Title	**Small wind turbine for private household**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	Installation of an 800 W wind turbine within a private household territory to foster energy independence and sustainability
Key outputs	• Independent Renewable Energy Source (RES) electricity-generating facility for the household • Enhanced sustainability through greening of the power supply • Improved energy reliability with an uninterrupted power supply (acting as a backup system) • Empowerment through self-generation of electricity • Reduction of electricity bills and reliance on fossil fuels
Key tasks	• Develop project documentation • Select suitable wind equipment / Wind Turbine (WT) • Procure necessary equipment • Construct the foundation • Install the WT • Configure the system for operation
Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	Estimated investment cost (CAPEX): 7.48 kEUR: • WT cost – EUR 6.39 kEUR (including 17 m mast, 2.4 kW inventor, 2.4 kW storage battery) • Construction cost EUR 1.1 kEUR Prices are as of 2023 and should be re-evaluated at the time of purchase.
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (4) transition to a circular economy (5) Pollution prevention and control

	(6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power
Critical observation points	No critical observation points
Related studies, projects and programmes	Not availbale
Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	Currently, Mykolaiv and the Mykolaiv region boast the highest wind potential in Ukraine. Therefore, the utilization of wind turbines presents the most promising opportunity for private households to reduce their electricity costs and enhance the reliability of their power supply.
Beneficiary	Local community members
Other stakeholders	

20-STIP. PRODUCTION

Title	**Rooftop small wind turbine for multistorey building**
Sector	Electricity production
COWI comment	COWI Proposal
Objective(s)	Installation of several 800 W Vertical Axis Wind Turbines (VAWTs) on the roof of a multistorey building
Key outputs	• Development of an individual Renewable Energy Source (RES) electricity-generating facility • Incorporating green energy into the power supply • Creation of an uninterrupted power supply (serving as a backup system) • Allowing for self-generation of electrical power • Reduction of electricity bills • Decrease in fossil fuel consumption
Key tasks	• Develop project documentation • Select appropriate wind equipment / Wind Turbine (WT) • Procure the equipment • Construct the foundation • Install the WT

	• Carry out system configuration and setting
Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	Estimated investment cost (CAPEX): 3.86 kEUR Including: • WT cost – 2.97 kEUR (including 2 kW controller, cables and mast) • Construction cost – 0.89 kEUR *This price is per VAWT as of 2023 and should be updated at the time of purchase
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change mitigation (4) transition to a circular economy (5) Pollution prevention and control (6) protection and restoration of biodiversity and ecosystems Key activities according to the EU Taxonomy Compass: (4.3) Electricity generation from wind power
Critical observation points	No critical observation points
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	No project documentation available
Background	Currently, Mykolaiv and the Mykolaiv region boast the highest wind potential in Ukraine. Therefore, the utilization of wind turbines presents the most promising opportunity for enterprises to reduce their electricity costs and enhance the reliability of their power supply.
Beneficiary	Local community members
Other stakeholders	

21-STIP. MONITORING AND MANAGEMENT

Title	**Implementation of an automated control system for technological processes of MCHPP**
Sector	District heating
COWI comment	Municipal project in line with COWI Masterplan
Objective(s)	Implement an automated control system to manage the technological processes of the Combined Heat and Power (CHP) plant, thereby ensuring efficient operation and energy-saving modes for all technological equipment.

Key outputs	The application of an automated control system creates the conditions for the operation of technological equipment in an efficient energy-saving mode. This is achieved through the system's adoption of optimal decisions at every moment of operation to eliminate disturbances that arise, both external and internal.
Key tasks	• Assess current processes and needs. • Design the system components. • Procure necessary hardware and software. • Install and integrate the system. • Test and commission the system. • Train staff and create documentation. • Deploy and optimize the system. • Maintain and provide ongoing support.
Expected timeline of project	2024-2026
Estimated investment cost (CAPEX)	0.28 MEUR (12.0 MUAH)
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change adaptation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (7.3) Installation, maintenance and repair of energy efficiency equipment
Critical observation points	The project is part of the complete reconstruction project of MCHPP and makes sense to be implemented in parallel with the reconstruction of MCHPP.
Related studies, projects and programmes	Not available
Readiness of project documents, including design documents	No project documentation available
Funding opportunities	To be identified
Interested local companies	To be identified
Background	By integrating an automated control system, the project seeks to enhance the monitoring, management, and optimization of various technological processes within the plant. This includes but is not limited to, the control of boilers, turbines, generators, and other critical components of the power generation process. The implementation of such a system is expected to improve overall plant performance, increase energy efficiency, reduce operational costs, and ensure the

	reliable and stable supply of heat and electricity to consumers in the Mykolaiv region.
Beneficiary	MCHPP
Other stakeholders	

22-STIP. MONITORING AND MANAGEMENT

Title	**Implementation of an automatic consumption metering and dispatching system**
Sector	District heating
COWI comment	Municipal project in line with COWI Masterplan
Objective(s)	The installation of modern digital heat meters with remote data transmission capabilities will facilitate real-time monitoring of heat supply parameters. This functionality enables a rapid response to potential emergencies. Combined with the use of Individual Heating Substations (IHSs) and frequency converters on network pumps, the system will support maintaining the heating network's optimal operating mode.
Key outputs	Daily monitoring of heating supply parameters for each individual building to promptly eliminate emergency situations or prevent them, preventing the risks of errors during readings and their documentation.
Key tasks	Equip residential buildings that were previously not equipped with commercial accounting units for thermal energy; replace thermal energy metering units that fail metrological verification, are out of order and beyond repair, and are outdated and lack the capability for remote transmission of measurement results with new ones.
Expected timeline of project	2024-2027
Estimated investment cost (CAPEX)	1-1,2 MEUR
Expected environmental impacts	Key environmental objectives of the EU Taxonomy addressed: (1) Climate change adaptation (5) Pollution prevention and control Key activities according to the EU Taxonomy Compass: (7.3) Installation, maintenance and repair of energy efficiency equipment
Critical observation points	TBD
Related studies, projects and programmes	In Ukraine, the installation of commercial accounting for all consumers is mandated by the Law of Ukraine “On Commercial Metering of Heat Energy and Water Supply,” enacted on 2 August 2017. This law is part of a package of legislative acts aimed at modernizing the housing and

	communal services market in Ukraine, promoting energy saving, and, consequently, energy independence of the country
Readiness of project documents, including design documents	The installation of commercial metering units is part of the routine ongoing work of all heat supply organizations and, in most cases, does not require the development of separate detailed project documentation.
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The project was planned in the development strategy of MCHPP, considering that MCHPP, JSC "Mykolaiv Combined Heat and Power Plant", provides heating services to 684 residential buildings, out of which 645 buildings are equipped with commercial accounting units. However, this automation and dispatching is foreseen by the roadmap and is an integral part of the development of the entire heating supply system of the city of Mykolaiv. Therefore, the project needs to be implemented for both MOTE and MCHPP and for all consumers.
Beneficiary	MOE, MOTE, MCHPP
Other stakeholders	

2.2 Mid-term projects

For a more comprehensive presentation, all projects were further divided into those related to energy consumption, distribution or production.

1-MTIP. CONSUMPTION.

Title	**Building new Individual Heating Substations (IHS) and piping system inside the buildings for existing and new consumers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The roadmap suggests that by 2050, all consumers should be equipped with individual heating points, as well as having centralized hot water supply, therefore, as in the case of short-term projects, the goal is to continue such fundamental tasks as restoring the centralized hot water system will enable thermal energy use in summer, facilitating electrical generation in cogeneration plants and supporting renewable energy systems like solar collectors for peak summer heat production. Implementing individual heating points will reduce thermal energy use, especially in upgraded homes, offering weather regulation, consumer control over consumption and costs, and improving comfort and heat supply reliability.
Key outputs	Individual heating substations; Domestic hot water installation
Key tasks	Implementing individual heating points makes sense and is feasible only if it's done for 100% of the consumers of a boiler house or for large districts where it's possible to change the hydraulic parameters of the network. Considering there's a natural limit to the number of individual heating points (IHPs) that can be installed in a season, which depends on the capacities of manufacturers and installers, the main task is to determine the number of IHPs that can be installed in one season. Based on this number, select districts where this amount will cover 100% of consumers.
Expected timeline of project	2030-2040
Critical observation points	Assessments should be made to determine if a significant number of new installations can be completed within the proposed timeframe.
Beneficiary	MOTE+MCHP

2-MTIP. CONSUMPTION.

Title	**Thermal modernization of the buildings**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The goal of this project is the further systematic thermomodernization of buildings, which will significantly reduce the need for heating and corresponding greenhouse gas emissions. The effect of reducing these emissions can be further enhanced by satisfying the reduced need for

	thermal energy through renewable energy resources or non-traditional heating systems, such as heat pumps.
Key outputs	Improved building insulation, resulting in lower heat consumption
Key tasks	
Expected timeline of project	2030-2040
Critical observation points	The number of buildings that can undergo reconstruction within a year is significantly limited by the capabilities and number of relevant construction companies. Even with an optimistic estimate, the number of buildings could be measured in tens per year. Meanwhile, the number of buildings in Mykolaiv is estimated to be over 4,000. Therefore, the ambitious goal of reconstructing 60% of buildings connected to the centralized heating system may require the launch of related projects aimed at increasing the number of buildings that can be reconstructed annually. These could include, for example, staff training, including for designers, favorable business loans, and the construction of a plant for producing insulation materials.
Beneficiary	MOTE+MCHP

3-MTIP. DISTRIBUTION.

Title	**Replacement of the distribution pipes due to thermal modernization**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The project aims to increase the efficiency of heat distribution, adapt existing pipelines for future low-temperature operation, and eliminate local bottlenecks
Key outputs	New, highly insulated pipes and an upgraded distribution network
Key tasks	The replacement of approximately 110 km of existing pipelines with new pipes designed for highly insulated and low-temperature operation
Expected timeline of project	2030-2040
Critical observation points	The proposed upgrade plans would necessitate a substantial installation of new pipelines – approximately 180 km, including both distribution and transmission, by 2040. Drawing on insights from the Danish and Polish markets, the average construction span for new pipelines by a district heating company is about 6 km per year. Limiting factors include financial constraints, the manufacture of necessary components, and the availability of skilled installation teams. To achieve this goal, Mykolaiv city would need to secure robust financing, resources, and workforce. Given that Mykolaiv will not be the only Ukrainian city undergoing substantial

	reconstruction during this period, fulfilling this ambition could be challenging, though not infeasible.
Beneficiary	MOTE+MCHP

4-MTIP. DISTRIBUTION.

Title	**Building new distribution pipes for connecting new consumers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	To connect new areas to the district heating network, expanding service coverage
Key outputs	Extension of the distribution network with new piping infrastructure
Key tasks	Construction of approximately 60 km of new pipes to expand the network
Expected timeline of project	2030-2040
Critical observation points	The expansion plan would entail a significant installation of new pipelines – approximately 190 km in total for both distribution and transmission, to be completed by 2040. Based on benchmarks from the Danish and Polish markets, district heating companies typically construct about 6 km of new pipelines annually. Key limiting factors include financial constraints, the manufacture of necessary components, and the availability of skilled labour. To meet this goal, Mykolaiv city would need to secure adequate financing and resources. Given that simultaneous reconstruction may be occurring in other Ukrainian cities, this objective, while ambitious, is not unattainable.
Beneficiary	MOTE+MCHP

5-MTIP. DISTRIBUTION.

Title	**Building new interconnecting pipelines**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	To consolidate several distributed district heating networks into a single integrated system using a set of interconnecting pipes. These pipelines will be differentiated from distribution pipelines by heat exchangers or shunting stations, as the operating temperatures may vary between the networks. The primary heat sources will feed into the interconnecting pipelines, promoting system efficiency.
Key outputs	New transmission pipelines added to the heating network
Key tasks	Construction of approximately 20 km of new transmission pipelines

Expected timeline of project	2030-2040
Critical observation points	The ambitious infrastructure upgrade will require a considerable installation of new pipelines – approximately 180 km in total, including both distribution and transmission, by 2040. Drawing on data from the Danish and Polish markets, the average output for district heating companies is about 6 km of new pipelines per year. Challenges include financial constraints, the production of necessary components, and the securing of skilled installation teams. Mykolaiv city must therefore secure robust financing and logistical support to achieve these goals. During this period, Mykolaiv will not be unique in its need for reconstruction in Ukraine, making this target challenging yet achievable.
Beneficiary	MOTE+MCHP

6- MTIP. PRODUCTION.

Title	**Installation of energy storage at MCHPP**
Sector	Power
COWI comment	Municipal project in line with COWI Masterplan
Objective(s)	The goal of the project is to significantly increase the reliability and efficiency of the MCHPP by installing an industrial electric energy storage system, which will help smooth out peaks in electricity consumption and improve the operating schedules of power generating equipment. In the event of a thermal power plant shutdown, it will ensure the supply of energy for its own needs and facilitate the restart of the plant when disconnected from the central grid of Ukraine.
Key outputs	Energy storage with capacity of 20 MWh
Key tasks	Development of a comprehensive feasibility study, development of detailed project documentation
Expected timeline of project	2036-2040
Estimated investment cost (CAPEX)	MEUR 1,1 – 1,4
Critical observation points	The existing development strategy for the MCHPP involves a complete reconstruction of the latter and a significant increase in its maneuverability through the installation of new equipment to enable operation within the current electricity market conditions. According to COWI, the installation of an electric energy storage makes sense only after the reconstruction of the MCHPP is completed.
Beneficiary	MCHPP
Other stakeholders	

7-MTIP. PRODUCTION.

Title	**Installation of gas cogeneration units (gas engines)**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Replacing existing inefficient gas boilers that require rehabilitation
Key outputs	The project's objective is the further improvement of the reliability and efficiency of the heating system in Mykolaiv through systematic annual reconstruction and modernization of existing boiler houses and the introduction of cogeneration units to replace outdated gas-fired water heating boilers.
Key tasks	Development of a feasibility study to determine the number of subscribers, and thus, the demand for heat. Creation of a financing program aimed at the systematic planned annual replacement of old gas water boilers with cogeneration units.
Expected timeline of project	2030-2035
Critical observation points	Considering that the project is medium-term and planned for implementation in the period after 2030, it is expected to be rolled out after a number of short-term projects, in particular the project 6-STIP "Construction of a biomethane plant at the agricultural company 'Promin' (Pervomaiskyi district)," meaning the focus should be on the implementation of facilities operating on biogas or biomethane.
Beneficiary	MCHPP, MOTE
Other stakeholders	

8-MTIP. PRODUCTION

Title	**Installation of additional heat pumps on Bug River**
Sector	District heating
COWI comment	COWI proposal
Objective(s)	To increase the share of renewable energy sources within the overall heat production mix. This entails constructing a reliable base load unit that operates throughout the year and is intended to partially supplant gas-fired heating systems.
Key outputs	An enhanced network of river water heat pumps serving as a base load unit
Key tasks	Identifying the optimal location for the installation of a heat pump along the Bug River
Expected timeline of project	2034-2035
Critical observation points	To effectively use heat pumps, which mainly produce heat up to 60-65 ℃, a comprehensive strategy is necessary, particularly for heating systems originally designed for higher temperatures of 95 ℃. The plan involves

	creating mixed heating systems that combine heat pumps with traditional heating for colder days, underlining the need for building improvements and better insulation to reduce heat requirements. It also includes the use of intelligent controls to improve efficiency, applying large-scale heat pumps for community heating in updated areas, and highlighting the importance of training for those installing and maintaining these systems, as well as educating the public about their benefits
Beneficiary	MCHPP
Other stakeholders	

9-MTIP. DISTRIBUTION.

Title	**Installation of sewage water heat pumps**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix. Building reliable base load unit working whole year long that will partially replace gas operation.
Key outputs	Sewage water heat pumps, base load unit
Key tasks	Finding optimal location for placing of sewage water heat pump (preferably at wastewater treatment plant)
Expected timeline of project	2030-2034
Critical observation points	The usual peak production out of sewage water heat pumps occur after the morning and evening peak consumption, meaning that production and consumption are not well coordinated. To enhance the process, heat storage facility might be considered, possibly next to sewage water heat pump installation.
Beneficiary	MOTE+MCHP
Other stakeholders	

10-MTIP. PRODUCTION

Title	**Heat recovery from excess heat sources**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increase the efficiency of the heat production, increase the share of renewables
Key outputs	Utilizing excess heat, base load unit

Key tasks	Determine the potential location of excess heat sources and make connection between those and district heating network. Possibly installing heat pumps next to the excess heat source to increase the operating temperature
Expected timeline of project	2030-2035
Critical observation points	No critical observation points
Beneficiary	MOTE+MCHP
Other stakeholders	

11-MTIP. PRODUCTION

Title	**Installation of additional electrode boilers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the capacity of electrode boilers that would run as peak load unit to replace heat production out of gas
Key outputs	More electrode boilers, peak load unit
Key tasks	Determine the installation location; potential sites may include existing boiler house areas or adjacent to heat pumps, to reheat water from the heat pumps to the desired temperature
Expected timeline of project	2036-2040
Critical observation points	No critical observation points.
Beneficiary	MOTE+MCHP
Other stakeholders	

12-MTIP. PRODUCTION

Title	**Hydrogen/hydrogen compounds fuel cells and engines**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Utilize excess heat generated during the synthesis of hydrogen to ammonia or methanol. Additionally, co-firing hydrogen and compounds synthesized from it in gas engines or using hydrogen and compounds synthesized from it to fuel cells. (Dependent on technological advancements)
Key outputs	Heat out of hydrogen, peak load unit

Key tasks	Finding the location
Expected timeline of project	2036-2040
Critical observation points	Since the technology is still immature, many issues may appear during the process that are not know currently.
Beneficiary	MOTE+MCHP
Other stakeholders	

13-MTIP. PRODUCTION

Title	**Building heat storage accumulator**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Building another heat storage tank. Considered might be different options of storaging heat (short/medium/long term storage)
Key outputs	Additional heat storage tank
Key tasks	Finding the location - possibly next to sewage water heat pumps
Expected timeline of project	2032-2034
Critical observation points	No critical observation points
Beneficiary	Utilities
Other stakeholders	

2.3 Long-term projects

For a more comprehensive presentation, all projects were further divided into those related to energy consumption, distribution or production.

1-LTIP. CONSUMPTION

Title	**Building new Individual Heating Substations (IHS) and piping system inside the buildings for existing and new consumers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The roadmap suggests that by 2050, all consumers should be equipped with individual heating points, as well as having centralized hot water supply, therefore, as in the case of short-term projects, the goal is to continue such fundamental tasks as restoring the centralized hot water system will enable thermal energy use in summer, facilitating electrical generation in cogeneration plants and supporting renewable energy systems like solar collectors for peak summer heat production. Implementing individual heating points will reduce thermal energy use, especially in upgraded homes, offering weather regulation, consumer control over consumption and costs, and improving comfort and heat supply reliability.
Key outputs	Individual heating substations; Domestic hot water installation
Key tasks	Implementing individual heating points makes sense and is feasible only if it's done for 100% of the consumers of a boiler house or for large districts where it's possible to change the hydraulic parameters of the network. Considering there's a natural limit to the number of individual heating points (IHPs) that can be installed in a season, which depends on the capacities of manufacturers and installers, the main task is to determine the number of IHPs that can be installed in one season. Based on this number, select districts where this amount will cover 100% of consumers.
Expected timeline of project	2040-2050
Critical observation points	Estimates shall be done if significant number of new installations can be done in presented period of time.
Beneficiary	MOTE+MCHP
Other stakeholders	

2-LTIP. CONSUMPTION

Title	**Thermal modernization of the buildings**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The goal of this project is the further systematic thermomodernization of buildings, which will significantly reduce the need for heating and corresponding greenhouse gas emissions. The effect of reducing these emissions can be further enhanced by satisfying the reduced need for thermal energy through renewable energy resources or non-traditional heating systems, such as heat pumps.
Key outputs	Improved building insulation, resulting in lower heat consumption
Key tasks	Ensuring that 100% of the buildings connected to the District Heating (DH) network undergo thermal modernization
Expected timeline of project	2040-2050
Critical observation points	Analysis of the current situation regarding buildings insulation shall be carried out. Afterwards, estimates shall be done if conducted thermal modernization on this scale in suggested period of time is possible.
Beneficiary	MOTE+MCHP
Other stakeholders	

3-LTIP. DISTRIBUTION

Title	**Replacement of the distribution pipes due to thermal modernization**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the efficiency of the heat distribution, adjusting existing pipes for future low temperature operation, removing local bottlenecks
Key outputs	New pipes, distribution network
Key tasks	Replacement of approx. 110 km of existing pipes for highly insulated pipes, adjusted for low temperature operation
Expected timeline of project	2040-2050
Critical observation points	Suggested reinforcements would require enormous number of new pipes to appear in considerably short time – approx. 180 km of new pipes (total distribution and transmission) up to 2040. Based on experience from Danish and Polish markets, average length of new pipelines built by district heating company for 1 year is approx. 6 km. The limitation factors are here: financial issues, availability of manufacturing of required components and availability of executive teams. In order to meet the goal Mykolaiv city would have to obtain good financing and source of people and materials. Since Mykolaiv city will not be the only city requiring

	substantial reconstruction in Ukraine at this time, this aim may be difficult to reach, however, not impossible.
Beneficiary	MOTE+MCHP
Other stakeholders	

4-LTIP. DISTRIBUTION

Title	**Building new distribution pipes for connecting new consumers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Connecting new areas to district heating network
Key outputs	New pipes, distribution network
Key tasks	Building approx. 60 km of new pipes
Expected timeline of project	2040-2050
Critical observation points	Suggested reinforcements would require enormous number of new pipes to appear in considerably short time – approx. 180 km of new pipes (total distribution and transmission) up to 2040. Based on experience from Danish and Polish markets, average length of new pipelines built by district heating company for 1 year is approx. 6 km. The limitation factors are here: financial issues, availability of manufacturing of required components and availability of executive teams. In order to meet the goal Mykolaiv city would have to obtain good financing and source of people and materials. Since Mykolaiv city will not be the only city requiring substantial reconstruction in Ukraine at this time, this aim may be difficult to reach, however, not impossible.
Beneficiary	MOTE+MCHP
Other stakeholders	

5-LTIP. DISTRIBUTION

Title	**Building new interconnecting pipelines**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Merging several distributed district heating networks into one big system by set of interconnecting pipes. Interconnecting pipelines will be separated by distribution pipelines by heat exchangers/ shunting stations since operation temperature on each of them may be different. Heat sources will mostly feed into interconnecting pipelines.
Key outputs	New pipes, transmission network

Key tasks	Building approx. 25 km of new transmission pipelines.
Expected timeline of project	2040-2050
Critical observation points	Suggested reinforcements would require enormous number of new pipes to appear in considerably short time – approx. 190 km of new pipes (total distribution and transmission) up to 2040. Based on experience from Danish and Polish markets, average length of new pipelines built by district heating company for 1 year is approx. 6 km. The limitation factors are here: financial issues, availability of manufacturing of required components and availability of executive teams. In order to meet the goal Mykolaiv city would have to obtain good financing and source of people and materials. Since Mykolaiv city will not be the only city requiring substantial reconstruction in Ukraine at this time, this aim may be difficult to reach, however, not impossible.
Beneficiary	MOTE+MCHP
Other stakeholders	

6-LTIP. DISTRIBUTION

Title	**Installation of gas cogeneration units (gas engines)**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	The project's objective is the further improvement of the reliability and efficiency of the heating system in Mykolaiv through systematic annual reconstruction and modernization of existing boiler houses and the introduction of cogeneration units to replace outdated gas-fired water heating boilers.
Key outputs	Development of a feasibility study to determine the number of subscribers, and thus, the demand for heat.
Key tasks	District heating
Expected timeline of project	2046-2050
Critical observation points	Considering that the project is medium-term and planned for implementation in the period after 2030, it is expected to be rolled out after a number of short-term projects, in particular the project 6-STIP "Construction of a biomethane plant at the agricultural company 'Promin' (Pervomaiskyi district)," meaning the focus should be on the implementation of facilities operating on biogas or biomethane
Beneficiary	MCHPP, MOTE
Other stakeholders	N/A

7-LTIP. DISTRIBUTION

Title	**Installation of additional air to water heat pumps**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix. Building reliable base load unit working whole year long that will partially replace gas operation.
Key outputs	More air to water heat pumps, base load unit
Key tasks	Finding the location for the installation: one of the considered locations may be the location of the existing boiler houses. By 2050 operation temperature shall be low so the heat pumps may supply directly to the distributed network
Expected timeline of project	2046-2050
Critical observation points	To effectively use heat pumps, which mainly produce heat up to 60-65 ℃, a comprehensive strategy is necessary, particularly for heating systems originally designed for higher temperatures of 95 ℃. The plan involves creating mixed heating systems that combine heat pumps with traditional heating for colder days, underlining the need for building improvements and better insulation to reduce heat requirements. It also includes the use of intelligent controls to improve efficiency, applying large-scale heat pumps for community heating in updated areas, and highlighting the importance of training for those installing and maintaining these systems, as well as educating the public about their benefits
Beneficiary	MOTE+MCHP
Other stakeholders	

8-LTIP. PRODUCTION

Title	**Installation of additional sewage water heat pumps**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix. Building reliable base load unit working whole year long that will partially replace gas operation.
Key outputs	More sewage water heat pumps, base load unit
Key tasks	Finding optimal location for placing of sewage water heat pump
Expected timeline of project	2045-2047

Critical observation points	The usual peak production out of sewage water heat pumps occur after the morning and evening peak consumption, meaning that production and consumption are not well coordinated. To enhance the process, heat storage facility might be considered, possibly next to sewage water heat pump installation.
Beneficiary	MOTE+MCHP
Other stakeholders	

9-LTIP. PRODUCTION

Title	**Installation of addtional heat pumps on Bug river**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix. Building reliable base load unit working whole year long that will partially replace gas operation.
Key outputs	More river water heat pumps, base load unit
Key tasks	Finding optimal location for placing of heat pump on Bug river
Expected timeline of project	2040-2043
Critical observation points	To effectively use heat pumps, which mainly produce heat up to 60-65 ℃, a comprehensive strategy is necessary, particularly for heating systems originally designed for higher temperatures of 95 ℃. The plan involves creating mixed heating systems that combine heat pumps with traditional heating for colder days, underlining the need for building improvements and better insulation to reduce heat requirements. It also includes the use of intelligent controls to improve efficiency, applying large-scale heat pumps for community heating in updated areas, and highlighting the importance of training for those installing and maintaining these systems, as well as educating the public about their benefits
Beneficiary	MOTE+MCHP
Other stakeholders	

10-LTIP. PRODUCTION

Title	**Heat recovery from excess heat sources**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increase the efficiency of the heat production, increase the share of renewables

Key outputs	Utilizing excess heat, base load unit
Key tasks	Determine the potential location of excess heat sources and make connection between those and district heating network. Possibly installing heat pumps next to the excess heat source to increase the operating temperature
Expected timeline of project	2043-2045
Critical observation points	No critical observation points.
Beneficiary	MOTE+MCHP
Other stakeholders	

11-LTIP. PRODUCTION

Title	**Installation of additional electrode boilers**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the capacity of electrode boilers that would run as peak load unit to replace heat production out of gas
Key outputs	More electrode boilers, peak load unit
Key tasks	Finding the location
Expected timeline of project	2047-2050
Critical observation points	No critical observation points.
Beneficiary	MOTE+MCHP
Other stakeholders	

12-LTIP. PRODUCTION

Title	**Hydrogen/hydrogen compounds fuel cells and engines**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Utilize excess heat generated during the synthesis of hydrogen to ammonia or methanol. Additionally, co-firing hydrogen and compounds synthesized from it in gas engines or using hydrogen and compounds synthesized from it to fuel cells. (Dependent on technological advancements)
Key outputs	Heat out of hydrogen, peak load unit

Key tasks	Finding the location
Expected timeline of project	2045-2050
Critical observation points	Since the technology is still immature, many issues may appear during the process that are not know currently.
Beneficiary	MOTE+MCHP
Other stakeholders	

13-LTIP. PRODUCTION

Title	**Building geothermal plant**
Sector	District heating
COWI comment	COWI Proposal
Objective(s)	Increasing the share of renewable energy sources in overall heat production mix.
Key outputs	Geothermal plant, base load unit
Key tasks	Analysis to be carried out checking availability and parameters of the sources. Potentially need for placing heat pumps next to geothermal sources to increase operating temperature.
Expected timeline of project	2040-2045
Critical observation points	There are no detailed analysis confirming the availability and potential of the geothermal sources. Therefore right now geothermal energy might be considered only as an option to be checked out.
Beneficiary	MOTE+MCHP
Other stakeholders	

3 Enabling projects

This chapter presents enabling projects in energy sector.

3.1 STEP. Comprehensive Hydraulic Modelling and Energy Planning Tools

Title	**Comprehensive Hydraulic Modelling and Energy Planning Tools**
Sector	**District heating, power**
Objective(s)	The objective of the project is the delivery and training in the use of two kinds of software. These are for: • Hydraulic and thermal modelling of DH system including optimal design of DH network • Energy planning: modelling of heat and power system as a whole and performance of on-line economical optimization of operation of heat and power production units.
Key outputs	The hydraulic and thermal modelling of the DH system will allow to analyse the consequences of any planned, new developments (connecting new consumers, determining pipe dimensions, determining location for new production units) through simulation of the resulting, hydraulic and thermal parameters, This tool will be extremely useful when planning the future development of the DH system. The energy planning tool will allow to determine the most economic ways to operate the available power and heat generation sources while covering the needs for electricity and heat at any given time, thereby lowering the combined costs of heat and power generation for the entire city. The system can also support the automated control process.
Key tasks	TBD
Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA
SDGs affected	

Critical observation points	TBD
Related studies, projects and programs	NA
Funding opportunities	To be identified
Interested local companies	To be identified
Background	TBD
Beneficiary	Mykolaiv utilities
Other stakeholders	Energy Ministry of Ukraine, SAEE

3.2 STEP. Establishment of a Decarbonisation Office

Title	**Establishment of a Decarbonization Office**
Sector	**Energy**
Objective(s)	• Achieve the decarbonization mission by promoting, informing, and offering practical support for the leading role of the Mykolaiv community in strengthening energy independence and contributing to the low-carbon development of the region and the country • Create a team of professional, competent, and motivated energy managers who will serve as the driving force behind implementing energy-efficient changes • Achieving energy independence and sustainability to save money and attract investment.
Key outputs	• Supplying social infrastructure facilities such as schools, hospitals, and kindergartens, as well as households, with reliable energy sources • Enhancing the community's economic growth and creating new job opportunities. • Establishing a cleaner, healthier, and more sustainable environment for the community.

Key tasks	• Define the main tasks of the future office and plan cooperation with the State Agency on Energy Efficiency and Energy Saving • Promote initiatives aimed at ensuring energy efficiency by utilizing low-carbon fuels, feedstocks, and energy sources. • Analyse the opportunities for the carbon capture, utilization, and storage (CCUS), net zero electricity generation, energy saving and green buildings, and sustainable transportation • Analyse availability of finance, assess opportunities for educating people and introduction of the modern technologies, modern infrastructures, including the implications of eventual higher energy and carbon intensities of consumption • Identify the correlation between sustainable development and harness the advantages of climate mitigation and adaptation actions to mitigate the costs associated with the transition to low-carbon development • Implementing the circular economy measures to further reduce the carbon footprint of the community activities • Development of the Renewable Energy Sources (RES) and introducing of the renewable energy technologies • Provide standardised data collection and reporting, processing the data and the skilled personnel and computational facilities • Facilitate amendments of existing Ukrainian legislation especially in relation to the EU acquis related to decarbonisation
Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA
SDGs affected	

Critical observation points	The war has significantly disrupted the GHG balance, with heavy shelling impacting energy infrastructure and causing the destruction of petroleum tanks. The transition from coal or gas-fired thermal power plants to those based on renewable energy may face challenges due to these disruptions. Nevertheless, the Mykolaiv community should be informed about the numerous benefits of low-energy-consuming industries based on renewable energy, despite the obstacles in the transition process.
Related studies, projects and programs	N/A
Funding opportunities	To be identified
Interested local companies	To be identified
Background	According to updated Nationally Determined Contribution under the Paris Agreement (2021) Ukraine is committed to achieve carbon neutrality no later than 2060. In 2020, greenhouse gas emissions (GSG) decreased to 33.7% from 1990 levels mainly due to the deceased industrial production and not due to the use of up-to-date technologies. The main sources of pollutants are those from mining and processing industry, energy and agricultural sector enterprises. Over the recent years a few legislative documents were adopted which constitute a legal background for the decarbonisation activities: • CMU Order of 30.07.2021 № 868 “On approval of the Renewed Nationally Determined Contribution of Ukraine to the Paris Agreement” (development of the Action Plan for its implementation is underway) • CMU Order of 20.10.2021 № 1363-r "On approval of the Strategy of ecological safety and adaptation to climate change for the period till 2030" • CMU Order of 20.10.2021 № 1363-r "On approval of the Strategy of ecological safety and adaptation to climate change for the period till 2030 • Law of Ukraine "On Principles of Monitoring, Reporting and Verification of Greenhouse Gas Emissions" and bylaws that allow to start the process of forming the framework of the national emissions trading system in accordance with the requirements of Directive 2003/87/EU;

	• Law of Ukraine "On regulation of economic activity with ozone-depleting substances and fluorinated greenhouse gases" in accordance with Regulation (EC) No 842/2006, Regulation (EC) No 2037/2000, Regulation (EU) No 517/2014, Regulation (EC) No 1005/2009. • Draft law "On the Basic Principles of Low-Carbon Development of Ukraine till 2050" has been developed in line with the provisions of Regulation (EU) 2018/1999, which establishes a general framework for integrated climate and energy policy.
Beneficiary	Mykolaiv utilities, Department of energy, energy saving and introduction of innovative technologies at MCA
Other stakeholders	Energy Ministry of Ukraine, SAEE

3.3 STEP. Heat Supply Scheme Development

Title	**Heat Supply Scheme Development**
Sector	**District heating**
Objective(s)	• Developing comprehensive measures to increase the energy efficiency of city heating system, including planning for the reconstruction of heat sources, distribution networks, and heat consumers • Reducing greenhouse gas emissions • Reducing the use of fossil fuels by using local renewable energy sources
Key outputs	• The development of a real thermal and hydraulic model of the location of all thermal generation facilities, centralized and individual heat points and heating networks of all forms of ownership • Development of a new scenario for the city's heat supply, which later on will lead to installation of the modular solid fuel boilers; installation of cogeneration plants in the 4 largest districts boiler house of MOTE, the main fuel for which is garbage and biomass, which will make it possible to produce the electricity for own needs and if necessary, supply electricity to the grid. • Closure of small and inefficient boiler houses of MOTE and development of heat supply organization of the city.
Key tasks	• Reviewing the current heat supply scheme, elaborated in 2019 incl. scope, limitations, and what precisely need to be updated in the new version of the scheme. • Drafting a ToR taking into account potential synergies with the analysis carried out by COWI as part of the development of Mykolaiv Masterplan and the development of a Heat Roadmap Ukraine, and what could be the roles of each of the stakeholders.

Expected timeline of project	2024-2025
Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA
SDGs affected	
Critical observation points	Under the current Ukrainian legislation in force, financing and implementation of heating system development projects are only possible based on a developed and approved heating scheme. Therefore, this work is of critical importance and social significance for the city of Mykolaiv in 2024.
Related studies, projects and programs	NA
Funding opportunities	Danish Energy Agency
Interested local companies	To be identified
Background	The heat supply scheme of the city of Mykolaiv was approved in 2019 but never implemented. Moreover, the Methodology for its development has been amended in 2020. Apart from that, the infrastructure has been damaged during the war and needs rehabilitation. The heat supply scheme serves as a pre-project document, which substantiates the economic feasibility and economic necessity of designing and building new, expanding, and modernizing existing heat energy sources and heat networks.
Beneficiary	Mykolaiv utilities
Other stakeholders	Energy Ministry of Ukraine, SAEE

3.4 STEP. Enhancing Public Awareness for Sustainable Solutions

Title	**Enhancing Public Awareness for Sustainable Solutions**
Sector	**Power, district heating**

Objective(s)	The objective is to facilitate educating residents and businesses about the benefits of modern energy solutions and encouraging active participation in sustainable development.
Key outputs	• Active community engagement and support • Adopting energy-efficient practices and technologies • Contributing to implementation of the EU Energy Acquis in Ukraine
Key tasks	• Public awareness campaigns • Creating incentives • Work out and implement policies • Scheduling public gatherings
Expected timeline of project	2024-2030
Estimated investment cost (CAPEX)	N/A
Estimated operation and maintenance costs (OPEX)	N/A
SDGs affected	
Critical observation points	N/A
Related studies, projects and programs	N/A
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The recovery of the communities (affected by the war and displaced) and making durable solutions initiatives has proven to be effective, when these war and displacement affected communities are paced at the center of operational decision-making in facilitating early recovery, building back better and sustainable development.
Beneficiary	Department of Housing and Municipal Services, Department of Energy, Energy Saving and Introduction of Innovative Technologies at Mykolaiv City Administration
Other stakeholders	MOTE and Mykolaiv CHP

3.5 STEP. Geothermal Potential Research

Title	**Geothermal Potential Research**
Sector	**District heating**
Objective(s)	• Provide analysis of the geothermal potential in the region • Untap the geothermal potential in the region • Evaluate the opportunity to create combined energy technology nodes for obtaining electricity, heat and valuable components contained in geothermal sources • Facilitate environmental sustainability
Key outputs	• Utilising the latest technologies to make it possible to reduce the negative impact that occurs during the operation of the geothermal energy sources to a minimum • One of the promising directions of the geothermal heat supply system development is fuel saving, environmental safety and creating favourable living conditions
Key tasks	The primary tasks involve: • Identifying potential locations for geothermal heat sources within the city or its vicinity and determining the distance between these sources and the city. • Assessing the depths and temperatures) of the geothermal sources. As an expansion of this analysis, consideration may be given to: • Investigating the restoration potential of previously discovered thermal water wells under conservation for further exploitation as a system for extracting geothermal heat. • Exploring the feasibility of implementing binary geothermal power plant initiatives, leveraging existing wells at abandoned oil and gas fields. • Establishing combined energy technology nodes to generate electricity, heat, and extract valuable components from geothermal sources. The implementation of the latest technologies is crucial to minimize the negative impact during the operation of geothermal energy sources.
Expected timeline of project	2024-2027
Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA

SDGs affected	
Critical observation points	• Geothermal energy in Ukraine is currently in the research stage • The sector is facing a shortage of funds to support the necessary research. • Potential of geothermal energy in Ukraine, the development of geothermal energy requires not only legislative regulation, but also the availability of detailed information on geothermal fields, sufficient funding, attraction of modern technology and international best practices. • Access to geological data is challenging due to the imposition of martial law since 2022, which is expected to persist beyond 2023.
Related studies, projects and programs	NA
Funding opportunities	To be identified
Interested local companies	To be identified
Background	It is assumed that the heat may also be supplied from geothermal sources, however it shall be confirmed with further investigations. First estimates point to temperatures reaching up to 75°C. It could indicate a possibility of either direct connection geothermal to DH network or with the heat pump, depending on the final temperature conditions.
Beneficiary	Mykolaiv utilities
Other stakeholders	Energy Ministry of Ukraine, SAEE

3.6 STEP. Prefeasibility study for new biomass-waste incineration CHP construction requirements

Title	**Prefeasibility study for defining preconditions for construction of new biomass-waste incineration CHP**
Sector	**District heating**
Objective(s)	The objective of this pre-feasibility study is to pave the way for introduction of heat and electricity production on the basis of biomass. The study shall assess the technical, environmental and economic feasibility of constructing a biomass-waste incineration CHP plant, including site suitability, resource availability and stakeholder interests.
Key outputs	A feasibility report outlining technical specifications, financial projections, environmental impacts, as well as a stakeholder impact summary to guide preliminary project decisions.
Key tasks	• Identify the location of the CHP

	• Evaluate the optimal capacities under different scenarios • Implement the green transition and sustainability goals
Expected timeline of project	TBD
Estimated investment cost (CAPEX)	N/A
Estimated operation and maintenance costs (OPEX)	N/A
SDGs affected	
Critical observation points	One of the assumptions is that existing CHP may be decommissioned by 2040. In 2050 some of the most efficient boiler houses may be remained as backup sources to operate in emergency situations.
Related studies, projects and programs	N/A
Funding opportunities	To be identified
Interested local companies	To be identified
Background	To verify the possibility of installing biomass-based CHP, an assessment of the potential bioenergy sources for use in DH and Power Sector in the city of Mykolaiv has been made by Renewable Energy Agency (REA) of Ukraine. The assessment describes the bioenergy potential in 2021 (just before the war started) as well as initial predictions for the future (2050). Future potential is based on UABIO's general approach to Ukraine's bioenergy potential in 2050. Results show high economic potential of biomass available for energy, both regarding solid biomass and biomethane. Main parts of the solid biomass potential are straw of cereals, by-products of sunflower production, sunflower husk, and energy crops. The biggest amount of biomethane can be produced from cover crops.
Beneficiary	MCA, Mykolaiv utilities
Other stakeholders	Mykolaiv Utilities

3.7 STEP. Reintroduction Program for Domestic Hot Water Systems in Urban Housing

Title	**Reintroduction Program for Domestic Hot Water Systems in Urban Housing: Technical Analysis**

Sector	District heating
Objective(s)	• Introducing of domestic hot water • Enabling low temperature operation of the space heating. • Engaging in the processes necessary to bring changes to building codes and standards; and improving home hot water temperature safety.
Key outputs	It is assumed that it could be initiated by Pilot Projects. The Pilot Projects are to be implemented in two different areas of the city, where domestic hot water could be distributed before 2030. The City has identified these areas as suitable for the prompt implementation of Individual Heating Systems (IHS) and for the potential rehabilitation of boiler houses in the short term. These are: Pilot Project 1: Bila street vicinity Pilot Project 2: Samoilovicha street vicinity Introduction of the mentioned Pilot Projects shall consider the following: • Examination of the existing BH and determination of the necessary rehabilitation works, including the need to increase installed capacity for covering HTW load. • Examination of existing distribution pipelines considering the increased loads due to low temperature operation and HTW supply. Determining the bottlenecks by means of hydraulic modelling, consider the needs for replacement of old pipes and develop an action plan for pipe replacement to minimize the inconvenience for the city transport. • Examine the existing consumer installations regarding potential location of substations, internal piping system and households' heaters. Determine precise requirements for the new installation. Regarding the consumers awareness, additional actions shall take place to prepare and motivate the affected population for the upcoming change. Besides, attractive tariffs for HTW shall be introduced.
Key tasks	• Building new installations for domestic hot water and the exchange of existing space heating installations (heat exchangers + pipe networks). Most remote consumers to be connected at this stage. • It is estimated that approx. 100% of connected consumers shall have exchanged installations in 2050 which corresponds to ~56000 consumers (if households, service, industry, and public consumers are considered).
Expected timeline of project	2024-2032

Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA
SDGs affected	
Critical observation points	Re-introduction of centralised HTW production would require a costly construction of new installations inside the consumers' premises, which is likely to be unpopular. In order to persuade consumers to convert to centralized HTW supply, a considerable effort will need to be put into campaigning for this solution and the benefits which can be achieved through the conversion. The campaign must highlight the potential cost savings and environmental advantages.
Related studies, projects and programs	N/A
Funding opportunities	To be identified
Interested local companies	To be identified
Background	The Mykolaiv district heating network currently provides heat solely for space heating purposes, with individual electric boilers at the consumer level responsible for producing domestic hot water. In the past, there was a period when domestic hot water in some parts of Mykolaiv city was supplied by the district heating network. However, residents gradually shifted away from this arrangement due to the more economical option of individual electric boilers, driven by lower electricity prices and higher heat prices. Consequently, the concept of receiving domestic hot water from the district heating system carries a negative connotation among citizens.
Beneficiary	Department of Energy and Energy Saving, Department of Housing and Municipal Services within Mykolaiv City Administration
Other stakeholders	Mykolaiv Utilities

3.8 STEP. Feasibility Study for Restructuring of DH Production Facilities

Title	**Technical and Economic Analysis for the Reduction of the Number of Boiler Houses**
Sector	**District heating**

Objective(s)	As part of the transformation process, the number of boiler houses (presently approx. 96) should gradually be reduced to not more than 10 in 2050 to simplify the operation and reduce the amount of maintenance work. Small, existing BHs will be shut down, while strategically well placed, larger BHs will be rehabilitated and developed with higher capacity
Key outputs	Creating the one, large, interconnected district heating system, avoiding rehabilitation of many of the individual gas boilers by merging heat production and demand, heat distribution optimization, utilization of sustainable heat, simplification of the control process and reduction of operational and maintenance costs
Key tasks	However, the task will require further detailed technical and economic analysis. Its starting point shall be the overview of the existing production units and projects suggested by MOTE, which are: • Rehabilitation of 27 boilers houses; • Construction of a 4 MWe boiler house at Yantarna Street; • Construction of a 5 MWe modular boiler house at Metalurgiv str; • Construction of 7 biomass fuelled CHP plants, each with a capacity of 2-4 MW; • Reconstruction of the boiler room building of the Mykolaiv School of I-III degrees No. 23 at the address: Garnizonna str 10. The project should consider the individual capacities, local heat demand, distances, and available space at the site. The BH rehabilitation projects currently considered by MOTE and MCCHP should constitute the input to the solution Islanded DH networks supplied by BHs that will be classified for cancelation should be connected to neighbouring BHs intended for future use.
Expected timeline of project	2024-2032
Estimated investment cost (CAPEX)	NA
Estimated operation and maintenance costs (OPEX)	NA
SDGs affected	

Critical observation points	
Related studies, projects and programs	NA
Funding opportunities	To be identified
Interested local companies	To be identified
Background	TBD
Beneficiary	MOTE, MCHP, Mykolaiv City Administration
Other stakeholders	