REQUEST FOR PROPOSALS

Rehabilitation of wastewater services in 4 cities of Ukraine:Horishni Plavni, Lubny, Lutsk, Khmelnytskyi

Country: Ukraine

Selection of a PIU Support Consultant for the DSIF & NORAD funded Programme "Rehabilitation of wastewater services in 4 cities of Ukraine (Horishni Plavni, Lubny, Lutsk, Khmelnytskyi)"

Client: NEFCO

February 2025

Section 1 – Letter of Invitation

Helsinki, 11 February 2025

Dear Sir/Madam,

Funds of up to **EUR 600,000** are expected to be allocated from Denmark and Norway for consulting services under the Programme "**Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi"** (**"the Programme"**) including **EUR 450,000** financed by **Danida Sustainable Infrastructure Finance (DSIF)** rehabilitation of wastewater infrastructure in Lubny, Lutsk, Khmelnytskyi (Component I) and **EUR 150,000 financed by the Norwegian Agency for development cooperation** ("**the NORAD**") for rehabilitation of wastewater infrastructure in Horishni Plavni (Component II). The Programme is coordinated and monitored by the Nordic Environmental Finance Corporation ("**NEFCO"**). This amount includes a 10% provision for contingencies, which shall be reserved in the budget of the Assignment.

The Programme is aimed to provide financing to the cities of Lubny, Lutsk, Khmelnytskyi, Horishni Plavni in Ukraine for rehabilitation of wastewater infrastructure of the cities.

NEFCO now invites proposals to provide the following consulting services: **Project Implementation ("PIU") support for the Programme "Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi"**. The details of the required services are provided in the attached Terms of Reference (**"ToR"**). The PIU Support Consultant (hereinafter - "**the Consultant**") will provide the PIU Support for two components. The two components cover the same subject matter, i.e. rehabilitation of wastewater services, but shall be executed separately with distinct financing structure, contractual agreement, implementation plan, reporting requirements etc.

The Component I (financed by DSIF) and Component II (financed by NORAD). Nefco intends to sign a contract with awarded consultant for PIU support for both Component I and Component II as soon as tender evaluation and contracts negotiations are completed. And due to the urgency character of water supply project measures, Nefco hereby intends to procure joint consultant for PIU support services for both components. Contracts to be awarded within this RfP will be awarded to the same consultancy firm.

By submitting the proposal, the Consultant agrees to provide services for Component I and Component II within the Programme.

This Request for Proposals ("RfP") has been published on Nefco's webpage.

Indication of Interest

Please inform NEFCO by e-mail to: *procurement@nefco.int* with a copy to *bo.nyhus@nefco.int* and *iryna.fedorenko@nefco.int* no later than **21 February 2025** if you intend to submit a proposal.

Any questions on the Terms of Reference or the other documentation in the RfP shall be provided in writing to NEFCO by e-mail: *procurement@nefco.int* with a copy to *bo.nyhus@nefco.int* and *iryna.fedorenko@nefco.int* no later than **28 February 2025** after which all questions will be compiled by NEFCO without any editing in the form they are sent to NEFCO. Answers to the questions are submitted by e-mail to all Consultants that have confirmed their intent to prepare a proposal.

Submission of Proposals

Proposals must be submitted to NEFCO no later than at **12:00 hrs local time in Helsinki on 18 March 2025** (submission date). You are recommended not to wait till last minute with submission, since the deadline is 100% strict and relates to NEFCO's reception of the bid, which may occur several minutes after your submission to the system. One minute late is too late. NEFCO may at its discretion extend the deadline for submission of proposals. Belated proposals will be rejected and returned unopened.

The proposal shall be divided into two parts: a technical proposal and a financial proposal.

The requirements for the proposals are described in detail in Section 2 – Instructions to Consultants. The attached standard forms are to be used for the purpose.

Proposals shall be submitted in English and must remain valid for 90 days. Consultants willing to prepare and submit a proposal are responsible for all associated costs.

The proposal shall be submitted to NEFCO using secure encrypted e-mails, in two separate emails:

Email A: Technical Proposal

The Technical Proposal shall be sent to NEFCO to email address *procurement@nefco.int* by using this link *https://www.securedmail.eu/message/procurement@nefco.int*. Please indicate as title in the subject field: "**Rehabilitation of wastewater services in 4 cities of Ukraine (Horishni Plavni, Lubny, Lutsk, Khmelnytskyi) Technical Proposal"**. In the message field please indicate at least the sender's name and company.

For further information, please see the enclosed document in Annex 3.

Email B: Financial Proposal

The Financial Proposal shall be sent to NEFCO to email address *nelly.eriksson@nefco.int* by using this link *https://www.securedmail.eu/message/nelly.eriksson@nefco.int*. Please indicate as title in the subject field: "**Rehabilitation of wastewater services in 4 cities of Ukraine (Horishni Plavni, Lubny, Lutsk, Khmelnytskyi); Financial Proposal**". In the message field please indicate at least the sender's name and company.

For further information, please see the enclosed document in Annex 3.

In case there are problems with the securedmail system, please contact *procurement@nefco.int* or *nelly.eriksson@nefco.int* for further assistance.

A Consultant will be selected under quality and cost-based selection method and procedures described in this RfP, in accordance with NEFCO's Procurement Policy and Procedures available at *www.nefco.int* under Procurement.

This RfP includes the following documents:

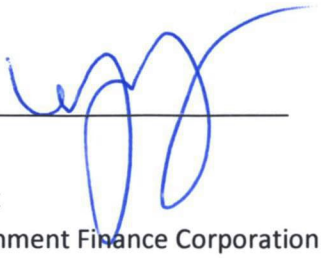
Section 1 - Letter of Invitation
Section 2 - Instructions to Consultants
Section 3 - Technical Proposal - Standard Forms
Section 4 - Financial Proposal - Standard Forms

Annex 1: General Conditions of Contract for Consultant's Services
Annex 2: Terms of Reference
Annex 3: Securedmail manuals

NEFCO

The Nordic Green Bank

Yours sincerely,



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Section 2 – Instructions to Consultants

1. Rules concerning nationality of consultants

The funds used for this consultancy assignment are made available from the DSIF for Component I and NORAD for Component II through NEFCO. According to the terms and conditions on the operation of the potential funds, there are no limitations on the nationality of the firm or the subconsultants.

2. Preparation and Submission of Proposals

2.1. Consultants submitting proposals are expected to examine carefully and respect all instructions, forms, General Terms and Conditions, Terms of Reference and specifications contained in this Request for Proposals. Failure to submit a proposal containing all the required information and documentation within the deadline specified in the Letter of Invitation may result in rejection of the proposal. The standard forms in Sections 3 and 4 of this Request for Proposals shall be used as applicable.

2.2. Consultants shall submit technical and financial proposals in separate emails marked **"Technical Proposal"** and **"Financial Proposal"**, as appropriate. No financial data of any sort shall be included in the technical proposal. Only emails containing technical proposals shall be opened at the time of submission of proposals. The financial proposals will be kept unopened and in safe custody until the technical evaluation is completed.

2.3. **Technical Proposal** (not exceeding 10 pages, excluding curricula vitae (CVs). CVs maximum 3 pages each). If documents are longer only the first 10 and 2 pages respectively will be considered. Font size minimum 11 for both Technical Proposal and CV).

Consultant's technical proposal shall demonstrate the firm's knowledge of the requirements of the assignment and its understanding of the requisite tasks set forth in the scope of work of the Terms of Reference. Information must be provided on the firm and any subconsulting firm associated with for the purpose of the assignment. Provision of the requested information, in full, must be presented as follows:

(a) A brief description of the firm, an outline of the firm's recent experience of assignments of a similar nature and specifically the firm's previous work, especially in the project country. Information on the current workload of the firm in the relevant areas of this assignment shall also be presented.

(b) Comments or suggestions, if any, on the Terms of Reference designed to improve performance in carrying out the assignment.

(c) Comments and elaborations on general approach and methodology.

(d) Composition of the team which the firm proposes to provide in the field and in the home office, together with CV of each individual team member and the specific task(s) to which each team member would be assigned. The team leader and the key experts listed in the evaluation criteria table (section 3.6 of the Instructions to Consultants) shall be specifically identified. Members of the team shall have requisite experience outside their own country, preferably under conditions similar to those prevailing in the project country. A good working knowledge of English is essential for the staff. Proficiency in Ukrainian or Russian is an additional merit. The language conditions for the assignment are stated in the Terms of Reference. If the firm proposes to have a member of the consultant's home office responsible for the supervision of the team in the field, similar details shall be given with the CV of that member.

(e) Work programme including a bar chart and a staffing schedule. The bar chart shall indicate estimates of the duration and total staff days, weeks or months that would be provided for each task. The staffing schedule shall indicate clearly the estimated duration (in both the home office and in the field) and the probable timing of the assignment of each professional (both foreign and local).

(f) Description of office space, vehicles, equipment, local counterpart support etc. required in the field for carrying out the proposed services.

2.4. **Financial Proposal**

(a) The firm's financial proposal shall be denominated in EUR. The costs shown shall include a detailed breakdown of *(i) remuneration* for the number of days/weeks/months of each team member to be assigned and the related unit rates, *(ii) direct expenses* in respect of subsistence costs and housing allowances, *(iii) all other reimbursable expenses*, *(iv) 10% of total financial proposal shall be reserved as contingency.*

(b) Financial proposals as submitted by the firm will be considered in the evaluation and selection of consultants. However, each element of the financial proposal of the selected firm will be reviewed during contract negotiations for determining the final contract price.

(c) **Audit.** NEFCO retains the right to audit, both during and after the assignment, the selected firm's accounts and time and cost records relevant to the services provided, including such accounts and records as will enable verification of the costs related to the assignment.

(d) **Funds.** The amount of funds allocated for this assignment is stated in the Letter of Invitation, exclusive of VAT. The financial proposal shall cover all foreign and local costs of services for this assignment including costs of staff in the field and in the home office. The financial proposal shall be based on a minimum of home office contribution during the assignment. It shall also cover international travel (economy class or equivalent), preparation of final reports, equipment, insurance, office supplies, subsistence, local transport, facilities, equipment, and all related expenses. The consultant shall be responsible for all direct and indirect tax liabilities (if any) arising out of or connected to the performance of the services wherever they arise.

The rates and prices shall be fixed for the duration of the assignment and no currency fluctuation or other adjustments will be made.

(e) **Contract.** A lump-sum contract will be concluded for the assignment. The payment milestones for the lump-sum contract are defined under section 3.9 below.

3. Evaluation of Proposals

3.1. Evaluation of the proposals will be carried out by an evaluation committee appointed by NEFCO.

3.2. A two-stage procedure is adopted for evaluating the proposals. The technical proposals will be evaluated first and merit points awarded and the proposals ranked in order of their respective merit points, prior to the opening and evaluation of financial proposals. Quality of the technical proposal, particularly that of the staff proposed, shall be the principal criterion for evaluation of proposals and selection of consultants.

3.3. ***Technical proposals*** shall be evaluated and merit points awarded based on the following factors:

(a) The firm's experience in the disciplines forming part of the total assignment, with specific reference to experience in the Former Soviet Union as well as specific reference to existing level of contracting with NEFCO;

(b) The approach to the assignment, the suggested work programme and organisation and composition of the proposed team of experts, plus comments, if any, on the methodology in response to the Terms of Reference; and

(c) The qualifications, experience and competence of the experts proposed for the assignment.

See further the scoring table below. All evaluations will be made relating to the Required Qualifications in the Terms of Reference.

3.4. A technical proposal may be treated as non-responsive if information with respect to any of the factors (a), (b) or (c) as requested above in section 3.3 is omitted. The workload of the experts in other ongoing assignments and their availability to undertake the assignment in case of an award, will be examined after the preliminary winner has been determined. If the conclusion of such examination is that an expert evaluated is not likely to have the availability indicated in the bid, a reassessment of the scoring will be made, with possible influence on the ranking of bidders.

Only firms (i) awarded a minimum of 70 technical proposal merit points and (ii) having technical merit points within 15 points of the highest technical score will be considered for the second stage (financial evaluation). If no firm scores the required minimum of technical points, NEFCO reserves the right to negotiate with the firm scoring the highest technical points, or to reject all proposals.

3.5. A firm will be excluded from the evaluation if, at the discretion of NEFCO, the firm has been, or might be placed, in a conflict of interest position in the procurement process or the performance of the contract. Firms, which believe such a situation may exist, shall seek guidance from NEFCO prior to preparing the technical proposal.

3.6. The Consultant is expected to provide **one team** for Project I and Project II. The specific evaluation criteria are listed below:

	PRINCIPAL FACTORS IN EVALUATION	**Maximum points**
1	**Experience of Consulting firm**	
	a) Experience in project preparations, management, design, procurement, and supervision of municipal projects funded by international organisations	10
	b) Experience from similar PIU assignments (water and wastewater infrastructure) in Ukraine since 2014	10
	Subtotal 1	**20**
2	**Approach and methodology**	
	a) Relevance to the Terms of Reference	5
	b) Suggested work programmes	5
	c) Staffing plans	5
	Subtotal 2	**15**
3	**Qualifications and competence of key experts**[1)]	
	1) Team Leader	10

	PRINCIPAL FACTORS IN EVALUATION	Maximum points
	2) Deputy Team Leader, Project Coordinator	9
	3) Water experts (international/local)	9
	4) Solar power plant expert	7
	5) Technical supervision engineers	6
	6) Lead Procurement expert (international/local)	7
	7) Procurement expert	5
	8) Financial and Disbursement expert	5
	9) Environmental and Social expert (international/local)	5
	10) Communication expert	2
	Sub-total 3	**65**
	TOTAL	**100**

[1)] For those positions where the ToR indicates the need for more than one key expert for each position, Nefco reserves the right to base the evaluation on the number of experts deemed relevant.

3.7. **The financial proposals** will be opened and evaluated only after the technical evaluation has been completed and merit points awarded to each proposal. The financial proposals emails of only those firms that have qualified for the second stage of the evaluation in accordance with section 3.4 above will be opened for financial evaluation. The financial proposals of the remaining firms will remain unopened.

3.8. **Correction of Errors**. Activities and items described in the technical proposal but not priced in the financial proposal shall be assumed to be included in the prices of other activities or items, and no corrections are made to the financial proposal.

3.9. **Lump-sum contract.** Lump-sum contract. The consultant is deemed to have included all prices in the financial proposal, so neither arithmetical corrections nor price adjustments will be made. The total price, net of VAT, specified in the financial proposal (Form FIN-1) will be considered as the offered price.

3.10. The financial proposal representing the lowest evaluated price will be given the score 100; others are rated as follows:

Financial score of firm A = lowest evaluated price / price of firm A x 100;

If the financial proposal exceeds the indicated available funds it may be rejected at the discretion of NEFCO. Financial proposals including cost components in other currencies than EUR shall be converted to EUR according to the exchange rates published by the European Central Bank on the submission date of the proposal.

3.11. In the final evaluation combining the adjusted technical and financial scores, the adjusted technical merit score will be given a weight of **80 percent** and the financial score shall be given a weight of **20 percent**. The firm with the highest evaluated weighted score will be invited to contract negotiations.

4. Contract Negotiations and Award

4.1. NEFCO reserves the right to reject all proposals.

4.2. The consultancy services are expected to commence no later than within 14 days after the conclusion of the consultancy agreement. Contract negotiations will be carried out by representatives of NEFCO.

4.3. The costs of preparing a proposal and of negotiating and concluding a contract including the costs of travel to participate in possible pre-bid meeting are not reimbursable as costs of the assignment.

4.4. NEFCO expects to conclude a contract on the basis of the experts named in the proposal and will require, in the contract negotiations, assurances that these experts can, in fact, be made available. NEFCO will, at its sole discretion, consider substitutions only in case the commencement of the assignment would otherwise be delayed, for reasons unrelated to selected consultant, or, exceptionally, because of incapacity of an expert for reasons of health. The desire of a firm to use an expert on another project will not be accepted as a reason for substitution of staff and may result in the rejection of the firm in question.

4.5. The firm (or the leading consultant, if there are several partners) that submitted the first-ranked proposal will be invited to discuss technical and financial details of the proposal and the terms of the contract without delay. Discussions will commence with a review of the technical proposal, the proposed approach and work plan, staffing and any suggestions the consultant may have made to improve the Terms of Reference. Agreements will be reached, first, on the final Terms of Reference, work plan, time schedule, the staff to be employed, their periods of work in the field and in the home office, frequency and timing of home travel, housing costs, budget to be allocated for the provision of office equipment, and next, on the facilities and services to be provided by local counterparts. Thereafter, financial negotiations will begin with discussions of the proposed fee rates for each team member, and of other costs as indicated by the consultants. In subsequent negotiations, the reasonableness of each item included in the Financial Proposal of the selected firm will be assessed. Consultants shall be prepared to disclose during negotiation data backing up the consultant fees and other costs and be aware and accept that the proposed rates and other costs will be subject to scrutiny and possible negotiation.

4.6. The representatives of the consulting firm invited for contract negotiations must be authorised (on behalf of all bidding partners) to discuss and agree on the technical and financial aspects of the proposal as well as the terms and conditions of contract and to conclude a binding agreement. Should the discussions with the first invited firm prove unproductive and/or unsatisfactory, the firm submitting the next-ranked proposal will be invited instead (and so on, if necessary, until an agreement is concluded). As soon as the contract is signed with the finally selected consulting firm (the "Consultant"), other short-listed firms will be informed accordingly.

4.7. Payments for PIU support services within **Programme "Rehabilitation of wastewater services in 4 cities of Ukraine"** will be made to the Consultant for Component I (Lutsk, Khmelnytskyi, Lubny) and Component II (Horishni Plavni) separately from the respective Technical Assistance budgets. The Consultant will be paid only for work performed based on the payment schedule finalised at the contract negotiations. Payments will be made in 30 days after receiving the Consultant's invoice.

4.8. Nefco will conclude one contract with awarded Consultant for contract price of Component I submitted in Form FIN-2, Sub-total for Component I and second contract for the price proposal for Component II submitted in Form FIN-2, Sub-total for Component II.

Section 3 – Technical Proposal – Standard Forms

FORM TECH-1
TECHNICAL PROPOSAL SUBMISSION FORM

[*Location, Date*]

To: NEFCO

Dear Sirs,

We, the undersigned, offer to provide the consulting services for **PIU Support Consultant for the DSIF & NORAD funded Programme "Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi"** in accordance with your Request for Proposals dated [*insert date*] and our Proposal. We are hereby submitting our Proposal, which includes this Technical Proposal, and a Financial Proposal sent in a separate secured mail.

[We are submitting our Proposal in association with: [*insert a list with full name and address of each associated Consultant/member of Consortium*].]

We hereby declare that all the information and statements made in this Proposal are true and accept that any misinterpretation or misrepresentation contained in it may lead to our disqualification.

If negotiations are held during the period of validity of the Proposal as defined in the Letter of Invitation, we undertake to negotiate on the basis of the proposed staff. Our Proposal is binding upon us during this period, and subject to the modifications resulting from Contract negotiations.

We undertake, if our Proposal is accepted, to initiate the consulting services related to the assignment not later than the date indicated in Clause 4.2 of the Instructions to Consultants.

We understand that you are not bound to accept any proposal you receive.

We hereby accept the General Conditions of Contract for Consultant's Services attached as Annex 1 to your RfP.

Yours sincerely,

Authorized Signature [*In full and the original copy initialized*]:

Name and Title of Signatory:

Name of Firm:

Address:

FORM TECH-2
CONSULTANT'S ORGANISATION AND EXPERIENCE

A - Consultant's Organisation

Provide here a brief (max 2 pages) description of the background and organisation of your firm/entity [as well as of each subconsultant] for this assignment.

B - Consultant's Experience

Please provide information on each assignment, relevant for this assignment, for which your firm [and each joint venture/consortium partner and subconsultant] was legally contracted either individually as a corporate entity or as one of the major companies within a consortium, for carrying out consulting services similar to the ones requested under this assignment (max 1 page per project and 5 pages in total) including information on contract value, contracting entity/client, project location/country, duration (months and years), expert months provided (if different from duration), main activities and objectives.

FORM TECH-3

COMMENTS AND SUGGESTIONS ON THE TERMS OF REFERENCE

A – Comments and Suggestions on the Terms of Reference

Present and justify here any modifications or improvement to the Terms of Reference you are proposing to improve performance in carrying out the assignment (such as deleting some activity you consider unnecessary, or adding another, or proposing a different phasing of the activities). Such suggestions shall be concise and to the point, and incorporated in your Proposal.

FORM TECH-4
DESCRIPTION OF APPROACH, METHODOLOGY AND WORK PLAN FOR PERFORMING THE ASSIGNMENT

Technical approach, methodology and work plan are key components of the Technical Proposal. You are suggested to present your Technical Proposal (max 8 pages, inclusive of charts and diagrams) divided into the following three chapters:

a) Technical Approach and Methodology,
b) Work Plan, and
c) Organisation and Staffing.

a) Technical Approach and Methodology. In this chapter you shall explain your understanding of the objectives of the assignment, approach to the services, methodology for carrying out the activities and obtaining the expected output, and the degree of detail of such output. You shall highlight the problems being addressed and their importance and explain the technical approach you would adopt to address them. You shall also explain the methodologies you propose to adopt and highlight the compatibility of those methodologies with the proposed approach.

b) Work Plan. In this chapter you shall propose the main activities of the assignment, their content and duration, phasing and interrelations, milestones, and delivery dates of the reports. The proposed work plan shall be consistent with the technical approach and methodology, showing understanding of the Terms of Reference and ability to translate them into feasible work plan. A list of the final documents, including reports, drawings, and tables to be delivered as final output, shall be included here. The work plan shall be consistent with the Work Schedule of Form TECH-8.

c) Organisation and Staffing. In this chapter you shall propose the structure and composition of your team. You shall list the main disciplines of the assignment, the key expert responsible, and proposed technical and support staff.

FORM TECH-5

TEAM COMPOSITION AND TASK ASSIGNMENTS

Due to the similarity of scope and measures, consultant shall submit one team composition and task assignments for Component I and Component II.

Professional staff for Component I and Component II				
Name of staff	**Firm**	**Area of Expertise**	**Position Assigned**	**Tasks Assigned**

FORM TECH-6

CURRICULUM VITAE (CV) FOR PROPOSED PROFESSIONAL STAFF

CVs may be provided in any format you prefer, but shall as a minimum clarify the following issues for every member of the proposed professional staff:

1. Proposed Position [o*nly one candidate shall be nominated for each position*]:

2. Name of Firm [*insert name of firm proposing the staff*]:

3. Name of Staff:

4. Date of Birth:

5. Nationality:

6. Education:

7. Membership of Professional Associations:

8. Other Training:

9. Countries of Work Experience:

10. Languages [*for each language indicate proficiency: good, fair, or poor in speaking, reading, and writing*]:

11. Employment Record Relevant to the Assignment:

12. Adequacy for the Assignment: Detailed Tasks Assigned [*list all tasks to be performed under this assignment*] and Reference to Prior Work/Assignments that Best Illustrates Capability to Handle the Assigned Tasks:

Expert's contact information: (e-mail ……., phone……)

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience, and I am available to undertake the assignment in case of an award. I understand that any misstatement or misrepresentation described herein may lead to my disqualification or dismissal by NEFCO, and/or sanctions by NEFCO.

{day/month/year}

Name of Expert Signature Date

{day/month/year}

Name of authorized Representative of the Consultant (the same who signs the Proposal) Signature Date

FORM TECH-7

STAFFING SCHEDULE

Staffing schedule shall be filled in with a breakdown into Component I and Component II. For professional staff the input shall be indicated individually; for support staff it shall be indicated by category. Weeks are counted from the start of the assignment. Indicate home and field work separately - field work means work carried out at a place other than in the home office.

No	**Name of Staff**	**Staff input (in the form of a bar chart)**														**Total staff-week input**		
		1	2	3	4	5	6	7	8	9	10	11	12	n		**Home**	**Field**	**Total**
Foreign																		
1		*(Home)*																
		(Field)																
2																		
n																		
												Subtotal						
Local																		
1		*(Home)*																
		(Field)																
2																		
n																		
												Subtotal						
												Total						

FORM TECH-8

WORK SCHEDULE

Work schedule shall be filled in with a breakdown into Component I and Component II.

No.	**Activity**	**Weeks**												
		1	2	3	4	5	6	7	8	9	10	11	12	n
1														
2														
3														
4														
5														
n														

Indicate all main activities of the assignment, including delivery of report (e.g inception, interim, and final reports) and other relevant benchmarks. Duration of activities shall be indicated in the form of a bar chart.

FORM TECH-9

COVENANT OF INTEGRITY

to the Purchaser/Client/Employer/NEFCO
from a Tenderer/Contractor/Supplier/Service Provider/Consultant
to be attached to its tender
(or to the contract in the case of a negotiated procedure)

"We declare and covenant that neither we nor anyone, including any of our directors, employees, agents, joint venture partners or sub-contractors ("the **Parties**"), where these exist, acting on our behalf with due authority or with our knowledge or consent, or facilitated by us, has engaged, or will engage, in any Prohibited Practices (as defined below) in connection with the tendering process or in the execution or supply of any works, goods or services for [*specify the contract or tender invitation*] (the "**Contract**") and covenant to so inform you if any instance of any such Prohibited Practices shall come to the attention of any person in our organisation having responsibility for ensuring compliance with this Covenant.

We shall, for the duration of the tender process and, if we are successful in our tender, for the duration of the Contract, appoint and maintain in office an officer, to whom you shall have full and immediate access, having the duty, and the necessary powers, to ensure compliance with this Covenant.

If any of the Parties, where these exist and as applicable, (i) have been convicted in any court of any offence involving Prohibited Practices in connection with any tendering process or provision of works, goods or services during the five (5) years immediately preceding the date of this Covenant, or (ii) have been dismissed or resigned from any employment on the grounds of being implicated in any Prohibited Practices, or (iii) have been excluded from participation in a tendering procedure by Nordic Environment Finance Corporation (NEFCO) or by any national or EU Institutions or any international financial institution or other sanctions authority, which NEFCO deems relevant, or (iv) is under any investigation in relation to Prohibited Practice, we shall give details of any event in (i)-(iv) above together with details of the measures that we have taken, or shall take, to ensure that no Party will commit any Prohibited Practices in connection with the Contract [*give details if necessary*].

In the event that we are awarded the Contract, we grant the Purchaser/Client/Employer/NEFCO and auditors appointed by either of them, as well as any authority or body having competence under relevant legislation, the right of inspection of our records and those of all our sub-contractors under the Contract. We accept to preserve these records generally in accordance with applicable law but in any case for at least six (6) years from the date of performance of the Contract."

For the purpose of this Covenant, "Prohibited Practices" includes:

- **Abuse** meaning theft, misappropriation, waste or improper use of property or assets related to the Contract, either committed intentionally or through reckless disregard.
- **Coercion** meaning impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party for the purpose of improperly influencing the actions of a party.
- **Collusion** meaning an arrangement between two or more parties designed to achieve an improper purpose, including for the purpose of improperly influencing the actions of another party.
- **Corruption** meaning the promise, offering, giving, receiving, or soliciting, directly or indirectly, anything of value or any undue advantage, or any act or omission that involves the abuse of authority or functions, for

the purpose of influencing or causing to influence improperly the actions of another party, or for the purpose of obtaining an undue advantage for oneself or for another party.

- **Fraud** meaning any act or omission, including misrepresentation or concealing a material fact, that knowingly or recklessly misleads, or attempts to mislead, a party for the purpose of obtaining a financial or other benefit or undue advantage for oneself or for a third party, or to avoid an obligation.
- **Obstruction** meaning
  (i) deliberately destroying, falsifying, altering or concealing evidence material to an investigation;

  (ii) making false statements to investigators in order to materially impede an investigation;

  (iii) failing to comply with requests to provide information, documents or records in connection with an investigation;

  (iv) threatening, harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to a NEFCO investigation or from pursuing an investigation; or

  (v) materially impeding NEFCO's contractual rights of audit or access to information; and

- **Money laundering** meaning

  (i) the conversion or transfer of property, knowing that such property is derived from criminal activity, to conceal and disguise the illicit origin of the property, or assisting any person who is involved in the commission of such activity to evade the legal consequences of this action;

  (ii) the concealment or disguise of the true nature, source, location, disposition, movement, rights with respect to, or ownership of property, knowing such property is derived from criminal activity;

  (iii) the acquisition, possession or use of property knowing, at the time of receipt, that such property was derived from criminal activity; or

  (iv) participation or assistance in any of the activities above; and

- **Financing of terrorism** meaning the provision or collection of funds, by any means, directly or indirectly, with the intention that they should be used or in the knowledge that they are to be used, in full or in part, in order to carry out terrorist activities (the "terrorist activities" shall have the same meaning as set out in Article 2 of the International Convention for the Suppression of the Financing of Terrorism).

Date:

Signature:
[Name and position]
for and on behalf of

[Name of the firm/individual or joint venture]
Note: When so required by NEFCO this Covenant must be sent to NEFCO together with a copy of the contract documents. In other cases, it must be kept by the Beneficiary and available upon request from NEFCO

Section 4 – Financial Proposal – Standard Form

FORM FIN-1
FINANCIAL PROPOSAL SUBMISSION FORM

[*Location, Date*]

To: NEFCO

Dear Sirs:

We, the undersigned, offer to provide the consulting services for **PIU Support Consultant for the DSIF & NORAD funded Programme "Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi"** in accordance with your Request for Proposals dated [*insert date*] and our Technical Proposal. Our attached Financial Proposal is for the **Total Cost of [*insert amount(s) in EUR in words and figure*]**. This amount is exclusive of the applicable VAT.

Our Financial Proposal shall be binding upon us subject to the modifications resulting from the contract negotiations, up to expiration of the validity period of the Proposal as defined in the Letter of Invitation. We understand that any final rates and prices resulting from the contract negotiations will remain fixed until the end of the assignment.

Commissions and gratuities paid or to be paid by us to agents relating to this Proposal and execution of contract, if we are awarded the contract, are listed below:

Name and Address, Amount and Purpose of Commission of Agents, Currency or Gratuity

[*If no payments are made or promised, add the following statement: "No commissions or gratuities have been or are to be paid by us to agents or any third party relating to this Proposal and Contract execution."*]

We understand you are not bound to accept any Proposal you receive.

We remain,

Yours sincerely,

Authorized Signature [*in full and the original copy initialized*]:
Name and Title of Signatory:
Name of Firm:
Address:

FORM FIN-2
SUMMARY OF COSTS

Type of cost	Costs, EUR
Component I	
Remuneration, Component I	
Reimbursable Expenses, Component I	
SUB-TOTAL for Component I	
Component II	
Remuneration, Component II	
Reimbursable Expenses, Component II	
SUB-TOTAL for Component II	
Grand total in EUR	

The relevant grand total must coincide with the Total Costs of the Financial Proposal given in Form FIN-1. Respectively, Remuneration and Reimbursable Expenses must coincide with the relevant Total Costs indicated in Forms FIN-3, and FIN-4.

FORM FIN-3

BREAKDOWN OF REMUNERATION

When used for lump-sum contract assignment, information to be provided in this form shall only be used to demonstrate the basis for the calculation of the contract's ceiling amount and, if needed, to establish payments to the Consultant for possible additional services requested by NEFCO. This form shall not be used as a basis for payments under lump-sum contracts.

Joint form shall be filled in for Component I and Component II.

A. Remuneration _____				
No.	**Name**	**Position (as in TECH-6)**	**Person-month Remuneration Rate**	**Time Input in Person/Month** (from TECH-6)
	Key Experts			
K-1			[*Home*]	
			[*Field*]	
K-2				
	Non-Key Experts			
N-1			[*Home*]	
N-2			[*Field*]	
				Total Costs, EUR

FORM FIN-4

BREAKDOWN OF REIMBURSABLE EXPENSES

When used for lump-sum contract assignment, information to be provided in this form shall only be used to demonstrate the basis for calculation of the contract ceiling amount and, if needed, to establish payments to the Consultant for possible additional services requested by NEFCO. This form shall not be used as a basis for payments under lump-sum contracts.

Joint form shall be filled in for Component I and Component II.

B. [*Reimbursable]* _____				
N°	**Type of [*Reimbursable Expenses]***	**Unit**	**Unit Cost**	**Quantity**
	*{e.g., subsistence costs**}*	{Day}		
	{e.g., International flights}	{Ticket}		
	{e.g., In/out airport transportation}	{Trip}		
	{e.g., Communication costs between Insert place and Insert place}			
	{ e.g., Reproduction of reports}			
	{e.g., Office rent}			
	.....			
	{Training of the project owner's personnel – if required in TOR}			
				Total Costs, EUR

NEFCO

NEFCO'S GENERAL TERMS AND CONDITIONS FOR CONSULTANCY SERVICES

1 RESPONSIBILITY, PROFESSIONAL PRACTICE, INTEGRITY, IMPARTIALITY AND INDEPENDENCE

1.1 The Consultant shall be fully responsible for the Services and perform them in an objective and professional manner in compliance with best industry practice for similar services.

1.2 While providing the Services, the Consultant shall protect NEFCO's interests and act dutifully and transparently towards NEFCO.

1.3 The Consultant shall not receive or request instructions for the performance of the Services from any other party than NEFCO (unless otherwise explicitly instructed by NEFCO).

1.4 The Consultant shall during the Assignment remain financially and otherwise independent of other consultants, manufacturers, suppliers, contractors and other actors and/or factors that may prejudice the Consultant's objectivity. In particular the Consultant shall not accept any referral fee or other compensation from other consultants, manufacturers, suppliers, or contractors recommended by the Consultant.

1.5 The Consultant shall promptly inform NEFCO of any assignment or relation with a third party which might affect or be seen to affect the Consultant's impartiality or create a potential conflict of interest in relation to the Assignment.

1.6 The Parties are independent parties and the Parties agree that the Agreement shall not be deemed as an employment agreement and that the Consultant is not, nor any other person performing services under this Agreement, engaged by NEFCO as an employee but as an independent consultant and that relevant provisions of the Swedish Employment Protections Act (1982:80) shall not be applicable on the Parties' arrangement under this Agreement.

2 TIME SCHEDULE, INFORMATION, ASSIGNED PERSONNEL AND COOPERATION WITH THIRD PARTIES

2.1 The Services shall be provided in accordance with the time schedule in the Special Terms and Conditions and as possibly described in more detail in the annexes. The Consultant shall ensure that the agreed time schedule is adhered to.

2.2 The Parties shall keep each other timely informed about events or matters relevant for the performance of the Services. The Consultant shall without delay inform NEFCO Responsible person of any events which have had or are likely to have an adverse impact on the Consultant's provision of the Services within the agreed time schedule and/or otherwise negatively impact the Consultant's performance and/or fulfilment of the Services. Any delay or other underperformance in carrying out the Services shall be subject to the remedies set out in Sections 4, 5 and 17.

2.3 The Services shall be carried out personally by the Consultant or the personnel of the Consultant as set out in Section 1 of the Special Terms and Conditions and as possibly described in more detail in the annexes (the "**Assigned Personnel**"). If the Consultant should wish to engage a subcontractor to perform a certain part of the Services, the matter shall be discussed with NEFCO, including its possible effects on the Consultant's remuneration, and can only be done subject to NEFCO's prior written approval. Notwithstanding such approval, the Consultant shall remain fully responsible and liable for the performance of the Services, including any Services provided by its subcontractors as if they had been carried out by the Consultant.

2.4 The Consultant shall, without unreasonable delay and at no cost to NEFCO, be obliged to replace any Assigned Personnel performing the Services, who NEFCO reasonably considers is lacking the necessary competence, whom NEFCO finds it manifestly difficult to collaborate with or whose conduct is inconsistent with what NEFCO reasonably expects. The

identity of such replacing personnel as well as any other changes of the Assigned Personnel and any possible effects on the Consultant's remuneration, shall be subject to NEFCO's prior written approval (except if triggered by a *force majeure* situation). If approved by NEFCO, the replacing personnel shall become Assigned Personnel. Any changes in the Assigned Personnel shall not affect the agreed time schedule, in the absence of NEFCO's prior written consent.

2.5 If and to the extent relevant, the Consultant shall while providing the Services co-operate with other parties as may be determined by NEFCO.

3 CHANGE REQUEST

3.1 NEFCO and/or the Consultant may request the other Party to make changes to the Services to be provided.

3.2 In such case, the requesting Party shall submit a written request (the "**Change Request**"). The Change Request shall contain a description of the content of the proposed change as well as the reasons for the change and the effect the change is deemed to have on the Services.

3.3 The receiving Party shall within reasonable time review the Change Request in terms of its possible impact on the agreed Total Fee, time schedule and/or other agreed terms and conditions, and each Party shall be entitled to either approve or reject the Change Request.

3.4 If the Change Request is accepted by the other Party, the change shall be formalized through both Parties approving it in writing and the change shall thereafter be considered as an amendment to the Agreement.

3.5 The Parties agree and acknowledge that comments to form or substance, revision, adjustment, correction and/or supplemental requirements to bring the Services to a final and acceptable/agreed form (including all reasonable incidental work related thereto, such as meetings, telephone calls, correspondence etc.) shall not be considered as changes to the Services in terms of Sections 3.1 to 3.4 above.

4 ERRORS, OMISSIONS AND DELAY

4.1 The Consultant shall, at no cost to NEFCO, assume responsibility for correcting any errors and/or omissions in the performance of the Services.

4.2 In the event that the Consultant is delayed in performing the Services or a material error, defect and/or non-conformity occurs in the Services, and the situation upon NEFCO's request is not remedied or corrected within 30 (thirty) days to NEFCO's satisfaction, NEFCO shall (without prejudice to NEFCO's other rights under the Agreement, including, without limitation, the right to liquidated damages in accordance with Section 5) have the right to:

(i) accept the Services in their then current form at a reduced price which corresponds to the value of the actually delivered part; or alternatively;

(ii) complete itself or appoint a third party to complete the Services at the Consultant's sole cost and expense; or alternatively;

(iii) terminate the Agreement in whole or in part with immediate effect, while reserving all other rights available to it under the Agreement and applicable law; and in addition to (i) - (iii)

(iv) seek damages from the Consultant.

5 LIQUIDATED DAMAGES IN CASE OF DELAY

5.1 If the Consultant is not able to provide the Services within the agreed time schedule and this is not caused by *force majeure* or circumstances related to NEFCO, then the Consultant shall pay liquidated damages to NEFCO in compensation for the delay.

5.2 The liquidated damages shall amount to 0.2 percent of the agreed Total Fee excluding VAT, for each working day the Services are delayed, but in any circumstances limited to a maximum of 50 (fifty) working days. NEFCO shall be entitled to deduct such liquidated damages from any amounts owed by NEFCO to the Consultant under the Agreement.

5.3 If only parts of the agreed Services are delayed, the Consultant may request NEFCO to reduce the liquidated damages in such way that the compensation is proportional to the ability of NEFCO to utilise those parts of the Services that have been performed and delivered to NEFCO.

5.4 Any claims for liquidated damages shall be presented by NEFCO in writing to the Consultant at the latest 90 (ninety) days from the day on which the Assignment was completed or the Agreement was terminated. If NEFCO should not present a claim to the Consultant within this time limit, NEFCO's right to liquidated damages shall be deemed forfeited.

6 REMUNERATION

6.1 The remuneration to be paid by NEFCO to the Consultant in return for the Services shall consist of the fee agreed in the Special Terms and Conditions.

6.2 The Total Fee can be either fixed or variable. Variable fees shall be based on performance on a time and material basis.

6.3 If agreed in the Special Terms and Conditions, NEFCO shall, against receipts or written clarification, in addition to the Total Fee, pay compensation for the costs listed below:

(i) reasonable travel costs in economy class including airport transfers;

(ii) reasonable accommodation costs in a standard hotel room including breakfast only; and

(iii) other expenditures required for providing the Services.

6.4 Notwithstanding Section 6.3, NEFCO will not reimburse (i) travel time, or (ii) travel costs within the Helsinki metropolitan area (meaning a range of sixty (60) kilometres measured from the centre of Helsinki).

6.5 NEFCO will not pay any daily allowances to the Consultant.

7 TERMS OF PAYMENT

7.1 Payment(s) will be made by NEFCO in accordance with the payment schedule agreed in the Special Terms and Conditions. If no payment schedule is agreed, the Consultant shall invoice NEFCO monthly in arrears after the Services have been performed by the Consultant and accepted by NEFCO.

7.2 According to Article 9 of the Agreement concerning NEFCO[1], NEFCO is in the Nordic countries exempted from taxation, including VAT, in relation to its official activities. Also, as an international organization, NEFCO is exempted from VAT within the European Union[2].

7.3 Invoices specifying the nature and extent of the Services performed will be paid by NEFCO within 30 (thirty) days from the date of receipt, subject to NEFCO's acceptance of the Services as satisfactory. Should an invoice or a part thereof be disputed by NEFCO, NEFCO will up-front pay the undisputed part.

7.4 The Consultant shall submit a written confirmation issued by the account-holding bank confirming that the Consultant is the legal owner of the bank account to which the payment is requested to be made.

7.5 At the latest within 90 (ninety) days after completion of the Assignment, the Consultant shall submit a final invoice specifying any outstanding payments with respect to the Services provided under the Assignment. NEFCO's payment of the final invoice will only take place once NEFCO has agreed to that the Assignment has been completed. Any subsequent claim for payment shall entail no more than the right of set-off of any payments owed by NEFCO to the Consultant, unless the Consultant, within the specified time, gives written notification to the effect that an outstanding payment, unknown to him at that time, may lead to a further claim, or can show that the claim is based on the outstanding sum that was unknown to him at the time.

7.6 If NEFCO should not make an undisputed payment on time, the Consultant shall be entitled to request interest on the overdue amount if the claim is presented within reasonable time not exceeding 45 (forty-five) days after the overdue date, at an annual interest rate of 9% p.a. (nine per cent per annum) from and including the due date to but excluding the date of actual payment.

8 LIABILITY AND LIMITATION OF LIABILITY

8.1 The Consultant shall, subject to the limitations specified below in this Section 8 and any additional provisions agreed in the Special Terms and Conditions, be liable for any damage that the Consultant, its subcontractors or any other party engaged by the Consultant for the performance of the Services, may cause NEFCO to incur as a consequence of the Consultant's wilful misconduct, negligence or breach of the Agreement.

8.2 NEFCO's acceptance of the Services shall not release the Consultant from liability.

8.3 The total aggregate liability of both Parties under or in relation to the Agreement shall be limited to the higher of (i) 50,000 euro; or (ii) the value of the Total Fee and possible costs compensation paid or payable by NEFCO to the Consultant under the Agreement.

8.4 The limitation of liability set out in this Section 8 shall not apply in case of gross negligence, fraud, wilful misconduct, death or personal injury, material breach of the Agreement or breach of the Agreement in relation to the intellectual property rights or indemnification provisions set out in Section 9 or in relation to the confidentiality provision in Section 12. Further, the limitation of liability set out in this Section 8 shall not apply in case the Consultant is liable for payments to any third party in accordance with Section 4.2.

[1]Agreement between Denmark, Finland, Iceland, Norway and Sweden concerning the Nordic Environment Finance Corporation, available at NEFCO's website www.nefco.int.

[2] On the basis of Article 151(1), point b, of Directive 2006/112/EC on the common system of value added tax (as amended by 2009/162/EC) and Article 12(1), point b, of Directive 2008/118/EC concerning the general arrangements for excise duty.

9 RIGHTS OF OWNERSHIP, INTELLECTUAL PROPERTY RIGHTS AND INDEMNIFICATION

9.1 All rights, title, interest and all intellectual property rights in and to any pre-existing material, information, data, programs, models, methods and/or work created by a Party outside the scope of this Agreement or prior to the execution of this Agreement, shall vest in and remain the sole and exclusive property of that Party.

9.2 All rights, title, interest and all intellectual property rights in or relating to the Services shall vest exclusively in NEFCO. The Consultant may retain copies of documents and data, but shall not be entitled to use this material for purposes unrelated to the Services without NEFCO's prior written consent.

9.3 Equipment, vehicles and materials made available to the Consultant by NEFCO, or purchased by the Consultant wholly or partly with funds supplied or reimbursed by NEFCO under this Agreement shall be the property of NEFCO and shall be marked as such. Upon completion of the Services or termination of the Agreement, the Consultant shall make available to NEFCO an inventory of such equipment, vehicles and materials and shall dispose of same equipment, vehicles and materials in accordance with NEFCO's instructions.

9.4 For the avoidance of doubt, nothing in this Agreement shall limit a Party's right to use the general professional skills, experience and know-how acquired and/or applied by it under or in relation to this Agreement for the benefit of itself or a third party.

9.5 The Consultant shall indemnify, defend and hold NEFCO harmless from any and all claims, suits, actions or demands asserted against NEFCO world-wide, and against all liabilities, damages, losses, costs and expenses (including but not limited to attorney's fees) which NEFCO may incur when arising directly or indirectly from any infringement or alleged infringement of any patent, trademark, copyright or design or any other intellectual property right of a third party, if such claim, demand, suit or action may be attributable to the Consultant's provision of the Services. Should an intellectual property claim, or threat for such claim, arise, the Parties shall seek to agree on appropriate measures to address the matter. The cost for the defence against any such claim shall be entirely borne and covered by the Consultant as set out above.

9.6 No limitation(s) of liability set out in the Agreement or otherwise shall apply to the indemnification undertaking to hold NEFCO harmless as set out in Section 9.5 above.

10 INSURANCE

10.1 The Consultant shall maintain adequate insurance for any liability under this Agreement, including for safeguarding of the documents and other property of NEFCO, which may be in the Consultant's possession during the Assignment.

10.2 Unless otherwise agreed between the Parties, the Consultant shall maintain adequate professional liability insurance throughout the entire period of the Assignment.

10.3 The Consultant shall be responsible for insuring its Assigned Personnel, and for ensuring that any subcontractor(s) is similarly insured, against death, injury, loss of property and illness. The Consultant shall also be responsible for ensuring that adequate travel insurance is in place.

10.4 Upon NEFCO's request, the Consultant shall provide evidence demonstrating that sufficient insurance is in place.

11 LEGAL STATUS OF NEFCO

11.1 The Consultant expressly acknowledges NEFCO's legal status as an international organisation, vested with certain immunities and privileges, and the impact this special legal status has on NEFCO's contractual obligations as follows:

(i) NEFCO is a legal person under international law and is governed solely by and operates under its constituent documents;

(ii) NEFCO enjoys immunity from jurisdiction, which means that the chosen dispute resolution mechanism shall be arbitration and only a final arbitral award is binding upon NEFCO;

(iii) NEFCO itself, its property and assets (wherever located and by whomsoever held) are immune from search, requisition, confiscation and expropriation by executive and legislative actions (including any interim court orders, injunctive reliefs etc.);

(iv) NEFCO's premises, archives, and all documents belonging to NEFCO or held by NEFCO are inviolable and the communications of NEFCO are protected by bank secrecy and are confidential;

(v) NEFCO has its own established governing and supervisory bodies and, therefore, NEFCO is exempted from audit inspections and disclosure requirements under national laws or as otherwise may be imposed on a party through a contractual relationship; and

(vi) NEFCO is not bound by any national or EU legislation on protection of personal data. NEFCO's Global Privacy Policy (available at NEFCO's website) provides information on why and how personal data is processed at NEFCO.

11.2 Nothing in this Agreement shall be construed as a waiver, renunciation or other modification of any immunities, privileges or exemptions accorded to NEFCO pursuant to the Agreement concerning NEFCO, any international convention or any applicable law. Notwithstanding the foregoing, NEFCO has made an express submission to arbitration under Section 16 and accordingly, and without prejudice to its other privileges and immunities (including, without limitation, the inviolability of its archives), it acknowledges that it does not have immunity from suit and legal process in respect of the enforcement of a final arbitral award duly made against it as a result of its express submission to arbitration pursuant to Section 16.

12 CONFIDENTIALITY

12.1 The Consultant understands and agrees that as part of the Assignment, the Consultant may get access to information (in hard copy, electronic format or verbally) that relates to NEFCO's or NEFCO's clients' and cooperation partners' past, present or future operations, businesses, research, development, finances, services and technical know-how or knowledge (the "**Confidential Information"**). Any information related to NEFCO and its activities is protected by bank secrecy and shall therefore be treated as Confidential Information and be subject to the confidentiality obligation set out in this Section 12. Furthermore, all information contained in this Agreement shall be deemed Confidential Information.

12.2 The Consultant undertakes to keep confidential any Confidential Information it may receive from NEFCO, a client of NEFCO or any third party under or in connection with this Agreement and, save as specifically permitted below, not to divulge this information to any third party without NEFCO's prior written consent. The Consultant undertakes to use the Confidential Information solely for the purposes of this Agreement.

12.3 Save as may follow from statutory obligations of confidentiality, the above shall not apply to any information that:

(i) is in the public domain at the time of disclosure or later becomes a part of the public domain through no breach of this Agreement;

(ii) is received by the Consultant in good faith from a third party who is under no obligation of confidentiality with respect thereto;

(iii) is known to the Consultant without any obligation of confidentiality prior to disclosure by NEFCO;

(iv) is independently developed by the Consultant without utilizing the Confidential Information as evidenced by the Consultant's written records;

(v) is expressly authorised to be disclosed by NEFCO in writing; or

(vi) is required to be disclosed by law or in accordance with the requirement of a supervisory or regulatory authority to which the Consultant is subject to. For the sake of clarity, the Consultant expressly acknowledges that NEFCO enjoys inviolability of its archives and communication, including any data, information and material, and therefore any disclosure in accordance with this subsection shall always be subject to NEFCO's prior written consent. Any such authorised disclosure shall only be made to the extent required.

12.4 The Consultant may give access to Confidential Information received from NEFCO to its Assigned Personnel and/or subcontractors (if any) only on a need-to-know basis, and provided that there is always a clear understanding of the confidential nature of the information as set out in this Section. The Consultant further represents and warrants that it will ensure that the Assigned Personnel and/or subcontractors (if any) will agree to be bound and adhere to the confidentiality obligations set out in this Section. The Consultant also accepts that all Assigned Personnel performing the Services shall, at NEFCO's request, be obliged to sign a separate confidentiality agreement.

12.5 The Consultant shall exercise its utmost care in safeguarding that the Confidential Information is appropriately processed, stored, handled and protected.

12.6 The rights and obligations set out in this Section shall survive the expiry or termination of this Agreement. Upon expiry or termination of the Agreement for any reason, the Consultant shall immediately cease using the Confidential Information and, upon NEFCO's request, destroy or promptly return all concerned material (and all copies thereof) to NEFCO and confirm to NEFCO, within 15 (fifteen) days after NEFCO's request, that all of the Confidential Information has been destroyed or returned.

13 PERSONAL DATA PROTECTION

13.1 The Consultant shall at all times comply with the applicable data protection laws in processing any personal data, including by procuring all requisite consents where necessary, including where explicit consent is required.

13.2 The Consultant

(i) has introduced and applies appropriate data protection policies and procedures concerning the collection, use, storage, retention, transfer and security of personal data;

(ii) has implemented regular staff training, using testing, audits or other documented mechanisms to ensure and monitor compliance with those policies and procedures;

(iii) has ensured that only authorised personnel has access to personal data and that such access has only been granted on a need to know basis; and

(iv) maintains complete, accurate and up to date records of all of its personal data processing activities as required by the applicable data protection laws.

14 AUDITING, ANTICORRUPTION AND ETHICAL CONDUCT

14.1 The Consultant shall (i) keep accurate and systematic accounts and records with respect to the Services provided under the Agreement, in accordance with internationally accepted accounting principles and in a form and detail which clearly identifies all relevant charges and costs, and their basis; and (ii) upon request up to two (2) years from the expiration or termination of the Agreement, permit NEFCO or its designated representative to inspect these accounts and records and to make copies thereof as well as to have them audited by auditors appointed by NEFCO.

14.2 The Consultant acknowledges and confirms that it is aware of and undertakes to comply with NEFCO's Policy on Anticorruption and Compliance, available at NEFCO's website (the "**Anticorruption Policy**"), which includes specifically an undertaking to (i) not engage directly or indirectly in any abuse, coercion, collusion, corruption, fraud, obstruction, money laundering or financing of terrorism as defined in the Anticorruption Policy (the "**Prohibited Practices**"), and (ii) promptly, upon becoming aware of any suspected or alleged Prohibited Practices in relation to the Services or the Agreement, notify NEFCO in writing.

14.3 The Consultant acknowledges and confirms that it is aware of and undertakes to comply with NEFCO's Policy on Prevention of Sexual Exploitation, Sexual Abuse and Sexual Harassment, available at NEFCO's website (the "**SEAH Policy**"), which includes specifically an undertaking to (i) refrain from directly or indirectly participating or engaging in any form of sexual abuse, sexual exploitation or sexual harassment as defined in the SEAH Policy, and (ii) promptly, upon becoming aware of any suspected or alleged SEAH in relation to the Services or the Agreement, notify NEFCO in writing.

14.4 The Consultant undertakes while performing the Services to observe the highest ethical standards and to follow all applicable laws, including but not limited to those relating to payment of taxes and/or social security contributions in accordance with the laws of the country in which the Consultant is domiciled, operates or where the Services are performed.

14.5 The Consultant shall provide NEFCO or any designated NEFCO representative its full and timely cooperation during any integrity due diligence process or investigation relating to an suspected or alleged breach of the Anticorruption Policy or the SEAH Policy, and shall require its agents, attorneys, accountants or other advisers, to cooperate as reasonably required during any due diligence, audits or investigations carried out by NEFCO. The Consultant shall also make relevant personnel available for a meeting with the NEFCO representative.

14.6 NEFCO shall, in its sole discretion, have the right to terminate the Agreement with immediate effect, should it become apparent in the reasonable opinion of NEFCO that the Consultant, the Assigned Personnel or any other parties involved in the provision of the Services have engaged in Prohibited Practices or in SEAH, and/or have not adhered to the obligations under this Section 14.

15 REFERENCE RIGHT

15.1 The Consultant shall be entitled to use NEFCO name as a reference for marketing or other purposes subject to NEFCO's prior written consent in each individual case.

16 GOVERNING LAW AND DISPUTE RESOLUTION

16.1 This Agreement shall be governed by and construed in accordance with the substantive laws of Sweden.

16.2 Any dispute, controversy or claim arising out of or in connection with this Agreement, or the breach, termination or invalidity thereof, which has not been settled amicably by mutual agreement of the Parties within 60 (sixty) days after the other Party's receipt of a written request for negotiations by either Party to such effect, shall be finally settled by arbitration administered by the SCC Arbitration Institute (the "**SCC**").

16.3 The Rules for Expedited Arbitrations of the SCC (the "**Expedited Rules**") shall apply where the amount in dispute does not exceed EUR 300,000. Where the amount in dispute exceeds EUR 300,000, the Arbitration Rules of the SCC (the "**Arbitration Rules**") shall apply. The arbitral tribunal shall be composed of a sole arbitrator appointed in accordance with the Expedited Rules or Arbitration Rules, as relevant. The amount in dispute shall be calculated as including the claims made in the request for arbitration and any counterclaims made in the answer to the request for arbitration. With reference to points 11.1 (ii) and 11.1 (iii) in Section 11 of this Agreement, Article 38 (Interim measures) of the Expedited Rules and Article 37 (Interim measures) of the Arbitration Rules shall not be applicable to NEFCO during the arbitral proceeding.

16.4 The legal seat and place of arbitration shall be Stockholm, Sweden. The arbitrator may, at /her discretion, hold hearings, meetings and deliberations at any other convenient geographical place in order to secure the efficient and cost-effective conduct of the proceedings.

16.5 The language to be used in the arbitral proceedings (including the documentation) shall be English.

16.6 The arbitral award shall be final and binding upon the Parties.

17 TERM AND TERMINATION

17.1 The Agreement shall become effective and binding upon signing by both Parties and shall remain effective until both Parties have fulfilled their respective obligations under the Agreement, unless terminated earlier in accordance with this Agreement.

17.2 NEFCO shall be entitled to terminate the Agreement with 30 (thirty) days prior written notice. In such case the Consultant shall be entitled to compensation, in accordance with this Agreement, (i) for the Services carried out until the notice of termination was made and (ii) for occurred verified necessary expenses which have not yet been reimbursed.

17.3 NEFCO shall be entitled to terminate the Agreement with immediate effect upon written notice, if the Consultant files for bankruptcy or is put into liquidation, receivership or becomes insolvent. In such case the Consultant shall be entitled to compensation, in accordance with this Agreement, (i) for the Services carried out until the notice of termination was made and (ii) for occurred verified necessary expenses which have not yet been reimbursed.

17.4 Either Party shall be entitled to terminate the Agreement with 30 (thirty) days prior written notice, if there is a *force majeure* event that continues for more than 30 (thirty) days or if the other Party is in material breach of its obligations under the Agreement and the breaching Party fails to remedy such breach within the notice period. Any unpaid fee that is disputed by NEFCO shall not constitute a material breach under this Section.

17.5 Upon termination, the results of work carried out shall immediately be handed over to NEFCO, unless otherwise agreed between the Parties.

18 AMENDMENTS TO THE AGREEMENT

18.1 Any amendments to the Agreement shall be made in writing and accepted and signed by the authorised representatives of both Parties.

19 TRANSFER OF THE AGREEMENT

19.1 The Consultant may not assign or transfer this Agreement or any of its rights or obligations under the Agreement without NEFCO's prior written consent.

20 NOTICES

20.1 Any notice to be given by one Party to the other shall be made in writing and deemed properly given or made when delivered to the recipient by hand, registered mail, courier or email during normal business hours to the address and contact person specified in Section 1 of the Special Terms and Conditions (or to such other address as may be notified in writing from time to time by either Party). If given by email, any notice shall promptly be confirmed by registered letter or courier.

21 SURVIVING TERMS

21.1 The following Sections of NEFCO's General Terms and Conditions for Consultancy Services shall survive any termination or expiry:

Section 8, Liability and Limitation of Liability;
Section 9, Rights of Ownership, Intellectual Property Rights and Indemnification;
Section 11, Legal Status of NEFCO;
Section 12, Confidentiality;
Section 13, Data Protection;
Section 14, Auditing, Anticorruption and Ethical Conduct;
Section 15, Reference Right; and
Section 16, Governing Law and Dispute Resolution.

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The Nordic Green Bank

Green Recovery Programme for Ukraine

Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi

PROJECT IMPLEMENTATION UNIT SUPPORT

Terms of Reference for consultancy services

February 2025

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List of abbreviations:

Cities, Municipalities	Horishni Plavni, Lubny, Lutsk, Khmelnytskyi
DSIF	Danida Sustainable Infrastructure Finance, the donor
NORAD	Norwegian Agency for development cooperation, the donor
Nefco	Nordic Environment Finance Corporation
Vodokanals	100% City-owned Municipal Water Utility Enterprises, including - Production Department of Water Supply and Sewage of Horishni Plavni City Council (MUC VUVKG); - Khmelnytskvodokanal (MUC KhVK); - Lutskvodokanal (MUE LtVK); - LubnyVodokanal (MUC LbVK);
Employer	City and/or Vodokanal
WWPS	Wastewater pumping station
WWTP	Wastewater treatment plant

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1. INTRODUCTION

Nordic Environment Finance Corporation (Nefco) is an international financial institution established by the five Nordic countries. It finances climate related and other environmental investments and projects primarily in Eastern Europe. In 2017 Nefco's geographical mandate was widened to a global one, with Eastern Europe still remaining as priority.

Nefco strives to promote energy efficiency and renewable energy projects and initiatives through different programmes and facilities supported by technical assistance and investment grants from different international donors. Besides climate and environment issues, Nefco is very supportive for social projects that make possible wider number of people to benefit from the municipal development projects. With some 200 municipal infrastructure and energy efficiency projects, Ukraine is the country where Nefco has funded the largest number of projects. Projects in public buildings, district heating, water and wastewater sectors result in significant energy efficiency, cost savings, positive environmental and climate impacts, as well as social benefits.

Today's political and institutional framework conditions in Ukraine are marked by the Russian's unprovoked and unjustified invasion of Ukraine started on the 24 February 2022 and escalating war to Ukraine with repercussions not only in Ukraine, but throughout the World. The war has affected significant material damage on municipal, transport and residential infrastructure that led not only to billions of financial losses of Ukraine but also caused a large migration within Ukraine as well as over the Ukrainian boarders to neighbouring countries.

The Green Recovery Programme for Ukraine was approved by Nefco's Board in June 2022. The aim of the programme is to provide financial and technical support to recovery projects in order to build a much-needed bridge between humanitarian crisis management and long-term sustainable development. The programme will support green economy and transition in the recovery process. The purpose is to enhance and finance projects focused on rebuilding infrastructure at the municipal level to ensure that Ukraine is built back greener and better.

It is expected that the 4 cities of Ukraine, Horishni Plavni, Lubny, Lutsk, Khmelnytskyi of Ukraine (the Cities) will receive a grant funding provided by DSIF and NORAD through Nefco for the Programme related to **rehabilitation of wastewater infrastructure in these cities.**

The Programme is split into two components related to respective sources of financing:

- **Component I:** Rehabilitation of wastewater infrastructure in Lubny, Lutsk, Khmelnytskyi to be financed by DSIF;
- **Component II:** Rehabilitation of wastewater infrastructure in Horishni Plavni to be financed by NORAD.

These Terms of Reference (ToR) define the objectives, tasks and qualification requirements for projects implementation support to both Components of the Programme.

For the Programme it is envisaged procurement of Project Implementation Unit Support Consultant (hereinafter **"the PIU Consultant"** or **"the Consultant"**). The Project Implementation Units (hereinafter **"the PIUs"**) will be formed by employees of the participating municipalities and respective water utilities.

The total grant amount to be provided by Nefco within the Programme is anticipated to be **up to EUR 8.8 million** and consists of two components:

- **Component I:** up to MEUR 6 financed by DSIF.
- **Component II:** up to MEUR 2.8 financed by NORAD.

For each of the Components a separate contracts will be signed with the Consultant according to the sources of financing.

2. BACKGROUND INFORMATION

The Consultant is requested to provide project implementation unit support services described in this ToR taking into account feasibility assessment developed for all four projects as attached in APPENDIX 1.

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3. THE ASSIGNMENT

3.1. Objectives of the Assignment

Nefco is now looking to engage a qualified Consultant to support the Project Implementation Units to be established by the Cities for the implementation of the Programme.

The support by the Consultant is essential to assist the Cities and Vodokanals in preparing and implementing projects in a way that ensures the greatest possible positive impact and sustainability.

The overall objective is to strengthen resilience and build capacity of the Cities and Vodokanals to respond to impacts generated by the war. The PIU Consultant shall provide technical assistance to Cities and Vodokanals during the project implementation phases, including but not limited to:

- management and capacity building support
- support in state registration of international assistance
- support in design and preparation of technical specifications
- procurement support
- support for administration of contracts and works supervision
- support in assuring compliance with Financial Documents and other agreements
- communications.

4. SCOPE OF WORK

Technical assistance will include but is not limited to the below main tasks, further detail of which is provided under each relevant heading:

4.1.Task 1: Management and capacity building support to the Cities

The Consultant shall provide project management support to the Cities and its respective Vodokanals in order to establish the PIUs, and to co-ordinate, administer, manage, monitor and evaluate all aspects of the projects, including project implementation, contract and financial administration.

The Consultant shall organise kick-off meeting with the PIUs as soon as possible after signing the consultancy agreements with Nefco. The kick-off meeting shall result in an initial plan of action, agreed with the PIUs including respective project implementation activities and respective timing, established lines of coordination with project stakeholders and as well as regular online meetings. The expectations of the Cities and Vodokanals should be heard and managed.

In addition, the following items should be covered:

(1) Information to the Municipalities and Vodokanals regarding basic documents and guidelines to be followed, such as the Framework Agreement between Nefco and Ukraine, Nefco's Procurement Policy and Procedures, Nefco's Practical Guide for Municipal Investment Projects, Anticorruption Policy and Integrity Due Diligence Policy etc; (2) roles of the PIU, the PIU Support Consultant and Nefco; (3) lines of communication; and (4) procedures for decision making.

Furthermore, the Consultant shall identify training needs for the PIUs staff, to effectively implement the projects. It is envisaged that training may be required in the following areas:

- Procurement procedures;
- Compliance procedures;
- Control and reporting, including financiers and other stakeholders;
- Administration of contracts (technical design, testing, supervision and inspection);
- Accounting and disbursement processing (to ensure their compliance with financier's requirements);
- Environmental and Social management.

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It is envisaged that training will include both formal training workshops and informal on the job training. The Consultant is expected to support the PIUs and ensure smooth project implementation according to Nefco's policies described above.

The PIUs should be of a size and structure appropriate to the complexity of the respective project. The PIU teams are expected to consist at least of the following experts:

- Head of PIU/project director;
- Water and wastewater expert (technical expertise);
- Procurement expert and financial expert;
- Communication expert.

The Consultant will develop job descriptions, including key qualifications required, for the PIUs staff. Municipalities will identify and appoint staff members with the requisite skills. Responsibilities and communications between the parties should be clearly defined.

The Consultant will assist the Municipalities and Vodokanals to establish the operating systems and procedures required to manage respective projects, including drafting of brief PIU Operations Manuals including, *inter alia*:

- A Project Procedures System, setting out the responsibilities and authorities of the parties involved in design and construction, together with all necessary procedures for communications, meetings, reporting, change control, quality control, etc. as are necessary for the efficient implementation and control of the Project.
- A Financial Management System, including: (i) project accounting and budget management systems; (ii) procedures for payments for services, goods and works; (iii) management of project accounts and preparation of the documentation as required by Nefco; (iv) systems for financial reporting to Nefco meeting reporting requirements specified in grant agreements.
- A Project Management System, by which all relevant parties are made aware and reminded regularly of the existence and timing of important milestones and events. This should include a Project Decision Matrix for all project stakeholders, showing dates for decisions and approvals over the forthcoming six months.

The Consultant, in consultation with the Municipalities and Vodokanals, shall develop respective well-structured Project Implementation Plans (PIPs) including Procurement Strategies and Procurement Plans with well identified scopes of work, investment measures and associated costs.

The PIPs of each Municipality shall cover all aspects of the project implementation including inter alia:

- Project Programme - a detailed programme of implementation of the whole project showing all activities and key events for design, approvals, permits and agreements, construction, commissioning, completion, payments, etc.
- Project Budget - a detailed cost budget as well as cash flow forecast for each.
- Procurement Plan - a detailed approach for each project.

The Procurement Plans shall be developed, approved by the Municipalities and Vodokanals and submitted for Nefco's no-objection. Following approval of the respective PIPs by the Municipalities and Nefco, the Consultant will closely monitor progress against the PIPs. Where the Consultant identify the need to change any aspect of the PIPs and/or Procurement Plans, a request for approval, accompanied by a clear outline of the need for such a change, will, with the support of the Consultant, be submitted by the Citiyes and Vodokanals to Nefco.

4.2. Task 2: Support in state registration of international assistance

Ukrainian legislation requires all technical assistance projects to be registered with the Cabinet of Ministers of Ukraine. This registration is also required for obtaining the right for VAT exemption for contractors to be awarded in result of procurement.

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The registration package includes the Procurement Plan for all procurements of goods, works and services planned in the projects as well as a number of other documents signed by Nefco, the Cities, the Vodokanals and respective Regional Administrations (as needed) as well as contractors and sub-contractors.

The Consultant shall assist the Cities in registration of the projects required for tax exemption, through preparation of respective documentation and ensuring continuous communication with the Cities and Vodokanals for the purpose of prompt preparation and signing of the necessary documents.

4.3. Task 3: Support in design and preparation of technical specifications

4.3.1. Assist with preparation and review of design documentation

Depending on the procurement strategies to be developed for each City, the Consultant shall assist the Cities with swift initiation and preparation of technical designs (including the review of design specifications, if not finalised prior to the engagement of the Consultant), and once prepared by local design institutes, review and verify the designs with regard to the contracts to be implemented under the Programme to ensure the design documentation is suitable for preparation of technical requirements and specifications for the plant & works. In case of turn-key procurement strategy, the Consultant shall review and verify designs developed by awarded contractor(s) during the projects implementation.

4.3.2. Implementation of capacity surveys for Lutsk WWPS and concept design for Khmelnytskyi WWTP

The Consultant shall implement:

- Survey of the operational modes of the 3 WWPS in Lutsk included to the Lutsk Project and instrumental measurement of the wastewater flow and pressure for these WWPS that will be used for confirmation/correction of the initial data used for hydraulic modelling included to APPENDIX 2. The result of this work shall clarify requirements for technical parameters and operating modes of new pumping equipment in automatic mode and used for preparation of the tender documentation, procurement and implementation within Assignment.

- It is planned of the construction new WWTP line in the existing Khmelnytskyi WWTP covering mechanical treatment, biological treatment, mechanical sludge dewatering facility, disinfection unit. The Consultant's scope of work for this task includes an additional component in accordance with clause 3.15 of DBN A.2.2-3:2014 (with amendments) - pre-design work (concept design), which is performed before the start of the design process to determine the fundamental volumetric and spatial solutions for the construction of a new WWTP line. The work includes the development of proposals for the placement of construction facilities on an existing land plot (substantiation of the location, required area and construction conditions), as well as the development of technological and engineering parameters of the WWTP, including its capacity. The result of this work shall confirm technical data for the construction of the 1st stage as new mechanical treatment facility such as capacity of the new line, location on the available land plot etc and provide clear WWTP concept allowing planning and construction of other parts of WWTP, which are not included in current project, at later stages. The copyright (intellectual) rights to this pre-design work (concept design) must be transferred to the Employer after its approval.

  NOTE: The Consultant is eligible to sub-contract necessary design services, measuring equipment etc and other necessary equipment and services in connection with the tasks to be performed as described in this paragraph. In case of sub-contracting, the Consultant shall estimate and envisage respective budget for such services and include them into its price proposal.

4.3.3. Development of Employer's requirements

The Consultant shall be responsible for preparing the required technical requirements and specifications for the plant & works in the detail sufficient for inclusion in tender documents. All technical specifications

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shall meet the requirements of Ukrainian Law and international standards. The Consultant shall also be responsible for preparing draft contracts.

4.4. Task 4: Procurement support

4.4.1. Monitoring of procurement

The Consultant will oversee all procurement activities and ensure that procurement is carried out in accordance with Nefco's Procurement Policy and Procedures.

4.4.2. Advice on procurement strategy

The Consultant will provide advice to the Cities and Vodokanals with respect to all aspects of the procurement strategy.

4.4.3. Support in preparation of Procurement Documentation

The Consultant will prepare the procurement documentation for approval by the City and Vodokanal and for obtaining required "No-objections" from Nefco. To this end, the Consultant will, inter alia:

- Draft tender documents based on Nefco's Recommended Tender Documents (available from Nefco) and, where appropriate, other internationally accepted standard tender documents;
- Develop appropriate tender evaluation and qualification criteria;
- Advise on the possibilities for alternatives, cost savings and value engineering opportunities etc. and the treatment of these in the Tender documents;
- Ensure that all applicable environmental procedures required by Nefco are addressed by the tender documents.

4.4.4. Support during the procurement process

The Consultant will support the City and Vodokanal throughout the procurement process. To this end, the Consultant will, inter alia:

- Ensure that all approvals and No-objections are applied for in a timely manner;
- Carry out the administration of the tender process, ensure that appropriate records are kept, documentation is properly stored, recorded and managed, and confidentiality is maintained;
- Prepare draft responses to Tender inquiries, arrange for approval and issue and record the same;
- Assist in arranging any site meetings, information meetings or other pre-tender events, and record the same; and
- Assist in arranging procurement in electronic format, public tender opening and prepare minutes.

The Consultant shall take into consideration that projects needs may require procurement of several lots, each requiring preparation of separate package of tender documentation, tender procedure, evaluation report and all related assistance to the municipality in connection with this. It should be also noted that in case of unsuccessful tenders, re-tenders may take place.

4.4.5. Support during the evaluation process

The Municipalities and Vodokanals are responsible for procurement and acting as the Employer in procurement. The Consultant will take the lead in organising and managing the evaluation process. To this end, the Consultant will, inter alia:

- Give guidance on the composition of the Evaluation Committee and to the Committee as required. Assist the Committee with initial examination and detailed evaluation of submitted tender proposals;

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- Provide draft detailed technical evaluation report for consideration by the Committee. Compile the evaluation report in a standard format, including all technical and financial analyses and clarifications requested and received;
- Arrange for meetings of the Evaluation Committee, attend as an advisor and keep record of these meetings, presenting the minutes for approval by the Evaluation Committee;
- Document the Evaluation Committee's deliberations in relation to the evaluation report and compile the agreements reached into the report prior to seeking all approvals;
- Ensure that all queries and complaints are promptly attended to as appropriate and copy such inquiries as appropriate to donors.

4.4.6. Integrity checks of the successful tenderers

Integrity assessment of the winning tenderers according to the Nefco's Policy on Integrity Due Diligence (IDD) shall be carried out to mitigate the risk of fraud and the reputational risk of the City and donors. The integrity checks shall basically confirm the identity, management and financial position of the contractor, confirm that the company is not ineligible or under sanctions, as defined by Nefco's Procurement Policy and Procedures. This examination should include, but should not be limited to, the following activities:

- Verifying that the tender is not in a conflict-of-interest situation;
- Verifying whether the evaluated tenderer had any integrity and/or corruption issues.

Furthermore, the Consultant shall upon request continuously monitor integrity issues in case of pending criminal cases, litigations etc.

4.4.7. Support during contract finalisation

The Consultant will provide support to the Cities and Vodokanals during contracts finalization. To this end, the Consultant will, inter alia:

- Prepare a brief for municipalities and Vodokanals indicating all the items to be resolved as pre-contract clarifications, if any.
- Prepare a draft contract incorporating all understandings between the parties and ensure compliance with the requirements of the tender documents.
- Attend pre-contract discussions, if any, and document the discussions, updating the contract documents as necessary and seeking all necessary approvals.
- Advise on the validity of performance and other contract-related securities.
- Oversee that unsuccessful tenderers are informed; ensure that all queries and complaints are promptly attended to as appropriate and report correspondingly to Nefco.

4.5. Task 5: Support for administration of contracts and works supervision

The Consultant will support the Employer's Project Manager(s) (PM) or equivalent to implement PM's duties as specified and/or implied by respective contract, in compliance with Ukrainian laws, technical standards, construction norms and rules. In order to do so, the Consultant will inter alia:

- Review the working drawings prepared by the Contractor, for approval by the Project Manager or equivalent;
- Support the Project Manager in administering the works and approving all materials, construction techniques and workmanship in accordance with the contract(s);
- Provide expert advice on all aspects of the works undertaken, especially regarding project management, measurement, contracts monitoring and quality control;

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- Ensure the proper programming, recording, measurement and accounting of the works by means of contemporary management and measurement techniques;
- Carry out monitoring of the project progress and promptly report to PM the details of any aspect that may jeopardize the progress of the works, as well as any implications such aspects may have on the original time of completion or cost of the works, and the measures being (or to be) adopted to mitigate these risks;
- Provide regular information on the status of the contracts implementation to the head of the PIU and to Nefco;
- Participate in regular progress meetings with the PIU and contractors on the progress of contracts implementation and issues to be addressed. The Consultant will also recommend to the municipalities the measures to be undertaken to address the implementation issues identified; and
- Coordinate with technical supervisors engaged by the municipalities on proper supervision and reflection of problems and defects during the project implementation according to the Ukrainian law.

The Consultant shall assist the Employer with seeking prior required "no objection(s)" before:

- Issuing any Variation Order/Change Order/Amendment to Contract with financial or time implications, except in an emergency situation when the approval of the Project Manager shall be issued as soon as practicable;
- Sanctioning additional items, sums or costs;
- Approving the sub-contracting of any part of the works; and
- Approving any extension for the time(s) for completion.

The Consultant will coordinate the work of all other parties involved in the projects. To this end, the Consultant will assist the municipalities to:

- Ensure that other parties involved in the implementation of the projects are provided with necessary documentation and any other assistance;
- Prepare an integrated time schedule for progress meetings with the various parties;
- Attend meetings together with the municipalities to support the Contractor's overall programme as a whole, seek response to reports, and discuss project issues on a regular basis with key stakeholders;
- Prepare and circulate minutes of the meetings, including follow-up actions required to ensure progress.

The Consultant shall also identify and advise the Cities and Vodokanals to initiate the procedures for all necessary local or sector licenses, permits or other approvals, including but not limited to licenses related to site access, building permits for permanent and temporary works as appropriate.

4.6. Task 6: Support in assuring compliance with Financial Documents and other agreements

4.6.1. Arrangement of timely disbursement under the contracts

To ensure timely disbursements under the contracts, the Consultant shall, inter alia:

- Prepare cash flow forecast for contracts and respective sub-projects as a whole;
- Assist with financial planning;
- Verify the invoices and payment documents for all contracts; and

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- Assist with preparing of disbursement requests according to the requirements of the financing agreements.

4.6.2. Conditions Precedent

The Consultant will advise the Cities and Vodokanals on actions required to discharge the Conditions Precedent/effectiveness to the availability of funds according to Grant Agreement between Nefco and the respective Cities/Vodokanals. The Consultant shall advice and support the Cities and Vodokanals to apply qualified electronic signature for signing documents as required in the Conditions Precedent in order to streamline disbursements.

4.6.3. Reporting in accordance with the Finance Documents

The Consultant shall provide on-the-job training to the Cities and Vodokanals to meet all requirements stipulated in the Finance Agreements. This includes regular reporting on any time-dependent covenants, implementation of any time or progress-dependent elements such as insurance policies, general progress reporting (programme, progress and financial status).

4.6.4. Environmental and Social Matters

The Consultant will ensure that all applicable environmental procedures required by Nefco are being adhered to and that the Cities and Vodokanals are duly informed about the procedures. The Consultant will develop Environmental Social Action Plan as well as the Results framework document (according to the template in APPENDIX 3) and support its update during project implementation.

4.6.5. Health and Safety Matters (H&S)

The Consultant shall develop general H&S guidelines to be applied in all projects and take care that the Contractors develop and execute the project and site-specific H&S plans.

The Consultant shall work closely with the contractors and their responsible H&S specialists to ensure that safety on site is adhered to. Regular H&S oriented site visits and/or monitoring visits should be carried out in addition to the works supervision visits.

The Consultant shall train / conduct a capacity building session to respective PIUs members in terms of key H&S requirements.

The Consultant will take supervise that all workers and people on-site are instructed and trained accordingly on H&S management.

All relevant H&S aspects should be adhered to already at the stage of development of the procurement documentation and reflected in contractual documents.

4.7. Task 7: Communications

The Consultant will be responsible for communications activities related to the Programme such as awareness raising, content creation, capacity building and dissemination of results of the project(s), and work in close cooperation with Nefco and/or Nefco's authorized partner taking into consideration respective security safeguards:

4.7.1. Awareness raising

- Ensure donors' and Nefcos' visibility in all communications activities related to the Programme.
- Ensure key messages are coherently used in all communications.
- Convey easily understandable messages about the benefits of implementing green and sustainable technologies and solutions, which would help target audiences see the benefits of not only rebuilding but rebuilding in a sustainable way.

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4.7.2. Content creation

- Provide content, photography and video materials from the project sites, which can also be used by Nefco and the donors in various communication activities.
- Create social media postings about Programme progress and milestones achieved, including relevant hashtags, and share these with Nefco and the donors.

4.7.3. Capacity building

- Support the PIUs and the Beneficiaries' communication:

(i) Provide support and review messages, social media postings, press releases and other articles by the city;
(ii) participate in communications trainings for the PIU carried out by Nefco or Nefco's authorised partner; and
(iii) make sure press releases get adequate approval from Nefco or Nefco's authorised partner.

4.7.4. Dissemination of results

- Regular status report meetings (mainly online) as regards communications activities with Nefco and/or Nefco's authorised partner.
- After project completion, create relevant reports, see 5.5. Reporting requirements

4.7.5. Other

- Assist Nefco or Nefco's authorised partner with media relations on local level by:

(i) providing contacts, when needed, for journalist briefings, pitches and news articles distribution;
(ii) informing about inquiries from media outlets/journalists, NGOs and/or general public; and
(iii) alert on possible critical topics and (negative) media coverage that may require prompt actions.

5. IMPLEMENTATION ARRANGEMENTS AND REPORTING REQUIREMENTS

5.1. Logistics, timing and arrangements

The intended start date is March 2025 and the period of implementation of the contract will be 36 months from this date. In average, each of the projects implementation is expected to be completed within 36 months from the commencement date.

The Consultant is responsible for the office space for his experts. The possibility to work in the Cities premises shall be agreed by the Consultant with the City and/or Vodokanal. It is expected that the experts may work remotely when feasible as long as they could deliver their services in the expected quality. The Consultant must ensure that its experts have all the necessary computer hardware and the software required to deliver the services, as well as the necessary office equipment. The Consultant is responsible for the residential accommodation for their specialists, whenever necessary, as well as for local and international transportation, office consumables, communications, internet and other required costs. The Consultant will be responsible for all salaries, fees, allowances, insurance, leave pay and taxes for the staff involved in the Assignment.

5.2. Cooperation with the City

Each participating City will designate:

- A senior official (deputy mayor or similar) to be the primary contact person with specific responsibility for overall cooperation with the Consultant;
- A coordinator(s) (head of respective cities' department/Vodokanal or similar) to be responsible for daily management and coordinating PIU activities relating to the projects;
- A PIU to be responsible for projects implementation.

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Each participating City will share all relevant project's information, such as records, plans, background reports, technical designs, archives and other documents, but it will be the responsibility of the Consultant to translate these documents, as necessary. Access to construction sites, objects and operational facilities are to be provided to the Consultant's experts as well.

All documentation related to the works will remain the property of the relevant participated City after completion of the Assignment. The Consultant shall not publish, use or dispose of this documentation without the written consent of the City.

5.3. Management of the Programme

The Team Leader appointed by the Consultant will be responsible for running the assignment and delivering the outputs on time and at a good quality level.

The Programme is managed by Nefco. The Consultant will provide Nefco with all relevant CVs of experts, reports, minutes of meetings, draft documents that are to be published/disseminated, proposals for the use of the budget for incidental expenditure, etc. relating to each activity to be implemented under the Programme. Before the activities can be carried out, some of these materials will need prior review and Nefco's no-objection, as defined in Nefco's Procurement Policy and Procedures.

Throughout the duration of the projects, particular attention will be paid to keeping a low carbon footprint, in particular, it is encouraged to hold project and coordination meetings via video conferencing or conference call.

Women's participation in the projects will be encouraged and documented, be it as hired experts or participants in the project's activities. The use of disaggregated gender data is encouraged. Furthermore, the projects will be expected to apply a gender analysis in the preparation of the work plans and specific activities. This analytical work should be clearly reported in the relevant project documents. The Consultant will explain in its Organisation and Methodology to what extent gender is relevant to climate action in Ukraine, and what activities can be proposed to bring a positive contribution to addressing gender issues.

5.4. Action Plan

An Action Plan for each Project in each participating City shall be prepared, once a Grant Agreement is signed between Nefco and each participating City and contain the following steps:

1. Preparation of tender dossiers by each participating City with assistance of the PIU Consultant according to agreed procurement rules.
2. Issuing of Nefco's no-objection to the tender dossiers.
3. Publication of tenders in webpages of each relevant City, Vodokanal, Nefco, Prozorro and other relevant portals.
4. Pre-tender meetings, clarifications to requests of the tenderers with assistance of the PIU Consultant.
5. Tender Evaluation by the tender evaluation committee of each City and Vodokanal with assistance of the Consultant.
6. Issuing of Nefco's no-objection to the Tender Evaluation Report prepared for each City/Vodokanal.
7. Preparation of contracts by the Municipalities with assistance of the Consultant.
8. Issuing of Nefco's no-objection to the draft contracts.
9. Contracts signing.
10. Issuing of Nefco's no-objection for any additional agreements to the contracts.
11. Tenders can be annulled and financing stopped in case of breach of procedures.

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5.5. Reporting requirements

Name of report	Content	Time of submission
Inception report	Analysis of existing situationand project implementation plan (including training and communication plan)	No later than 3 weeks after mobilisation of the Consultant.
Regular brief reports according to the agreed format	Short and concise updates to inform about the progress in project implementation	Every two weeks
Special report, Lutsk Project survey report	Survey report for Lutsk project covering wastewater pump stations included to the Project with the work scope as specified in 4.3.2	Two weeks after completion of the survey works
Special report, Khmelnytskyi WWTP concept design	Design Concept report for Khmelnytskyi WWTP included to the Project with the work scope as specified in 4.3.2	Two weeks after completion of the concept design works
ESAP	Environmental and Social Action Plan according to the project specifics	1 month after Consultants' mobilisation
Results framework document	List of key project indicators to be identified and achieved during project implementation	1 month after Consultants' mobilisation
Biannual Programme progress reports	Short description of progress (technical and financial) including problems encountered; planned work for the next 6 months. Any difficulties encountered or expected in the implementation of the project will be stipulated. Maximum 15 pages (excluding the annexes).	Not later than 1 month after the end of each 6-months implementation period.
Draft final report	Description of achievements including problems encountered and recommendations. Maximum 50 pages (excluding annexes).	Not later than 1 month before the end of the implementation period.
Final report	Description of achievements including problems encountered, mitigating measures and recommendations.	Within 2 weeks after receipt ofcomments on the draft final report from Nefco.
Communication Plan	Plan for each project considering security situation and requirements of Nefco describing the main target groups, communications responsibilities, goals and main communications activities and materials to be developed.	As part of PIP in the inception report, 2 weeks after the start of the assignment.
Projects reports		
Tender Evaluation Reports	Description of receipt and opening of tenders; Preliminary examination of tenders; Evaluation and comparison of tenders and Award recommendation.	On completion of Tender evaluation stage
Project Progress Reports	Description of projects progress, including the percentage completion achieved; Update on project costs, identified risks of cost overruns, if any; Recommendations on implementation risks' mitigation; Conclusion on City's readiness for tranche disbursement	On each disbursement within 2 weeks of receiving the disbursement documentation
Site-visits reports	Work progress, construction deviations, if any, photos.	Within 2 days of visit

Interim Reports shall include an "executive summary", highlighting the key developments, conclusions and recommendations. Wherever possible the Consultant shall make use of graphs, diagrams or tables, as an illustration of the text.

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The reports shall be submitted in the following way:

- Inception and Interim Reports shall be submitted to Nefco electronically in English language;
- Draft Final and Final Reports shall be submitted to Nefco electronically in English and Ukrainian languages.

The Consultant is also obliged to prepare and submit the ad-hoc reports and/or short project status reports on various aspects of the assignment, if/when and as requested by donors.

6. CONSULTANT'S PROFILE

The Consultant will be responsible for the overall projects support and monitoring including compliance with international practices.

The Consultant shall mobilise highly qualified staff, who has experience in consultancy role in providing PIU support, for implementation of the Programme, with relevant expertise and hands-on experience of Nefco's procedures and the ability to assist in drafting highly-qualified project descriptions, financing plans and other crucial decision-making documents and plans in accordance with Nefco's requirements. In addition, the Consultant shall have practical experience in project implementation with the ability to drive projects forward under time pressure.

The Consultant is expected to involve a group of international and/or local experts and support staff to make sure that all required expertise and resources are available. Such experts may include, e g electric engineer, structural engineer, installation and construction supervisors, expert(s) of environmental and social issues, expert(s) of legal/regulatory issues and requirements, as well as the local support staff to ensure proper implementation of its responsibilities under the assignment.

The consultancy company presenting a proposal should, either in its own capacity or through a partnership with another consultancies, be able to present significant experience both related to international procurement procedures, work with IFIs and grant organizations, as well as be able to prove an extensive knowledge regarding implementation of projects within the municipal infrastructure sector in the Former Soviet-Union countries and in Ukraine in particular and work with administrative bodies on all levels (local, regional, Ministries) and local utility companies.

It is envisaged that the Consultant is an international consulting company with strong local representation in Ukraine, with the capacity to engage local experts in the project municipalities.

6.1. Required experts

The Consultant's team is expected to consist of lead and senior experts who will perform the bulk of the work, assisted by short-term non-key experts in specific areas as necessary.

Information related to work of experts is indicated in the table below:

No	PIU experts	Minimum number of experts
		12
1	Team Leader	1
2	Deputy Team leader, Project coordinator	1
3	Water and wastewater experts (international/local)	2
4	Solar power plant expert	1
5	Technical supervision engineers	2
6	Lead Procurement expert	1
7	Senior Procurement expert	1
8	Financial and Disbursement expert	1
9	Environmental, Social expert, H&S expert (international/local)	1
10	Communication expert	1

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11	Non-key experts (as necessary)	

The Team Leader will develop close collaborative links with Nefco to ensure permanent coordination of Project management with the project beneficiaries and stakeholder's institutions at all levels. Experience in project management and knowledge of international procedures and rules are required for all experts.

Position, number of experts, time allocation	Qualifications and skills	Professional experience
Team Leader	▪ Master's degree in engineering, municipal infrastructure, economics or similar; ▪ Strong knowledge of project management, in particular for projects financed by international organisations; ▪ Proficiency with internationally accepted procurement rules and procedures. ▪ Excellent written and communication skills in English. Working knowledge of Ukrainian and/or Russian languages is advantageous; ▪ Strong planning and organisational skills, including team management.	▪ Minimum 10 years of professional experience in relevant fields; ▪ At least 7 years of experience in projects financed by international organisations (including project preparation and implementation); ▪ At least 5 years of experience in managing public infrastructure projects of similar size as a team leader;
Deputy Team leader, Project coordinator	▪ Master's degree in engineering, municipal infrastructure, economics or similar; ▪ Strong knowledge of project cycle management, in particular for projects financed by IFIs; ▪ Strong knowledge of contracting practices, rules and legislation in Ukraine; ▪ Good written and communication skills in English. Fluency in Ukrainian and/or Russian is essential.	▪ Minimum 7 years of professional experience in relevant fields; ▪ At least 5 years of experience with contract administration in infrastructure projects in Ukraine, including IFIs funded projects; ▪ Experience of financial, administration and organisational matters, reporting, communication with stakeholders; ▪ Experience of coordinating IFIs and/or NEFCO projects is advantageous.
Water and wastewater experts	▪ Master's degree in civil engineering (water supply and wastewater treatment), municipal infrastructure or similar ▪ Knowledge of Ukrainian and international standards and rules, best international practices applicable for water supply and wastewater systems ▪ Experience in drafting of design/technical specification and Employer's requirements; ▪ Knowledge of internationally accepted procurement rules and procedures ▪ Good written and communication skills in English are advantageous.	▪ Minimum 10 years of professional experience in relevant fields; ▪ At least 5 years of experience in implementation water and wastewater infrastructure projects of similar nature and scope; ▪ At least 5 years of experience of working in projects funded by IFIs; ▪ At least 5 years of experience in preparation, designing, process optimisation, evaluation of water/wastewater

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Position, number of experts, time allocation	Qualifications and skills	Professional experience
		systems as well as project monitoring in Ukraine;
Solar plant expert	▪ Master's degree in engineering (power production) ▪ Knowledge of Ukrainian and international standards and rules, best international practices applicable for implementation of solar power off-grid and grid connected solar power plants (SPP) ▪ Experience in drafting of design/technical specification and Employer's requirements ▪ Knowledge of internationally accepted procurement rules and procedures ▪ Good written and communication skills in English are advantageous.	▪ Minimum 7 years of professional experience in relevant fields; ▪ At least 5 years of experience in implementation of SPP projects of similar nature and scope; ▪ At least 3 years of experience in preparation, designing, process optimisation, evaluation of SPP as well as project monitoring in Ukraine;
Technical supervision engineers	▪ Master's degree in engineering, municipal infrastructure or similar; ▪ Technical Expert on work supervision has a qualification certificate according to the law of Ukraine that entitles him/her to perform the technical supervision for construction works with reference to respective certificate in experts' CV. Technical supervision certificate shall be attached to the CV. ▪ Strong knowledge and practical experience with work supervision in the construction sector ▪ Good knowledge of project cycle management, in particular for projects financed by Multilateral Development Banks and other international organisations; ▪ Knowledge of internationally accepted procurement rules and procedures; ▪ Good written and communication skills in English are advantageous.	▪ Minimum 7 years of professional experience in relevant fields; ▪ At least 5 years of experience in implementation of infrastructure projects of similar nature and scope; ▪ At least 3 years of experience of working in projects funded by international organisations; ▪ At least 5 years of experience in work supervision in the construction sector ▪ Experience in the field of sustainable energy would be an asset.

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Position, number of experts, time allocation	Qualifications and skills	Professional experience
Lead and Senior Experts on Procurement	▪ Master's Degree in engineering, economics, financing or similar, or minimum 5 years of experience in relevant fields; ▪ strong knowledge of project management, in particular for projects financed by international organisations; ▪ Good written and communication skills in English and Ukrainian. **For lead expert:** ▪ proficiency with internationally accepted procurement rules and procedures. ▪ excellent written and communication skills in English. **For senior expert:** ▪ good knowledge of internationally accepted procurement rules and procedures. ▪ good knowledge of procurement and contracting practices, rules and legislation in Ukraine	▪ Minimum 7 years of professional experience in relevant fields; ▪ At least 5 years of experience in procurement documentation and contract preparation and administration in projects financed by International Finance Institutions (IFIs) and other international organisations;
Financial and Disbursement expert	▪ Master's Degree in finance, economics or similar, or minimum 5 years of experience in relevant fields; ▪ Knowledge and understanding of financing rules and procedures of International Financial Institutions, as well as municipal financial reporting procedures applicable in Ukraine. ▪ Good written and communication skills in English and Ukrainian.	▪ At least 5 years of experience in financial management/ accounting/ economic analysis; ▪ At least 3 years of experience with financing rules and procedures of International Financial Institutions (loans and grants), as well as municipal financial budgeting and reporting procedures applicable in Ukraine and communication with authorities;
Environmental and Social expert	▪ Master's degree in in environmental science or management. ▪ knowledge of Ukrainian and EU environmental, social, health and safety laws, regulations and standards with relevance to buildings and water; ▪ Experience in monitoring of compliance with environmental and safety rules during construction/reconstruction of municipal facilities; ▪ Good written and communication skills in English and Ukrainian.	▪ Minimum 7 years of professional experience in fields relevant to environmental and social assessments, studies and monitoring; ▪ At least 5 years of experience in implementation of environmental and social assignments in infrastructure projects of similar nature and scope; ▪ At least 3 years of expertise of environmental monitoring during construction of municipal facilities;

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Position, number of experts, time allocation	Qualifications and skills	Professional experience
		▪ At least 3 years of experience of working in projects funded by IFIs.
Communication expert	▪ Degree in Communication or related field; ▪ Experience in content creation, social media, public relations; ▪ Good written and communication skills in English. Fluency in Ukrainian is essential.	▪ Minimum 5 years work experience in communication activities, public awareness, of which at least 3 years in Ukraine / Ukrainian organisations ▪ Experience of public sector administration in Ukraine. ▪ Experience of working with IFIs, MFIs and/or international organisations.

6.2. Non-key experts

The Consultant is expected to nominate other non-key experts necessary for the Assignment.

The Consultant should provide for reasonable distribution of budget between experts and be prepared for approximately 50% overall presence in the field during the duration of the Assignment during periods of tender evaluation contract award, design and construction phases.

7. KEY CONTACTS AT NEFCO

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All communication with donors shall be in English, and with the local stakeholders in Ukrainian, unless otherwise agreed.

8. APPENDIXES

APPENDIX 1 - Feasibility Studies for four projects

APPENDIX 2 - Provisionally hydraulic modelling operating new pumping equipment on 3 WWPS in Lutsk city

APPENDIX 3 - Results framework template

APPENDIX 1

SCOPING AND PROJECT PROPOSALS IN WATER AND WASTEWATER SECTOR FOR SELECTED COMMUNITIES IN UKRAINE

KHMELNYTSKYI, LUTSK, LUBNY, HORISHNI PLAVNI

DANIDA SUSTAINABLE INFRASTRUCTURE FINANCE

NEFCO

FINAL SCOPING REPORT

KOHILA JULY 2024

Revision 04

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List of Abbreviations

AC	Alternating current
BOD	Biological Oxygen Demand
BPS	Booster Pumping Station
COD	Chemical Oxygen Demand
DC	Direct current
DMA	District Metering Area
DSIF	Danida Sustainable Infrastructure Finance
HPM	Horishni Plavni Municipality
HPVK	Horishni Plavni Vodokanal, municipal water utility enterprise
IDP(s)	Internally displaced person(s)
KhM	Khmelnytskyi Municipality
KhVK	Khmelnytskyi Vodokanal, municipal water utility enterprise
LbM	Lubny Municipality
LbVK	Lubny Vodokanal, municipal water utility enterprise
LtM	Lutsk Municipality
LtVK	Lutsk Vodokanal, municipal water utility enterprise
m.a.s.l.	Metres above sea level
m.w.g.	Metres of water gauge
M€	Million euros
NEFCO	Nordic Environment Finance Corporation
NPV	Net Positive Value
NRW	Non-Revenue Water
Ntot	Total Nitrogen amount
pcs	pieces (plural of piece)
PE	Polyethylene
PIU	Project Implementation Unit
PS	Pumping Station
Ptot	Total phosphorus amount
Solar PV	Solar Photovoltaic
SPP	Solar Power Plant
SS	Suspended Solids
ToR	Terms of Reference
UAH	Ukrainian hryvnia, national currency of Ukraine
UAW	Ukrainian Association of Water Supply and Sewerage Enterprises "UKRVODOKANALEKOLOHIIA"
VAT	Value Added Tax
WPS	Water Pumping Station
WR	Water Reservoir
WS	Water Supply
WTM	Water Transmission Main
WTP	Water Treatment Plant
WW	Wastewater
WWPS	Wastewater Pumping Station
WWTP	Wastewater Treatment Plant
€	Currency sign used for the euro

1 Executive Summary

1.1 General Summary

Russia's large-scale invasion of Ukraine which started on 24 February 2022, has provoked a serious crisis with enormous human and economic consequences that continue to unfold. In response to the war's impact, NEFCO has established Nefco Green Recovery Programme for Ukraine to unite resources under one umbrella for addressing urgent war-related and long-term sustainability needs of Ukraine with the focus on green recovery. The longer the war continues and the greater the vulnerability of critical infrastructure, the more communities and conflict-affected people require sustained support and decent access to basic municipal services, in particular potable water and wastewater services. This means that Ukrainian local communities, which became a shelter to many IDPs forced to flee from their homes, are in a deep need in strengthening of their water infrastructure, increasing its resilience and energy independence through green solutions paving the way towards green recovery.

At the same time, NEFCO as Lead Finance Institution of the EU-financed action – Neighborhood Investment Platform (NIP) since the end 2019 is implementing water sector projects in 6 Ukrainian cities[1] under NEFCO NIP Water Modernisation Programme for Ukraine ("NIP Water Programme"). When the war began, Ukraine was deprived from access to credits. Nefco, alongside with other IFIs, stopped further disbursement of loan funds and/or cancelled loans to municipal projects. As a result, several projects under implementation decreased in scope in order to fit available investments after loans cancellations. While loan funds will be allocated to Ukraine in the future it is unlikely that it will happen in any significant volumes as long as the war is ongoing and martial law is introduced. It is therefore not likely that any municipal projects will be implemented in next years based on loan funds while fundamental needs of a liveable society, including the supply of basic municipal services, will only increase. Availability of grant funds for scoping and projects proposals preparation in 2024 is therefore important.

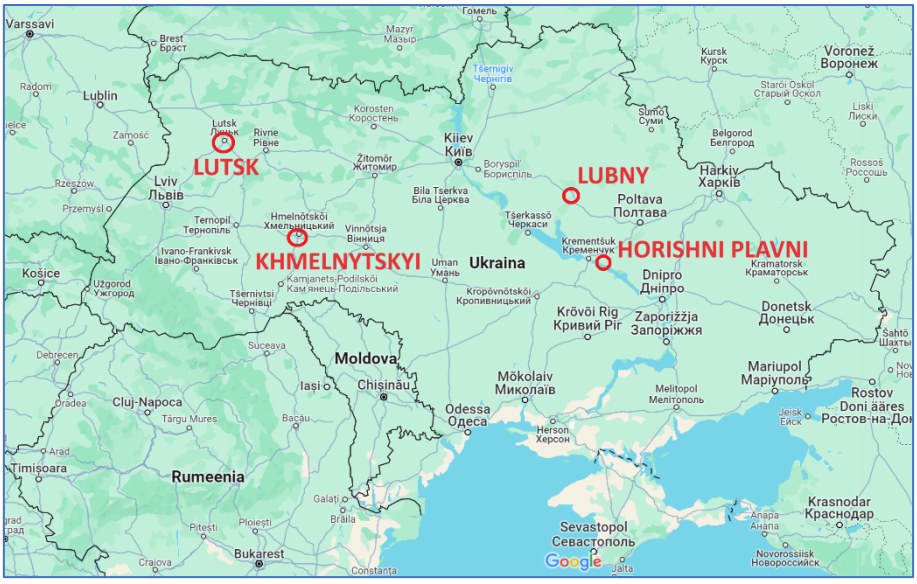


Figure 1: Executive Summary; Location of Municipalities

[1] Khmelnytskyi, Lutsk, Lubny, Horishni Plavni, Fastiv and Berdychiv.

By this assignment Consultant identified **1st priority projects** in four towns (Khmelnytskyi, Lutsk, Lubny and Horishni Plavni) with total cost estimate of **10.91 M€** (excl. VAT). Total co-financing from the communities is summarising to 20.05%. Additionally second priority projects were identified with total cost estimate of 27,363 M€ (excl. VAT).

Table 1: Executive Summary; Investment Programme Summary (excl. VAT)

Pos.	City	Unit	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate	M€ (%)	2.514 (23.04%)	2.711 (24.85%)	2.002 (18.35%)	3.683 (33.76%)	**10.910 (100%)**
3	Including co-financing	M€ (%)	0.415 (16.5%)	0.542 (20%)	0.330 (16.5%)	0.900 (24.44%)	**2.187 (20.05%)**

Scoping resulted in reconstruction of wastewater pumping stations in three cities and treatment plant in one municipality, but also in installation of solar power plants in all four cities. And in particularly as following:

- **Khmelnytskyi Khm-2 project** consisting of (i) 1st construction phase of new WWTP and (ii) installation of SPP at WWTP;
- **Lutsk Lt-1 project** consisting of reconstruction of (i) WWPS 1 and (ii) WWPS 2, (iii) reconstruction of Central Valve Chamber, (iv) installation of new Central SCADA system and (v) installation of SPP at Hnidavskiy 2-nd lift PS and (vi) at WWTP;
- **Lubny Lb-1 project** consisting of reconstruction of (i) WWPS 4 and (ii) WWPS 4A, (iii) installation of solar panels at WWPS 10 and (iv) at WWTP;
- **Horishni Plavni project** consisting of (i) construction of WWPS 1B at the same site and (ii) installation of solar panels at WWPS 1B.

The total proposed installed PV capacity for all four cities is **3 065 kW**, which should cover approximately 7% of total energy needs of the four water utilities (see table below).

Table 2: Executive Summary; SPP Power Production Summary

Pos.	City	Unit	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni	Total
1	Total power consumption in 2023	MWh/a	24 363	17 743	3 233	3 374	48 712
2	Total generated energy by SPP	MWh/a	981	1 487	734	291	3 493
3		%	4%	8%	23%	9%	7%

All PV projects are for water utilities own needs only, i. e. no sales (nor cash-flow) will be generated from the power production. All the land plots needed for solar installations have been identified and municipalities are ready to allocate them.

Total material (non-monetary) savings from the 1st priority projects are summarised in the table below.

Table 3: Executive Summary; Material Savings Summary

Pos.	City	Unit	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate (excl. VAT)	M€	2.514	2.711	2.002	3.683	10.910

Pos.	City	Unit	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni	Total
3	Energy savings from efficiency improvement	MWh/a	-174[2]	984	144	100	1 054
4	Total generated energy by SPP	MWh/a	981	1 487	734	291	3 493
5	Total CO_2 emissison savings	t/a	646	1 977	702	313	3 638
6	from efficiency improvement	t/a	-139	787	115	80	843
7	from SPP energy generation	t/a	785	1 190	587	233	2 794

Monetarised savings and payback periods are summarised in the table below. Total payback time of identified projects is summarised to 15 years. However, considering co-financing (20.05 %) the payback period is only 3 years.

Table 4: Executive Summary; Monetarised Savings Summary (excl. VAT)

Pos.	City	Unit	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate	M€	2.514	2.711	2.002	3.683	10.910
3	incl. cofinancing	M€	0.415	0.542	0.330	0.900	2.187
4	Total energy savings	MWh/a	807	2 471	878	391	4 547
5	Energy savings from efficiency improvement	MWh/a	-174	984	144	100	1 054
6	Total generated energy by SPP	MWh/a	981	1 487	734	291	3 493
7	**Total savings**	M€/year	**0.129**	**0.395**	**0.140**	**0.063**	**0.728**
8	Energy savings from efficiency improvement	M€/year	-0.028	0.157	0.023	0.016	0.169
9	Total generated energy by SPP	M€/year	0.157	0.238	0.117	0.047	0.559
10	Total payback time	year	19	7	14	59[3]	15
11	**Cofinancing payback time**	year	**3**	**1**	**2**	**14**	**3**

Besides, identified projects will lead to the following environmental and social effects:

- Reconstruction (renovation) of wastewater collection, pumping (in Lutsk, Lubny and Horishni Plavni) and treatment facilities (in Khmelnytskyi) leads to reduction of environment pollution and improvement of living conditions for the population;
- Reduction in CO_2 emissions significantly improve the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality;
- Increase in energy independence: The solar power plant contributes to energy independence, reducing reliance on imported energy resources;
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

[2] Introduction of mechanical pretreatment unit (absent by now) will increase WWTP's energy consumption.
[3] Some investments are critically needed in terms of asset substitution. As an example, if the current pumping stations are already quite modern, thus the effect on energy efficiency is not as immense as compared with decades-old pumping facilities from the Soviet era. The background situation with pumping stations in HP is somewhat better (smaller and less energy-consuming pumps) than in other towns compared, but that does not imply that these investments are inferior to others. Moreover, the pumping station itself (structure and other equipment) is in a very bad condition, actually falling apart. And this is the reason why reconstruction (actually construction of new PS at the same site) is of highest priority.

Other than indicated above effects are not generated within the project (or have very insignificant not worth mentioning effects).

1.2 Khmelnytskyi city. Identified measures

Project proposals for Khmelnytskyi include 3 projects:

- 1st priority project **Khm-2**:
  - 1st construction phase of new WWTP (mechanical treatment building with compact unit sand-grid separator);
  - Installation of solar panels (841 kW) at WWTP;
- 2nd priority project **Khm-1**:
  - Reconstruction of existing wastewater treatment plant by reconstruction of the aeration system in aeration tanks and replacement of air blowers;
  - Reconstruction of WS 2nd Lift PS consisting of (i) installation of water hammer protection equipment and (ii) replacement of pumps, 6kV Switchgear, installation of 6kV VFD, automation system and SCADA;
- 3rd priority project **Khm-3**: Completion of construction of 5 km of back-up (parallel) water transmission main (WTM) from main ground water intake (2-nd lift PS) to town (3-rd lift PS).

The planned program is related to the impact on the environment and the saving of energy resources. The projects examined in the proposals are related to the impact on the environment, the measures envisaged will reduce water pollution, increase the reliability of water supply and save electricity costs.

A priority project Khm-2 is planned for the modernization of existing wastewater treatment plant by construction of new mechanical treatment building with compact unit sand-grid separator. The implementation of this project would improve the quality of treated wastewater. Failure to implement the project would have a serious impact on the environment, especially for the residents of the areas below Southern Bug.

It has been estimated that adding the mechanical pretreatment unit (which does exist currently) will improve treated wastewater quality as follows[4]:

- Reduction of suspended solids (SS) by 10% or approximately by 1000 t/year
- Reduction of chemical oxygen demand (COD) by 2% or approximately by 350 t/year
- Reduction of biological oxygen demand (BOD) by 2% or approximately by 190 t/year.

WWTP modernization is important also from the environmental point of view as many cities (incl. Vinnitsa) below the stream (to which treated water is discharged) are taking in their own drinking water from the very same river.

Implementation of green technologies in Khmelnytskyi involves the installation of a solar power plant (SPP) at the location of WWTP to meet it's own energy needs. This project will enhance the energy efficiency of the municipal enterprise and reduce the overall negative impact on the environment, particularly carbon dioxide (CO_2) emissions and other greenhouse gases, by substituting a significant portion of the electricity consumption from the grid with self-generated energy.

Preliminary modelling of SPP at WWTP shows:

- installation of Solar PV in the amount of 1450 pcs (841 kW peak)
- estimated generation of SPP 981 MWh/year

[4] Other effects are not generated within the project (or have very insignificant not worth mentioning effects)

- CO_2 emissions saved 785 t CO_2/year.

Total preliminary budget of the 1st priority project **Khm-2** is estimated to 2 514 000 € (excl. VAT) with the break down given in the Table below.

Table 5: Khmelnytskyi; Total Cost Estimate of the 1st Priority Project Khm-2 (excl. VAT)

Pos. No.	Item	Cost Estimate, €
Khm-2.1	**Modernization of existing wastewater treatment plant**	**1 308 000**
Khm-2.1.1	Construction of new wastewater mechanical treatment unit	1 308 000
Khm-2.2	**Installation of solar panels at WWTP (841 kW)**	**626 000**
Khm-2.3	**Subtotal**	**1 934 000**
Khm-2.4	Design and cost estimate documentation 10%	193 000
Khm-2.5	Contingency 20%	387 000
Khm-2.6	**Total**	**2 514 000**

Cost of next priority projects are estimated as following (excl. VAT): Khm-1 to 5 478 000 € (excl. VAT) and Khm-3 to 13 000 000 € (excl. VAT).

1.3 Lutsk city. Identified measures

Project proposals for Lutsk include only one 1st priority project **Lt-1**: consisting of (i) reconstruction of two WWPS (nos: 1 and 2), (ii) reconstruction of central Valve Chamber on wastewater system, (iii) installation of new Central SCADA system, (iv) installation of SPP at Hnidavskyi 2-nd lift PS (664 kW) and (v) installation of SPP at WWTP (640 kW).

Potential annual savings in power consumption for reconstruction of two WWPS compared to the baseline (i. e. pumping of the same amount of water) are estimated to 984 327 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

The power savings at two WWPS will result in annual reduction of CO_{2eqv} in the amount of 788 000 kg/year.

Implementation of green technologies in Lutsk involves the installation of a solar power plant (SPP) at two locations: (i) at Hnidavskyi 2-nd lift PS and (ii) at WWTP to meet their energy needs. This project will enhance the energy efficiency of the municipal enterprise and reduce the overall negative impact on the environment, particularly carbon dioxide (CO_2) emissions and other greenhouse gases, by substituting a significant portion of the electricity consumption from the grid with self-generated energy.

Preliminary modelling of SPP at Hnidavskiy 2-nd lift PS shows:

- installation of Solar PV in the amount of 1145 pcs (664 kW peak)
- estimated generation of SPP 763 MWh/year
- CO_2 emissions saved 610 t CO_2/year.

Preliminary modelling of SPP at WWTP shows:

- installation of Solar PV in the amount of 1105 pcs (641 kW peak)
- estimated generation of SPP 724 MWh/year
- CO_2 emissions saved 580 t CO_2/year.

Cost Estimate of a SPP is 972 000 € (excl. VAT):

- at Hnidavskiy 2-nd lift PS constitutes to 486 000 € (excl. VAT)
- at WWTP constitutes to 486 000 € (excl. VAT).

Total preliminary budget of the 1st priority project **Lt-1** is estimated to 2 711 000 € (excl. VAT) with the break down given in the Table below.

Table 6: Lutsk; Total Cost Estimate of the 1st Priority Project Lt-1 (excl. VAT)

No	Item	Cost Estimate, EUR
Lt-1.1	Reconstruction of WWPS 2	518 000
Lt-1.2	Reconstruction of WWPS 1	213 000
Lt-1.3	Reconstruction of Central Valve Chamber	182 000
Lt-1.4	New Central SCADA system	200 000
Lt-1.5	Installation of alternative power sources	972 000
Lt-1.5.1	Installation of solar panels at Hnidavskiy 2-nd lift PS (664 kW)	486 000
Lt-1.5.2	Installation of solar panels at WWTP (640 kW)	486 000
Lt-1.6	**Subtotal**	**2 085 000**
Lt-1.7	Design and cost estimate documentation 10%	209 000
Lt-1.8	Contingency 20%	417 000
Lt-1.9	**Total**	**2 711 000**

Cost of second priority project Lt-2 is estimated to 1 569 000 € (excl. VAT).

1.4 Lubny city. Identified measures

Project proposal for Lubny includes 2 projects:

- 1st priority project **Lb-1**: reconstruction of 2 WWPS (WWPS and WWPS 4A),
- 2nd priority project **Lb-2**: reconstruction of 10 WWPS including also reconstruction of pressure sewers at some WWPS.

The planned program is related to environmental impact and saving energy resources. The projects evaluated in the proposals are related to the reconstruction of the city's wastewater system (pipelines and sewage pumping stations). After the implementation of the planned projects, the reliability of the wastewater system will be increased and the electricity costs of it will be reduced.

Planned 1st priority project **Lb-1** provides for the reconstruction of two main city wastewater pumping stations. Implementation of this project will reduce operational costs and improve reliability of wastewater pumping stations. If the project is not implemented, the existing risks of increasing frequency of accidents in the wastewater disposal system can materialized, because the condition of the wastewater pumping stations is unsatisfactory.

Potential annual savings in power consumption for reconstruction of two WWPS compared to the baseline (i. e. pumping of the same amount of water) are estimated to 143 776 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

The power savings at two WWPS will result in annual reduction of CO_{2eqv} in the amount of 115 000 kg/year.

Implementation of green technologies in Lubny involves the installation of a solar power plant (SPP) at two locations: (i) at WWPS 10 (next to WPS 3) and (ii) at WWTP to meet their own electricity demand. This project will enhance the energy efficiency of the municipal enterprise and reduce the overall negative impact on the environment, particularly carbon dioxide (CO_2) emissions and other greenhouse gases, by substituting a significant portion of the electricity consumption from the grid with self-generated energy.

Preliminary modelling of SPP at WWPS 10 (next to WPS 3) shows:

- placement of panels in the amount of 450 pcs (260 kW peak)

- placement of a battery rack (480 kWh)[5]
- estimated yield from the SPP 282 MWh/year
- CO_2 emissions saved 225 t CO_2/year.

Preliminary modelling of SPP at WWTP shows:

- placement of panels in the amount of 690 pcs (400 kW peak)
- estimated yield from the SPP 452 MWh/year
- CO_2 emissions saved 362 t CO_2/year.

Total preliminary budget of the 1st priority project **Lb-1** is estimated to 2 002 000 € (excl. VAT) with the break down given in the Table below.

Table 7: Lubny; Total Cost Estimate of the 1st Priority Project Lb-1 (excl. VAT)

No	Item	Cost Estimate, EUR
Lb-1.2	Reconstruction of WWPS 4 (KHC-4)	448 000
Lb-1.2.1	Construction of new WWPS at the same site	448 000
Lb-1.3	Reconstruction of WWPS 4A (KHC-4A)	420 000
Lb-1.3.1	Construction of new WWPS at the same site	420 000
Lb-1.5	Installation of alternative power sources	672 000
Lb-1.5.1	Installation of solar panels at WWPS 10 and WPS 3 (PV 260 kW, Battery 480 kW)	374 000
Lb-1.5.2	Installation of solar panels at WWTP (400 kW)	298 000
Lb-1.6	**Subtotal**	**1 540 000**
Lb-1.7	Design and cost estimate documentation 10%	154 000
Lb-1.8	Contingency 20%	308 000
Lb-1.9	**Total**	**2 002 000**

Preliminary budget of a next priority project **Lb-2** is estimated to 4 667 000 € (excl. VAT).

1.5 Horishni Plavni city. Identified measures

Project proposal for Horishni Plavni includes two projects:

- 1st priority **HP-1**: consisting of (i) new construction of the main WWPS 1B pumping all city wastewater to the wastewater treatment plant (including renovation of gravity wastewater collector) and (ii) installation of SPP at the same site (260 kW);
- 2nd priority **HP-2:** consisting of (i) reconstruction of WWPS 8 (including renovation of gravity wastewater collector) and (ii) reconstruction of WWPS 9 (including renovation of gravity wastewater collector).

Potential annual savings in power consumption compared to the baseline (i. e. pumping of the same amount of wastewater) are estimated to 100 262 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

The power savings at WWPS 1B will result in annual reduction of CO_{2eqv} in the amount of 80 210 kg/year.

Implementation of green technologies in Horishni Plavni involves the installation of a solar power plant (SPP) at the location of WWPS 1B to meet it's own electricity demand. Second location near existing WTP was initially also considered, but rejected because of land ownership dispute. This project will enhance the energy efficiency of the municipal enterprise and reduce the overall negative impact on the environment, particularly carbon dioxide (CO_2) emissions and other greenhouse gases, by

[5] Inclusion of a battery in a smaller capacity SPP is considered feasible as in other much higher capacity stations it would be too expensive

substituting a significant portion of the electricity consumption from the grid with self-generated energy.

Preliminary modelling of SPP at WWPS 1B shows:

- placement of panels in the amount of 450 pcs. (260 kW peak)
- estimated yield from the SPP 291 MWh/year
- CO_2 emissions saved 233 t CO_2/year.

Total preliminary budget of the 1st priority project **HP-1** is estimated to 3 683 000 € (excl. VAT) with the break down given in the Table below.

Table 8: Horishni Plavni; Total Cost Estimate of the 1st Priority Project HP-1 (excl. VAT)

No	Item	Cost Estimate, €
HP-1.1	Construction of WWPS 1B	2 639 000
HP-1.1.1	Construction of new WWPS at the same site	2 639 000
HP-1.2	Installation of alternative power sources	194 000
HP-1.2.1	Installation of solar panels at WWPS 1B (260 kW)	194 000
HP-1.3	**Subtotal**	**2 833 000**
HP-1.4	Design and cost estimate documentation 10%	283 000
HP-1.5	Contingency 20%	567 000
HP-1.6	**Total**	**3 683 000**

Preliminary budget of a next priority project **HP-2** is estimated to 3 138 000 € (excl. VAT).

1.6 Financial Analysis

For financial analysis proposed projects` budgets were evaluated against direct cost savings from reduced consumption of electricity. Cost saving from electricity is consisting of two factors:

- *firstly*, cost saving from more efficient pumps in wastewater pumping stations and
- *secondly*, substitution of purchase of electricity from networks after installation of solar panels, used exclusively for internal needs of water enterprises.

That means that we have considered production capacity of solar panels as potential cost saving for purchasing electricity.

O&M costs of operating relevant facilities have been considered. The main impact on the O&M costs has been therefore highlighted, as investments in sewage pumps have a direct influence on energy efficiency and thus energy costs. Some other O&M costs, notably personnel costs, are not influenced by given investments, therefore the impact on HRM is not relevant in economic terms. Main approach towards O&M costs is consistent with the *ceteris paribus* principle, where non-relevant key factors are considered to be stable in time.

Regarding investment, other savings cannot be monetarised in reasonable extent as they are not substantial in estimating cost effectiveness of investment. After estimating total impact on energy consumption of enterprise, payback time is calculated both for total investment and separately equity invested on minimum required level (16.5 %).

As a result, findings for duration of payback time varied significantly between municipalities. However, payback time for every proposed investment analysed were long enough for justification of grant involvement in financing schemes, as shown in the table below.

Table 9: Executive Summary; Financial Analysis Summary (excl. VAT)

	Khmelnytskyi	Lutsk	Lubny	Horishni Plavni
Budget of investment (MEUR)	**2.514**	**2.711**	**2.002**	**3.683**
Cost saving from more efficient WWPS pumps and other equipment (MEUR)	-0.028	0.157	0.023	0.016
Cost saving from production of installed SPP (EUR)	0.157	0.238	0.117	0.047
Total cost saving per year (MEUR)	0.129	0.395	0.140	0.063
Payback time for total investment (years)	19	7	14	59
Payback time for equity invested (years)	3	1	2	14

Remark: Price of electric energy is expected to be on level 0.16 € per kWh.

2 General Approach

2.1 Editorial Note

Consultant's team members were responsible for the following issues in compilation of this Report:

- Madis Maddison – general compilation of the Report, WS and WW technical issues for Lutsk and Horishni Plavni;
- Gediminas Kemzura – WS and WW technical issues for Khmelnytskyi and Lubny;
- Taras Vasylyk – review of PV projects in Ukrainian water sector, technical issues for Solar PV installations in all four cities;
- Volodymyr Nechuyviter – site visit reports and description of existing WS and WW systems
- Raul Altnurme – financial analysis for all four cities.

This Report is guided by the following structure:

- First the Executive Summary summarizes the Report by listing main conclusions. It is intended as an aid to decision-making by managers;
- Review of PV Projects in Water Sector in Ukraine and analysis of risks involved is given as a separate chapter;
- Below the detail technical and financial analysis for each city is given by following the time-line principal, *i. e.* each stage of forming the investment programme is described;
- Finally, Investment Programme is summarised at the last chapter.
- All supporting documents (MoMs, Site Visit Reports *etc*) are given in the annexes.

Though the Report includes all four cities, used wording (*e.g.* general issues repeated in chapters for each city) enables to divide it into four different Reports for each city.

Number formatting in this report is guided by the following principles:

- Space (" ") is used for a thousand delimiter;
- The decimal separator of a period (".") is used to mark the border between the integer and the fractional parts of a decimal numeral;
- The euro sign (€) is the currency sign used for the euro, which follows the value, e.g., 10 000 €, with an intervening space.

2.2 Project Background

Russia's large-scale invasion of Ukraine which started on 24 February 2022, has provoked a serious crisis with enormous human and economic consequences that continue to unfold. In response to the war's impact, Nefco has established Nefco Green Recovery Programme (the "Programme") for Ukraine to unite resources under one umbrella for addressing urgent war-related and long-term sustainability needs of Ukraine with the focus on green recovery.

In order to support the Ukraine in withstanding the war-generated threats and consequences, the Danish Ministry of Foreign Affairs (MFA-DK) allocated funds for Ukraine. The use and purpose of these funds are divided into two parts: (i) emergency and humanitarian type assistance via NGOs, and (ii) project type assistance via Danida Sustainable Infrastructure Finance (DSIF). The latter is the Danish Government's legal body for providing soft loans in developing countries, has included Ukraine on its list of countries eligible for receiving assistance for financing sustainable projects within energy, water and sanitation. Furthermore, NEFCO was assigned and entrusted by DSIF to manage the DSIF funds and facilitate projects preparation and implementation and channelling funds to Ukraine. It is also aimed at continuation of activities of NIP Water Programme. For that, 4 cities were preselected by NEFCO for scoping projects in water and wastewater sector, including energy efficiency measures and

green measures to be identified during scoping phase. The investments shall be dedicated to the strengthening of water infrastructure, increasing its resilience and energy independence.

This assignment is for scoping and project proposals preparation in water and wastewater sector in following Ukrainian municipalities: Khmelnytskyi City, Lutsk City, Horishni Plavni City and Lubny City.

2.3 Assignment Objective

The general purpose of this assignment is preparation and final definition of the project proposals for investment measures for each community. According to ToR the Project Proposals shall meet the following requirements:

- the project size shall be not less than 1.5 M€ and should it be feasible to introduce more green components in the project as justified by consultant – the project size can be increased up to 5 M€.
- The projects will require city's co-financing in amount of not less than 16.5% of total project investments. The consent to provide co-financing shall be obtained from the city.

NEFCO, as a Fund Manager, together with DSIF will make the final selection of the projects using the following selection criteria:

- priority to projects with higher % of green components in total investments;
- priority to projects with higher % of city co-financing in total project investments;
- priority to projects with higher social effect (number of population and IDPs benefitted from measures).

To meet the requirements set by the ToR the Consultant has employed the following approach (activity sequence):

- Overview of the measures completed by NIP I Water Programme. This chapter is giving only the general overview of the completed actions needed for background information for persons who have not been familiar with the project before. More detail time schedule and financial information is available at NEFCO's office
- Identification of the preliminary proposed investment programme by the communities
- Data collection
- Analysis of collected data and preliminary dimensioning of the measures
- Preparation of preliminary cost estimates and of preliminary financial analysis a
- Preparation of intermediate reviewed proposal for the investment projects
- Calculation of environmental benefits, energy efficiency effects and other savings
- Discussions with the communities to compile the final reviewed investment programme
- Development of the Scoping Report, which shall be approved by NEFCO
- Preparation of Project Proposal Forms.

All cost estimates and other investment costs in this document are calculated excluding VAT.

3 Review of PV Projects in Water Sector

3.1 Description of a Solar Power Station and Its Operation

3.1.1 How a Solar Power Station Works

A solar power station utilizes photovoltaic (PV) panels to convert sunlight into electricity. The main components of a solar power station include:

- Photovoltaic Panels (Solar Panels): made from semiconductor materials, typically silicon, panels convert solar light into electricity;
- Inverters: convert the direct current (DC) generated by panels into alternating current (AC) used in electrical grids;
- Batteries (optional): store excess generated electricity for use when sunlight is not available;
- Mounting System: supports and positions panels for optimal sun exposure;
- Electrical Components: cables, connectors, protective devices, and other elements ensure the system operates smoothly.

3.1.2 How Solar Panels Work

Solar panels consist of numerous photovoltaic cells that operate on the principle of the photovoltaic effect. When sunlight hits a cell, photons excite electrons within the semiconductor material, generating an electric current. This current is collected and sent to an inverter for conversion into AC power.

3.1.3 Technological Aspects

- Photovoltaic Cells: The core of each solar panel, these cells are made from monocrystalline or polycrystalline silicon. Monocrystalline cells offer higher efficiency but are more expensive to manufacture.
- Inverters: Come in various types including central inverters, string inverters, and microinverters. They vary in size, efficiency, and ability to handle voltage from individual panels or entire arrays.
- Mounting Systems: Allow panels to be optimally placed on rooftops or ground mounts, ensuring the correct tilt and orientation for maximum sunlight capture.

3.1.4 Losses and Their Impact on Performance

- Losses from Soiling: dirt, dust, leaves, and other debris can reduce the amount of sunlight reaching the panel, decreasing its efficiency. Regular panel cleaning can mitigate these losses.
- Losses from Irradiance: reduction in efficiency due to incomplete or uneven panel illumination, such as from clouds or shading by trees or buildings.
- Light-Induced Degradation Losses: some panels, especially those made from monocrystalline silicon, may lose part of their initial efficiency due to prolonged exposure to sunlight. This degradation typically occurs in the first few months of operation.
- Temperature Losses: panel efficiency decreases at high temperatures. Losses depend on the temperature coefficient specific to each panel.
- Losses in Electrical Components: include losses in inverters, cables, and other system elements. Using high-quality components and proper system design can minimize these losses.

Below the SPP annual energy generation estimates the abovementioned losses have been taken into account. Therefore, no further separate calculation of losses is needed.

3.2 Potential Use of Solar PV in Water Sector Projects

Solar PV installations connected to the electricity grid can generate electricity during periods of sunlight. This electricity can be used to power water-related operations such as pumping, treatment, and distribution. By offsetting grid electricity consumption with solar-generated electricity, water utilities can reduce their reliance on conventional energy sources and lower their electricity bills.

While the initial investment in Solar PV installations may require upfront capital expenditure, the long-term savings on electricity costs can outweigh the initial investment. Solar PV systems have minimal operating and maintenance costs compared to conventional energy sources, making them a cost-effective solution for water utilities over the system's lifespan. Additionally, as solar technology continues to advance and become more affordable, the economic viability of Solar PV installations in the water sector is expected to improve further.

Below a short overview of potential use of solar power in water sector is described.

- **Water Pumping**: Solar PV installations can power water pumps used for irrigation, drinking water supply in remote areas, livestock watering, and groundwater management. Solar-powered pumps can provide a sustainable and cost-effective solution, especially in regions with ample sunlight.
- **Water Treatment**: Solar PV installations can power water treatment plants, including processes such as filtration, disinfection, and chemical treatment. Solar-powered water treatment systems can be particularly useful in off-grid or rural areas lacking access to centralized electricity grids.
- **Reservoir Management**: Solar PV installations can be integrated into reservoir management systems to power sensors, monitoring equipment, and data transmission devices. Solar-powered monitoring systems enable real-time monitoring of water levels, water quality, and environmental conditions, supporting effective reservoir management and conservation efforts.
- **Hydropower Support**: In hydropower facilities, Solar PV installations can complement existing infrastructure by providing auxiliary power for lighting, monitoring, and control systems. Solar energy can also be used to pump water to higher elevations during periods of low electricity demand, improving the overall efficiency and reliability of hydropower generation.
- **Peak Demand Reduction**: Solar PV installations can help water utilities mitigate peak electricity demand charges, which are often based on the highest level of electricity consumption within a billing period. By generating electricity during peak sunlight hours, Solar PV systems can offset peak demand from the grid, leading to lower demand charges on utility bills. This can result in substantial cost savings for water utilities, especially during periods of high energy demand.

3.3 Solar PV Implemented in Ukrainian Water Sector Projects (examples)

The Consultant performed desk research to explore experience of Solar PV projects in water sector of Ukraine by contacting the following main information sources:

- Ukrainian Association of Water Supply and Sewerage Enterprises “UKRVODOKANALEKOLOHIIA” (**UAW**)

- The non-government organization **Ecoclub**.

According to **UAW** there are no PV projects yet implemented in Ukrainian water sector, with the exception of project no: 7 in the Table below. They provided a short list of water utilities that are planning to design or co-finance SPP /with total installed capacity of 2 613 kW), see Table below.

Table 10: PV Review; PV projects Implemented in Ukrainian Water Sector

Pos. No:	Company Name Object	Project Name	Power, kW	Status of Implementation
1.	Municipal Enterprise "Kryzhopilvodokanal"	Construction of alternative energy (solar energy) power supply for the water pumping station in the village of Holubeche	150	By the end of 2024
2.	Chernivtsi Water Utility	WTP "Bila"	278	End of 2024 (ESCO Contract)
3.		WTP "Vikno"	1000	2025 (Credit+Net Billing)
4.	Municipal Utility "Waterworks of Uzhgorod"	Reconstruction of the power supply for the surface water treatment complex with the construction of an alternative energy generation source (Solar Energy System) for internal consumption at the following address: Uzhhorod, Novodomanyntska Street, 27.	605	The project is at the stage of seeking financing, so the future implementation date is currently unknown.
5.	Vyshhorod Municipal Utility "Vodokanal"	Solar power station for Vyshhorod Municipal Utility "Vodokanal"	200	May 2025
6.	Municipal Enterprise "Kremenchukvodokanal"	Implementation of alternative energy sources through the installation (new construction) of a rooftop solar energy system at the following address: Poltava region, Kremenchuk city, Heroiv Mariupol Street, Z 5-A.	120	Being developed is the detailed design documentation (PCD). The implementation deadline is by the end of 2024.
7.	Municipal Enterprise "Zviaghelvodokanal"	Reconstruction of electrical networks at the treatment plants and installation of a solar power station on the sewage treatment facilities in the village of Chyzhivka, Zviaghelsky district, Zhytomyr region.	150	Second quarter of 2024 (as of April 2024, construction works completed).
8.		Energy service of the main production of Zviaghelvodokanal Municipal Enterprise	110	After the procurement and implementation of the energy service project

UAW also informed about the International Organization for Migration financing and implementation of borehole pumped solar power plants in the villages of Yurivka, Kalynivka, Kobzartsi, Pershotravneve, Tamaryne, and Vasylivka in Mykolaiv Oblast[6].

EcoClub is a public organization in Rivne working for 25 years to preserve the environment, which has launched the "Solar Aid for Ukraine" campaign[7] aimed at enhancing energy security, reducing costs, and promoting sustainable energy use amidst the ongoing war. The campaign focuses on installing solar power stations (SPP) on public buildings such as hospitals and water utilities, which are critically important for community resilience. This year, EcoClub plans to help communities install a minimum of 35 solar stations for hospitals and water utilities across Ukraine. Currently, there are 4 projects for

[6] More about the campaign can be found at: http://ukrvodokanal.in.ua. Contact details: 067-325-90-61 – Tatiana, 067-354-57-66 – Irina.
[7] More about the campaign can be found at: https://ecoclubrivne.org/solar_aid4ukraine

building SPP for water utilities in the following cities: Bilhorod-Dnistrovskyi (Odesa region), Myrhorod (Poltava region), Sumy (Sumy region), and Bohuslav (Kyiv region). Additionally, they provide support to the Brody community for the construction of an SPP for their water utility.

The non-government organization **Ecoclub** has on it's webpage information about one PV project at "Zviaghelvodokanal" (project no: 7 in the Table above) which had already generated 78 370 kWh of solar energy.

According to **Ecoclub** the PV projects have faced the following risks:

1. Inconsistency of project decisions with normative-technical documentation in the electric power industry. The most common cause is the lack of integrity by the chief designer. Impact: Inability to proceed with project implementation until identified violations are rectified. Minimization strategies: Selecting a chief designer with extensive experience in similar projects and positive feedback on their work.
2. Delayed equipment delivery (photovoltaic modules, inverters, etc.). The cause is the absence of equipment in Ukraine at the start of construction, border blockades, and high demand from commercial organizations. Impact: Delay in commissioning solar energy systems (SPP). Minimization strategies: Ordering equipment during the development of project cost estimates. Maximizing the use of locally sourced equipment and materials. Ordering turnkey construction with a time buffer.
3. Lack of equipment at the beginning of construction. The cause is changes in the solar energy market or updates to the manufacturer's product line. Impact: Need for adjustments to project cost estimates. Minimization strategies: Selecting modern equipment models and minimizing the time gap between developing project cost estimates and project implementation.
4. Construction delays due to a lack of workers in the subcontractor organization due to their mobilization. The cause is hostilities in Ukraine. Impact: Delay in commissioning. Minimization strategies: Prefer local or subcontractors able to guarantee an adequate number of workers throughout the construction period when choosing the installation organization.
5. Non-compliance of the constructed object with project documentation. The cause is unscrupulous installation organization or poor project quality, making execution impossible. Impact: Disruption in SPP operation or inability to operate. Minimization strategies: Warning about and thorough implementation of author and technical supervision at all construction stages in accordance with regulatory acts in the Ukrainian electric power industry.
6. Decreased electricity demand due to reduced city water consumption. The cause is the shutdown of industrial consumers or population decline. Impact: Reduced economic efficiency of SPP operation. Minimization strategies: Investigate general trends in city water consumption reduction and industrial water consumer activity before project development. Based on this, evaluate water needs. Consider energy storage options, such as filling clean water reservoirs, or redistributing excess electricity to external grids or neighbouring consumers.
7. Equipment failure. The cause is low equipment quality. Impact: Partial or complete shutdown of SES operation. Minimization strategies: Choose reputable equipment brands with local representation in Ukraine.

8. Equipment damage due to Russian shelling. The cause is war. Impact: Partial or complete shutdown of SPP operation. Minimization strategies: When making project decisions, whenever possible, involve sections located at a certain distance from each other. Design SPP with separate modules capable of working independently if necessary. This reduces the likelihood of complete SPP destruction and ensures the operation of intact equipment.

9. Lack of political will in the community for renewable energy development (lack of project advancement, delays in signing contracts, etc.). The causes are unawareness of the benefits of such projects and corruption. Impact: Delay in project implementation or its complete absence. Minimization strategies: Conduct initial project meetings. Maintain constant communication during project implementation. Provide training on SPP maintenance. Refuse to collaborate with communities lacking political will or engaged in corrupt practices.

10. Worn-out and outdated water supply equipment; pipes with numerous leaks and bursts. The causes are lack of modernization. Impact: Low efficiency of installed solar power stations due to water leaks and inefficient equipment. Minimization strategies: Modernize water supply equipment before installing solar power stations.

11. Failure to account for the need for wastewater disposal and operation of treatment facilities in the project. The causes are focusing solely on water supply. Impact: Often, inability to provide water supply. Minimization strategies: Study wastewater disposal and treatment conditions before designing the object.

12. Lack of reliable subcontractors. The causes are mobilization and increasing demand from businesses. Impact: Project delays, risks of involving dubious subcontractors. Minimization strategies: Form a pool of reliable subcontractors, include buffer time in the plan, and constantly search for potential subcontractors.

The ongoing war has severely weakened the local economy and depleted municipal budgets. Despite these challenges, SPP on public facilities have proven to be economically viable with a payback period of about five years without batteries, which is significantly shorter than community-funded models.

The information was provided by Olena Kondratiuk Project manager at NGO Ecoclub, email: kondratyuk@ecoclubrivne.org, Telephone.: +380 966975125.

3.4 Ukrainian legislation and regulations on Net-Biling

The following laws affect the SSP market in Ukraine:

The Law of Ukraine on the Electricity Market

According to Article 58/1 of the Law of Ukraine "On the Electricity Market", a consumer acquires the status of an active consumer simultaneously with: the conclusion of a contract for the sale and purchase of electricity under the self-production mechanism, which is an annex to the contract for the supply of electricity to the consumer.
Link: https://zakon.rada.gov.ua/go/2019-19

Activities of an active consumer in the retail electricity market
Link: https://www.nerc.gov.ua/sferi-diyalnosti/elektroenergiya/diyalnist-aktivnogo-spozhivacha-na-rozdribnomu-rinku-elektrichnoyi-energiyi-1/diyalnist-aktivnogo-spozhivacha-na-rozdribnomu-rinku-elektrichnoyi-energiyi

Resolution of the NERC
On Approval of the Procedure for the Sale and Metering of Electricity Generated by Active Consumers and Payments for It.
Link: https://zakon.rada.gov.ua/rada/show/v2651874-23#n9

A brief description of laws previously adopted to encourage the use of alternative energy sources:

- The Law of Ukraine "On the Electricity Market" regulates the basics of the electricity market, allowing consumers to produce and sell electricity to the grid.
- The Law of Ukraine "On Alternative Energy Sources" encourages the production of electricity from alternative sources and provides support mechanisms for consumers using renewable energy sources.
- The Law of Ukraine "On Energy Saving" aims to promote the use of energy-efficient technologies and renewable energy sources.
- The Rules for Connection to Electrical Networks regulate the technical conditions and procedures for connecting electricity producers to the grid, which is important for transferring excess electricity to the network.
- The Net-Billing Mechanism allows active consumers to transfer excess electricity to the grid and receive compensation, reducing electricity costs through the offset of produced and consumed energy. This mechanism is regulated by separate NERC resolutions and agreements with energy companies.

Compliance with these laws and regulations enables active consumers to successfully implement solar power plant projects and efficiently manage electricity using the Net-Billing system.

3.5 Net-Billing System for Solar Power Plants of Utilities Own Needs

Below a detailed overview of Ukrainian Net-Billing system for Water Utility Companies is given. The purpose of the overview is to assure that no cash flow can be developed when the Water Utility uses SPP combined with the Net Billing system.

The NET-BILLING system allows water utility companies to offset their own energy consumption by generating solar power. The figure below illustrates how such a system operates during different months of the year.

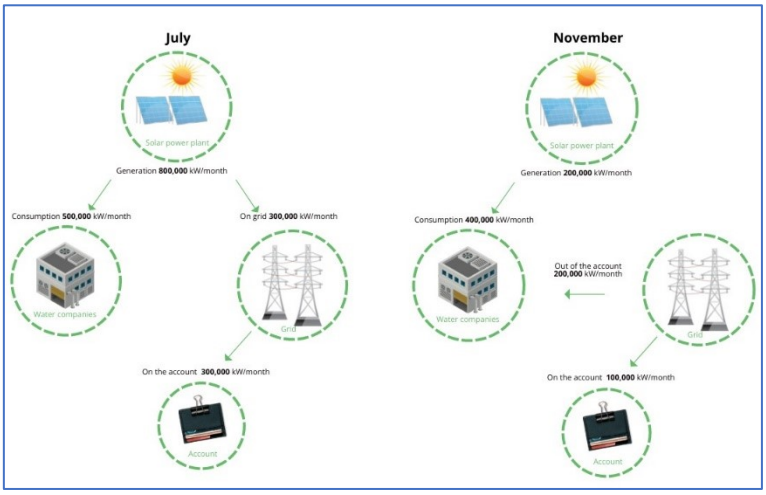


Figure 2: PV Review; How the NET-BILLING System Works

NET-BILLING system enables energy producers, such as solar power plants, to feed surplus electricity into the grid. When electricity production exceeds consumption, the excess is credited to a special account **in kilowatt-hours** (kWh). These kilowatt-hours can be used in the future when consumption surpasses production. In other words, national power grid is used as some kind of power accumulator.

Table 11: PV Review; Example of How Net Billing System Works

	July	November
Power Generation, kWh	800 000 kWh *(due to high solar activity in summer)*	200 000 kWh *(due to reduced solar activity in the autumn-winter)*
Power Consumption, kWh	500 000 kWh	500 000 kWh
Export of Surplus to the Grid, kWh	300 000 kWh *(fed into the general electricity grid)*	
Deficit Compensation from the Grid		300 000 kWh *(consumed from the general electricity grid)*
Balance on the Net Billing Account	300 000 kWh	0 kWh

There are some advantages and disadvantages for Water Utility Companies:

- Reduction in Electricity Costs: By generating their own electricity and accumulating surplus, water utility companies reduce the costs of purchasing electricity from external sources;
- Independence from Price Fluctuations: Self-generation of electricity helps reduce dependency on market price fluctuations;
- No Direct Profit: Water utility companies do not earn monetary profit (no cash flow is generated) from selling electricity to the power distribution grid or other potential consumers.
- Dependence on Weather Conditions: Solar power generation is highly dependent on solar activity, which can vary with seasons and weather conditions.

The NET-BILLING system allows water utility companies to effectively use solar energy to offset their own electricity consumption. This ensures significant cost savings without direct financial profit. The primary goal of using such a system is to achieve energy efficiency and resilience against price fluctuations in the electricity market.

The Consultant recommends to use Net Billing system for proposed SPPs. Therefore, calculation of payback period is based on full production of SPPs assuming that the Net Billing system is in use.

3.6 Solar PV Project Risk Analysis

3.6.1 Approach to Risk Analysis

Risks can appear related to any aspect of a project, including the budget, resources, processes, or technology. It can be easily assumed that all risks result in negative consequences. However, it is essential to understand that positive risks can also occur. Nevertheless, in this analysis we only handle negative risks.

Below a risk assessment matrix is used as a tool to identify and capture the likelihood of project risks and evaluate the potential impact (damage or interruption) caused by those risks. Depending on likelihood and impact, risks are categorized as high (6-9), moderate (2-4) or low (1). Likelihood is assessed into three categories: unlikely (1), likely (2) and highly likely (3). And impact is also categorised the same way: low impact (1), moderate impact (2) and high impact (3). A cumulative risk score is usually derived by multiplying the risk's likelihood score by the risk's Impact score. Consequently, risks are prioritised according to the risk score.

likelihood / impact	low impact (1)	moderate impact (2)	high impact (3)
unlikely (1)	low risk (1)	moderate risk (2)	moderate risk (3)
likely (2)	moderate risk (2)	moderate risk (4)	high risk (6)
highly likely (3)	moderate risk (3)	high risk (6)	high risk (9)

Figure 3: PV Review; Applied Risk Analysis Matrix

The likelihood is usually determined according to the following methodology:

- **Unlikely**: risks in this category have a relatively low chance of occurring.
- **Likely**: risks in this category are predicted to occur and require a mitigation strategy.
- **Highly Likely**: risks in this category are almost guaranteed to occur and require a mitigation strategy.

Based on already implemented projects and personal experience the Consultant has identified the following risk landscape (each risk with it's cumulative score):

- Regulatory risk (risk score = moderate)
- Electricity Market Risks through Net-Billing Arrangements and self-consumption (risk score = moderate)
- Grid Access Risks (risk score = moderate)
- Plant Design and Construction Risk (risk score = moderate)
- Plant Operation Risk (risk score = moderate)
- Natural Risks (risk score = moderate)

Below each risk is analysed and mitigation measures described in detail.

3.6.2 Regulatory Risk

Context: Since the introduction of Net billing, it has directly competed with the "green" tariff. Experts are pondering whether the implemented system will endure. And overall, whether "active consumers" will prefer Net billing.
One factor that may affect the attractiveness of Net billing for "active consumers" is the limitation on the volume of electricity allowed to be sold to the grid. The legislature has clearly defined these limitations. This aligns well with the core idea of the law, which prioritizes self-sufficiency in electricity over its sale. However, this may also affect the attractiveness of Net billing for investors. If the equipment payback period increases, the expansion of distributed generation may slow down.
"The volume of supply of produced electricity to the grid cannot exceed 50% of the consumer's connected capacity. That is, if you, for example, are connected with a capacity of 100 kW, you can only supply to the grid the electricity generated with a capacity of 50 kW."

Risk Score: moderate (4). Likelihood of occurrence – possible (2). Potential impact – moderate (2).

Mitigation: At the same time, there is a provision for reducing the "green" tariff for households, starting from 2024, by 10%. Thus, the government aims to incentivize "active consumers" to choose Net Billing system.
Solar energy systems (SPP) for self-consumption are the most efficient system as they allow consumers to reduce their electricity expenses since they can generate electricity independently, regardless of

electricity prices in the market. They also contribute to network stability: Distributed energy systems (including SPP) can reduce the load on centralized energy supply systems, helping to ensure network stability in case of emergencies or extraordinary situations.

3.6.3 Electricity Market Risks

Context: Various risks, including counterparty risks and price volatility, characterize the electricity market.

Risk Score: moderate (4). Likelihood of occurrence – possible (2). Potential impact – moderate (2).

Mitigation: Operating under a net-billing arrangement helps mitigate these risks by minimizing the need for direct involvement in the electricity market. The focus is on self-consumption and selling surplus electricity to a designated supplier, thereby confining activities within the realm of retail electricity transactions.

3.6.4 Grid Access Risks

Context: The physical access to the grid appears to be without significant issues. Existing connection points utilized by the Beneficiary's water facilities for electricity consumption will also accommodate surplus electricity output. However, potential risks arise concerning connections to internal terminals of the site, including concerns about the installed capacity of LV cables from PV plant inverters and balancing energy consumption with grid energy sales.

Risk Score: moderate (2). Likelihood of occurrence – possible (2). Potential impact - low risk (1).

Mitigation: Early negotiations with local grid companies and PV plant design firms can help to secure the use of existing grid connection points for surplus electricity output, thereby mitigating potential risks associated with internal terminal connections.

3.6.5 Plant Design and Construction Risk

Context: Risks associated with inadequate plant design and construction include underperformance and unplanned downtime. Furthermore, the absence of essential input data, such as hydrology and geology studies, could affect the capital expenditure of PV plants.

Risk Score: moderate (4). Likelihood of occurrence – likely (2). Potential impact – moderate (2).

Mitigation: To address these risks, it's crucial to conduct necessary studies before commencing design work. Fortunately, Ukraine boasts a robust solar PV power sector with a significant number of qualified engineering and construction firms capable of offering turnkey plant solutions for the project.

3.6.6 Natural Risks

Context: Ukraine, like many other countries, is susceptible to various natural hazards that can have a significant impact on the economy, infrastructure, and citizens' lives. Here are some of the most common natural hazards in Ukraine:

- Floods: Due to river floods, snowmelt, or heavy rainfall, flooding can occur, especially in spring and summer. Floods can lead to the inundation of settlements, destruction of buildings, loss of life, and other negative consequences.
- Droughts: Some regions of Ukraine, especially the southern and eastern parts, are at risk of droughts. This can result in reduced crop yields, threats to food security, fires, and other problems.

- Earthquakes: Although Ukraine is not considered earthquake-prone, there is a risk of earthquakes, especially in the Carpathian Mountains and the southern regions of the country. Earthquakes can cause building and infrastructure damage, as well as human casualties.
- Forest fires: Forest fires can become a serious problem in summer, especially in dry regions of the country. They can lead to the destruction of forest areas, threaten the lives and health of people, and cause significant environmental problems.
- Hailstorms: Hailstorms can cause significant damage to agriculture, vehicles, buildings, and other property. Large hailstones can result in significant crop and infrastructure losses.
- Tornadoes and hurricanes: Unusual but possible conditions can lead to the formation of tornadoes and hurricanes, which can have a serious impact on buildings and property, as well as pose a threat to human safety.

Risk Score: moderate (3). Likelihood of occurrence – unlikely (1). Potential impact – high impact (3).

People cannot directly influence natural hazards because they are unpredictable and result from natural processes, such as weather patterns, geological activity, and climatic conditions, which are beyond human control.

Mitigation: measures which can help reduce the impact of natural risks on the construction and operation of solar power plants.

- Strategic Planning: taking into account local climatic conditions, geological characteristics, and potential hazards during planning and construction.
- Use of Resilient Technologies: employing materials and technologies that provide resilience to weather and geological factors.
- Monitoring and Planning: systematic monitoring of weather conditions and geological processes to respond promptly to any potential threats.

4 Khmelnytskyi

4.1 Existing Water Supply and Wastewater Services

4.1.1 Khmelnytskyi General Information

Khmelnytskyi is a city located in western Ukraine, the administrative centre of Khmelnytskyi region, Khmelnytskyi district and Khmelnytskyi urban territorial community. Industrial, trade and cultural center of Podillia. Located on the South Bug River. From west to east, the Ploska River flows through the city of Khmelnytskyi, a tributary of the Southern Bug, which also flows through the city. Ploska is a small river in the western part of the city in the "Grechany" district and the decoration of the park named after Chekman, where it spreads in the form of channels. The Southern Bug is the second largest river in Ukraine, the waters of which flow exclusively through the territory of Ukraine and flow into the Black Sea. Its length is 79 km.

The city is situated at the intersection of motor roads Zhytomyr - Chernivtsi and is a part of the highway of international importance Stryi – Ternopil – Vinnytsya – Kirovograd – Znamianka.

Khmelnytskyi is known throughout Ukraine as a market city – one of the biggest markets of Europe is situated in the city – Khmelnytskyi merchandise market. One of the priority tasks of economic and social development of the city is to improve energy efficiency and stability of infrastructure performance.

The population of the city is 274452. Number of IDPs who were forced to leave their homes due to russian aggression has not been made available to the Consultant.

4.1.2 WS and WW Services

The first artesian well drilled and accepted for operation by the Act of the special commission dated January 15, 1909 can be considered the beginning of the water supply in the city. At the beginning of the 1930s, a municipal water supply system operated in the city - six wells, two pumping water stations - with a capacity of 1.2 thousand m³/day. In 1940 the water supply capacity was 2000 m³/day. In the 1940s and 1950s, the first constructions and sewage networks were built: in 1946 – 600 m³/day, in 1959 – 1200 m³/day. In the 60s of the 20th century, the capacity of the municipal water supply system increased by 4 000 m³/day due to the construction of wells and pumping stations of the 2nd rise in the Eastern and South-Western districts of the city. Until 1968 the water supplied to the population did not undergo high-quality additional treatment, it was only chlorinated. In 1968, a new Western water intake was put into operation on the municipal water supply system with water pump station No: 5 with a capacity of 5 000 m³/day, where the removal of iron from water was used for the first time. Later, the capacity of this water intake increased to 8 000 m³/day. At the same time, new sewage treatment facilities with a capacity of 12 000 m³/day and the main sewage station were built. Unfortunately, the development of the municipal water supply system in the 1970s lagged far behind the needs of the city, which was developing at a rapid pace. Only in 1974 a new water intake "Sharovechka" with water pumping station No: 8 with a capacity of 7 200 m³/day was put into operation. In 1976, a powerful (up to 105 000 m³/day) source of underground water was found at a distance of 34 km from the regional center. Design and construction works were completed in several years. In 1981 the first phase of the main water pipeline was put into operation. In connection with the putting into operation of the Cherneliv water intake in the mid-1980s, water consumption in the city increased to 70 000 m³/day, and sewage treatment facilities allowed to clean only up to 30 000 m³ of sewage per day.

Therefore, in 1981, the construction of new wastewater treatment facilities with a total capacity of 75 thousand m³/day began, which, unfortunately, due to errors in design solutions and during

construction, as well as due to a decrease in the funds intended for these purposes, was not completed in full. In 1986, the treatment facilities were put into operation without a post-treatment complex and a mechanical sludge dewatering workshop. In 1991, the construction of highly loaded sludge platforms was started to remove excess sludge and dispose of it. In general, during the times of the Soviet Union, the city's water supply and sewerage facilities were built very energy-consuming, and the pipelines were made of materials that wear out quickly. As of today, the city with a population of about 300 000 inhabitants operates more than 700 km of water pipelines, more than 400 km of sewage networks, 10 WPS, 34 BPS and 31 WPS.

4.1.3 Measures completed by NIP I Water Programme

NIP Water Programme, financed by NIP (the Neighbourhood Investment Platform – EU financing initiative), is aimed at increasing of energy efficiency of water supply and sewage sector in 6 cities – Lutsk, Khmelnytskyi, Lubny, Horishni Plavni, Fastiv and Berdychiv. Implementation of Project Component 1 began in 2019 and is under implementation.

The planned investments in Khmelnytskyi were targeted at increasing the energy efficiency and in reducing the environmental pollution. The investments are the following:

- reconstruction of WWPS 2 including replacement of pumps;
- reconstruction of WWPS 7 including replacement of pumps;
- reconstruction of WWPS 12 including replacement of pumps.

Contract agreement was signed on 19.10.2020 and by the end of May 2024 the contract was completed by 95%.

4.2 Preliminary Proposed investment Programme

At the kick-off meeting (see MoM in Annex 1.1) Khmelnytskyi Water Utility (KhVK) and Municipality (KhM) proposed the following investment programme:

- Completion of construction of parallel water transmission main (WTM) from main ground water intake (WS 2-nd lift PS) to town (WS 3-rd lift PS). Out of 34 km 20 km has been already constructed. Proposed pipe made of Glass Reinforced Epoxy (GRE) with diameter 1000 mm. Design, cost estimate and EIA documents are from 2021. For this project construction of 5 km (out of missing 14 km) (parallel to deteriorated WTM made of reinforced concrete RC, where most of the pipe breaks occur) is proposed.
- Reconstruction (1st stage of construction) of existing wastewater treatment plant (WWTP). Design and cost estimate documentation for construction of new WWTP on the same site is available (2020). Proposed works include the following measures:
    - Replacement of pumping equipment, 15 units in total
    - Replacement of air blowers and aeration system (3 units)
    - Installation of SPP to supply power as minimum 600 – 800 kW.

4.3 Data Collection

Consultant issued the Questionnaires concerning technical issues (at 08.04.24, 19.04.24) and Social and Economic issues (at 08.04.24).

4.4 Analysis of Collected Data

The WS 2nd Lift PS currently has:

- 6 pumps (installed in 2012-2016), each with a capacity of 1600 m^3/h, developed pressure of 106 m. The electric motors of the pumps are for a voltage of 0.63kV.

- 1 pump (installed in 2023), with a capacity of 1000 m³/h, developed pressure 106 m, pump electrical motor is 0.4 kV voltage.
- 1 pump with diesel engine is for emergencies in cases of power failure. Its capacity is 200 m³/h.
- design capacity of the WS 2nd Lift PS station – 55 000 m³/d, currently up to 46 000 m³/d of water is supplied.

Operational data on WS 2nd Lift PS:

- pumped water quantity (m³/year):
  in 2020 — 18 997 000;
  in 2021 — 18 637 500;
  in 2022 — 17 423 040;
  in 2023 — 17 324 220
- average raising head: 110 m, on 2-nd lift PS output
- consumed electrical power for pumping water by the 2-nd lift PS to the distribution water supply system (kWh/year):
  in 2020 — 11 072 000;
  in 2021 — 10 899 000;
  in 2022 — 10 335 000;
  in 2023 — 10 190 000
- number of pipe breaks on WTM:
  in 2020 — 5;
  in 2021 — 7;
  in 2022 — 9;
  in 2023 — 4
- average repair cost of one pipe break: 120 000 UAH.

The water transmission main (WTM) with a diameter of DN 1000 mm is 34 km long. Due to the reliability of water supply, the water main consists of 2 parallel pipelines DN 1000 mm. According to the design prepared in 2021, due to a lack of funds, a 5 km long section has not been installed. Proposed pipe made of Glass Reinforced Epoxy (GRE) with diameter 1000 mm.

The wastewater treatment plant WWTP was built in 1981 and currently the condition of its facilities is bad. Devices and pumps work inefficiently and consume a lot of electricity compared to modern devices. The main element of the sewage treatment plant is a biological reactor (aeration tank), where biological processes of decomposition of wastewater pollutants take place. These processes require oxygen, which is equipped with special equipment - aerators. Currently, the aeration system works very inefficiently, and the air supply blowers are the biggest consumer of electricity in the wastewater treatment plant. Currently, the WWTP does not include mechanical wastewater treatment.

The design capacity of the existing wastewater treatment plant is 80 000 m³/d (4 900 m³/h). Currently, about 46 000 m³/d of wastewater flows into the wastewater treatment plant. In 2017, a project for the expansion and reconstruction of the wastewater treatment plant was prepared.

4.5 Reviewed Investment Programme

Because of maximum limit of the project cost 5 M€, the preliminary project proposal was grouped into three projects: Khm-1 with total cost estimate 3.631 M€ (excl. VAT), Khm-2 with total cost estimate 6.834 M€ (excl. VAT) and Khm-3 with total cost estimate 14.000 M€ (excl. VAT). **With first priority to project Khm-1.**

Composition and scope of projects:

- **Khm-1 as the 1st priority project**[8] consisting of:
    - Reconstruction of WS 2nd Lift PS including (i) installation of water hammer protection equipment and (ii) replacement of pumps, 6 kV switchgear, installation of 6 kV VFD, automation system and installation of SCADA
    - Installation of SPP at WWTP (841 kW)
- Khm-2: 1st construction phase new WWTP consisting of:
    - New construction of Mechanical treatment facility with compact unit sand-grid separator
    - reconstruction of the aeration system in aeration tanks, replacement of 2 existing air blowers
- Khm-3: Completion of construction of a part of back-up (parallel) water transmission main (WTM) from main ground water intake (2-nd lift PS) to town (3-rd lift PS).

Measures of reconstruction of WS 2nd Lift PS was proposed by the Consultant in addition to the preliminary proposed programme by KhVK.

4.6 Dimensioning of the Investment Programme

The parameters of the objects to be implemented are presented below and are determined based on the data provided by KhVK, previously prepared design documentation. This dimensioning is preliminary and used only for compilation of cost estimates. More detail and precise parameters of investment programme components (capacity, pipe diameter etc) will be established at the next design stage.

4.6.1 Water Transmission Main

According to the design prepared in 2021, due to a lack of funds, a 5 km long section has not been installed. Proposed pipe made of Glass Reinforced Epoxy (GRE) with diameter 1000 mm.

4.6.2 Reconstruction of WS 2nd Lift PS

The following works have been included into the investment programme:

- Installation of 4 pump units (capacity of each 1000 m³/h, developed pressure 106 m), including the necessary mechanical work to connect the pumps,
- Electrical works, reconstruction of the WS 2nd Lift PS electricity supply system, incl. 6 kV switchgear, installation of 6 kV VFD
- Automatic control and SCADA
- Other miscellaneous works.

4.6.3 1st construction phase of new WWTP

Mechanical Treatment Facility

The following works have been included into the investment programme:

- Construction of new Mechanical treatment facility with compact unit sand-grid separators, 2 units of combined wastewater pre-treatment equipment with a total capacity of 3000 m³/hour.

[8] The consulting team proposed 1st priority project Khm-1. But later during the discussions with KhmVK (and KhM) different project Khm-2 was selected for the 1st priority.

The wastewater treatment plant reconstruction design was prepared in 2017. Design capacity of WWTP was 4900 m³/hour. Currently, the inflow of wastewater is only about 57% of the total design volume. After evaluating the data of the prepared design and the current sewage flow rate, we propose to install mechanical treatment devices with a capacity of 2500 m³/hour. It is recommended to install two separate lines with a capacity of 1250 m³/hour each and each of which should contain:

- fine screening,
- aerated grit chamber,
- grease chamber,
- sand washing and compacting unit.

In order to install mechanical treatment units, a building must be built according to the solutions of the already prepared design and the parameters provided for in the design.

There will be no direct reduction in operating costs after the construction of mechanical treatment facilities, but it is a necessary and unavoidable element of the WWTP plant to ensure the needed treatment effect.

Reconstruction of Aeration System at existing WWTP

Effective and proper operation of the entire wastewater treatment plant cannot be guaranteed and ensured without the installation of aeration equipment.

- replacement of aerators and other mechanical works (for 2 reactors, dimensions of each aeration tank 18m×66m×5,24m). High efficiency membrane or similar type aerators will have to be installed replacement of blowers (2 units, each one Q = 12 500 m³/h; N = 257 kW; U=3~400V).

Currently, the wastewater treatment plant has a 6-section aeration tank. According to the solutions of the 2017 design, it is planned to build 3 additional sections. The aeration system must be replaced in all the sections, but due to the limited budget, it is planned to replace only 2 sections.

Such a scope of reconstruction will not have a significant economic benefit, as only a part of the work would be done. Replacing 2 blowers and aerators in 2 sections will reduce air supply losses and optimize wastewater treatment in these sections. A significant cost reduction is possible only after the complete reconstruction-modernization of the entire WWTP.

4.6.4 Installation of SPP

Installation of a solar power plant (SPP) at the water utility will help reduce electricity costs and improve the environmental safety of the enterprise. This chapter describes the site where the SPP is planned to be installed, the initial data for calculations, and the results of the calculations.

Description of the Site

The location site for the solar power plant installation is situated on the premises of the water utility. The first plot dimensions are 100 meters by 50 meters, and the second plot dimensions are 90 meters by 60 meters. The chosen locations have a flat terrain but contain small trees and other obstacles that may cast shadows. The next consultant must consider this to eliminate shading in the subsequent project stage. Overall, the area is well-lit by sunlight throughout the day, which is crucial for the efficient operation of the solar power plant. The average distance from the solar power plant locations to the 0.4 kV transformer station is 300 meters. The power cables can be laid either underground or above ground on poles, and the next consultant must determine the appropriate method in the project.

Figure 4: Khmelnytskyi; Location of WWTP SPP

Initial Data and Key Characteristics of the Site:

- Geographical Location: WWTP of the Khmelnytskyi water utility
- Solar insolation in the Khmelnytskyi region: 1149 W/m².

The following initial data were used for the calculations:

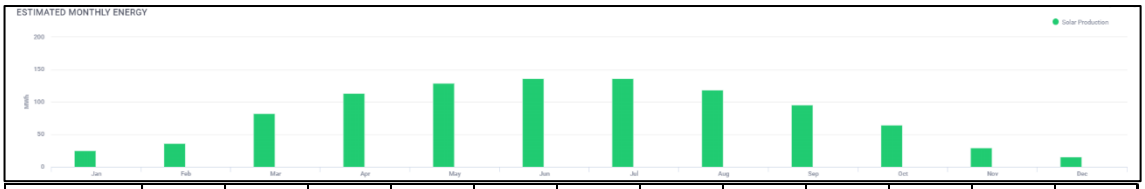
- Area available for solar panel installation: 15 000 m²
- Allowed power capacity of the transformer station: 1200 kW
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: Grid-tied with generation control system.

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 12: Khmelnytskyi; WWTP SPP Calculation Results

Installed capacity of solar panels	841 kWp
Maximum AC power output	800 kW
Estimated annual electricity production	981 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	25,424	36,186	81,918	112,619	128,854	136,574	136,1	118,234	95,435	64,25	29,956	15,479

Figure 5: Khmelnytskyi; WWTP SPP Estimated Generation Schedule

4.7 Estimated Budget

Preliminary budget for Final Reviewed Investment Programme below is based on the Consultant's experience, the estimates of previously completed projects, commercial offers and in-house data for contemporary price level in Ukraine.

Miscellaneous works in the tables below are estimated to 5% of sum of other works.

4.7.1 Reconstruction of WS 2nd Lift PS

Total cost of reconstruction WS 2nd Lift PS is estimated to 2 644 000 € (excl. VAT).

Table 13: Khmelnytskyi; Detail Cost Estimate of Reconstruction of WS 2nd Lift PS (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Khm-1.2	**Reconstruction of WS 2nd Lift PS**					**2 644 000**
Khm-1.2.1	**Installation of water hammer protection equipment**					**405 000**
Khm-1.2.1.1	Civil works	lumpsum	1	25 000	30 000	55 000
Khm-1.2.1.2	Water hammer protection equipment	lumpsum	1	300 000	30 000	330 000
Khm-1.2.1.3	Miscellaneous, 5%	lumpsum	1	17 000	3 000	20 000
Khm-1.2.2	**Replacement of pumps, 6 kV switch-gear, installation of 6 kV VFD, automation system and SCADA**					**2 239 000**
Khm-1.2.2.1	Civil works	lumpsum	1	20 000	28 000	48 000
Khm-1.2.2.2	Pumps: Q=1000 m³/h, H=106 m, 400 kW	pcs	4	312 000	10 000	1 288 000
Khm-1.2.2.3	Other mechanical works	lumpsum	1	8 000	8 000	16 000
Khm-1.2.2.4	Electrical works, power supply	lumpsum	1	400 000	300 000	700 000
Khm-1.2.2.5	Automatic control and SCADA	lumpsum	1	60 000	20 000	80 000
Khm-1.2.2.6	Miscellaneous, 5%	lumpsum	1	87 000	20 000	107 000

4.7.2 1st construction phase of new WWTP

Total cost of reconstruction of WWTP (1st phase of construction) is estimated to 2 878 000 € (excl. VAT).

Table 14: Khmelnytskyi; Detail Cost Estimate of Reconstruction of WWTP (1st phase of construction) (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Khm-2.1	**Reconstruction of existing wastewater treatment plant**					**2 878 000**
Khm-2.1.1	**Construction of new wastewater mechanical treatment unit**			**940 000**	**368 000**	**1 308 000**
Khm-2.1.1.1	Civil works (building 18m*21m*8m)	lumpsum	1	183 000	132 000	315 000
Khm-2.1.1.2	COMBINED WASTEWATER PRE-TREATMENT UNIT Q=1250 m³/h	pcs	2	250 000	16 000	532 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Khm-2.1.1.3	Other mechanical works	lumpsum	1	20 000	34 000	54 000
Khm-2.1.1.4	Electrical works, power supply	lumpsum	1	40 000	30 000	70 000
Khm-2.1.1.5	Automatic control and SCADA	lumpsum	1	15 000	20 000	35 000
Khm-2.1.1.6	HVAC	lumpsum	1	30 000	20 000	50 000
Khm-2.1.1.7	Plumbing and sanitation	lumpsum	1	2 000	2 000	4 000
Khm-2.1.1.8	Site works	lumpsum	1	40 000	30 000	70 000
Khm-2.1.1.9	Networks for connection	lumpsum	1	65 000	50 000	115 000
Khm-2.1.1.10	Miscellaneous, 5%	lumpsum	1	45 000	18 000	63 000
Khm-1.1.1	**Reconstruction of the aeration system in aeration tanks**					**1 570 000**
Khm-1.1.1.1	Civil works (reconstruction of the 2 aerotanks)	lumpsum	1	157 500	90 000	247 500
Khm-1.1.1.2	Replacement of blowers (Q = 12500 m³/h; N = 257 kW; U=3~400V)	pcs	2	320 000	173 000	986 000
Khm-1.1.1.3	Replacement of aerators and other mechanical works (for 2 reactors)	lumpsum	1	70 200	15 000	85 200
Khm-1.1.1.4	Reconstruction of electrical substations and electrical networks. Electrical works. Changing the electricity network to a low voltage system	lumpsum	1	80 000	35 000	115 000
Khm-1.1.1.5	Automatic control and SCADA	lumpsum	1	42 500	17 500	60 000
Khm-1.1.1.6	Miscellaneous, 5%	lumpsum	1	50 000	26 000	76 000

4.7.3 Water Transmission Main

Total cost of completion of construction of a water transmission main (WTM) is estimated to 10 M€ (excl. VAT).

Table 15: Khmelnytskyi; Detail Cost Estimate of Construction of WTM (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Khm-3.1	**Construction of a part of back-up (parallel) water transmission main (WTM**					**10 000 000**
Khm-3.1.1	Construction of WTM DN1000 mm	m	5000	1 200	800	10 000 000

4.7.4 Installation of SPP

The cost estimate allows for accurate determination of financial expenses of the project. Below Consultant considers the cost assessment process based on his personal experience and current average prices in the Ukrainian market. Additionally, the developed cost calculations for the SPP have been approved by the water utility, adding further reliability to the obtained results.

The main components of a solar power station include:

- Solar panels - converting sunlight into direct current;
- Inverters - converting the direct current generated by the panels into alternating current, which can be used in the electrical grid;
- Mounting systems - structures for panel mounting;
- Cables and connectors - for component connection;
- Monitoring and control systems - for tracking and managing SPP operation;
- Civil and site works.

To assess the cost, average prices in the Ukrainian market are used.

Total preliminary budget of installation of SPP at WWTP is estimated to 626 000 € (excl. VAT).

Table 16: Khmelnytskyi; Detail Cost Estimate of Construction of installation of SPP at WWTP (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Khm-1.2	**Installation of solar panels at WWTP (841 kW)**					**626 000**
Khm-1.2.1	Civil works	lumpsum	1	113 000	43 500	156 500
Khm-1.2.2	PV panels, [841 kW]	pcs	1450	140	30	246 500
Khm-1.2.3	Inverters, [800 kW]	lumpsum	1	50 240	4 900	55 140
Khm-1.2.4	Electrical works, power supply	lumpsum	1	72 000	19 000	91 000
Khm-1.2.5	Automatic control and SCADA	lumpsum	1	9 000	4 000	13 000
Khm-1.2.6	Site works	lumpsum	1	21 000	11 000	32 000
Khm-1.2.7	Miscellaneous, 5%	lumpsum	1	24 000	7 000	31 000

4.8 Final Reviewed Investment Programme

At the Investment Programme meeting on 24.05.24 (see MoM in Annex 3.1) it was agreed that despite of importance of project Khm-3 it can be regarded as a low priority project.

KhVK's position regarding Khm-1.1 Reconstruction of WS 2nd Lift PS was that it is not the first priority project. There are reserve pumps installed, one new pump has just been purchased. Additionally, there has not been problems with needed pressure.

It is KhVK's opinion, that the first priority should be given to project Khm-2 including installation of SPP at WWTP.

Nevertheless, because of the budget restrictions, component Khm-1.1.1 "Reconstruction of the aeration system in aeration tanks" was moved under the 2nd Priority Project Khm-1. So, the 1st Priority Project Khm-2 finally included installation of SPP (at WWTP) and construction of new wastewater mechanical treatment unit for WWTP. The selection in favour of the latter component is justified because new aeration system would not work without proper wastewater mechanical treatment.

WWTP reconstruction is important also from the environmental point of view as many cities (incl. Vinnitsa) below the stream (to which treated water is discharged) are taking in their own potable water from the very same river of Southern Bug.

Reviewed Proposed Investment Programme (see Chapter 4.5) by the Consultant will be divided into three projects:

- 1st Priority Project Khm-2 with total cost estimate of 2 514 000 € (excl. VAT)
- 2nd Priority Project Khm-1 with total cost estimate of 5 478 000 € (excl. VAT).
- 3rd Priority Project Khm-3 with total cost estimate of 13 000 000 € (excl. VAT).

Main proposed project Khm-2 will include the following components:

- Reconstruction (1st phase of reconstruction) of existing wastewater treatment plant (WWTP), including:
    - Construction of new Mechanical treatment facility with compact unit sand-grid separator
- Installation of solar panels at WWTP (841 kW).

Reconstruction of WS 2nd Lift PS and Reconstruction of the aeration system in aeration tanks (Khm-1); and Completion of construction of a part of back-up (parallel) water transmission main (Khm-3) will be included into the next priority projects.

Table 17: Khmelnytskyi; Total Cost Estimate of the 1st Priority Project Khm-2 (excl. VAT)

Pos. No.	Item	Cost Estimate, €
Khm-2.1	**Reconstruction of existing wastewater treatment plant**	**1 308 000**
Khm-2.1.1	Construction of new wastewater mechanical treatment unit	1 308 000
Khm-2.2	**Installation of SPP at WWTP (841 kW)**	**626 000**
Khm-2.3	**Subtotal**	**1 934 000**
Khm-2.4	Design and cost estimate documentation 10%	193 000
Khm-2.5	Contingency 20%	387 000
Khm-2.6	**Total**	**2 514 000**

Table 18: Khmelnytskyi; Total Cost Estimate of the 2nd Priority Project Khm-1 (excl. VAT)

Pos. No.	Item	Cost Estimate, €
Khm-1.1	**Reconstruction of existing wastewater treatment plant**	**1 570 000**
Khm-1.1.1	Reconstruction of the aeration system in aeration tanks	1 570 000
Khm-1.2	**Reconstruction of WS 2nd Lift PS**	**2 644 000**
Khm-1.2.1	Installation of water hammer protection equipment	405 000
Khm-1.2.2	Replacement of pumps and installation of SCADA	2 239 000
Khm-1.3	**Subtotal**	**4 214 000**
Khm-1.4	Design and cost estimate documentation 10%	421 000
Khm-1.5	Contingency 20%	843 000
Khm-1.6	**Total**	**5 478 000**

Table 19: Khmelnytskyi; Total Cost Estimate of the 3rd Priority Project Khm-3 (excl. VAT)

Pos. No.	Item	Cost Estimate, €
Khm-3.1	**Construction of a part of back-up (parallel) water transmission main (WTM) from main ground water intake (2-nd lift PS) to town (3-rd lift PS)**	**10 000 000**
Khm-3.2	**Subtotal**	**10 000 000**
Khm-3.3	Design and cost estimate documentation 10%	1 000 000
Khm-3.4	Contingency 20%	2 000 000
Khm-3.5	**Total**	**13 000 000**

KhmM has plans to construct a completely new modern wastewater treatment plant (WWTP) next to the existing one. However, it will take 5-10 years until this could be completed. The proposed Mechanical Pretreatment unit and SPP will serve the existing WWTP but shall also be part of the new WWTP. To ensure that this mechanical pretreatment unit constructed now will fit the future wastewater treatment process, the understanding of which components the future WWTP will consist (what are the optimal treatment process options) shall be formulated in the conceptual design of future WWTP which should be prepared before the tendering of design-build works of the proposed pretreatment unit. This conceptual design shall focus on key design choices that provide a clear vision of future treatment process. It should not be a "design document" in a sense of construction legislation. Its main goal is to ensure that mechanical pretreatment unit constructed now will fit into future WWTP treatment scheme. It is proposed, that this work should be performed by the PIU consultant before the compiling of TD for design-build works. This should be performed in close cooperation with KhmVK - the water utility shall accept the "ownership" of the document.

In Consultant's opinion the conceptual design shall cover at least the following issues:

- dimensioning flow requirements

- description of the raw wastewater quality
- treated effluent quality requirements
- identification of treatment process options
- selection of two treatment options for further elaboration
- general dimensioning of treatment facilities including general lay-out drawing and elevation scheme (for 2 options)
- generation of preliminary cost estimates (for 2 options).

Compilation of this conceptual design is a job for 1-2 process engineers in the total amount of 40 mandays and it should take approximately 2 months to complete.

4.9 Investment Programme Benefits and Savings

Below the benefits and savings of each finally proposed projects are established separately.

4.9.1 Reconstruction of WS 2nd Lift PS

The pumping station (2nd Lift PS) is the main source of water supply for the city. The pumps installed in the pumping station in 2012-2014 are equipped with 6 kV motors, each with a power of 630 kW. The operating efficiency of these pumps is in Consultant's low, resulting in high electricity consumption.

Power supply to the 2nd lift PS is provided in accordance with current standards for the 1st category from two independent sources. To ensure uninterrupted operation of pumps in the event of possible interruptions in power supply and the operation of all 6 kV electrical equipment (incl. new pumps) in automatic mode, it is recommended to replace the outdated electrical equipment of the 6 kV switchgear and install at least 2 units of 6 kV VFD, automation system and SCADA.

Replacing the pumps with more efficient ones and reconstructing the pumping station would optimize the operation of the pumping station and increase the reliability of its operation. This measure would reduce operational costs and reduce water supply losses. However, without more detail specially designed investigations, it is impossible to calculate the savings of the project. Nevertheless, according to Consultant's rough estimate, energy consumption would be reduced as a result of pump replacement by 5-10%.

More relevant measures that would ensure the reliability of water supply are hydraulic hammer protection measures. Therefore, equipment that protects against hydraulic hammer must be installed as a matter of priority. After detailed calculations, the most optimal measures must be provided - a water tower, special air inlet valves or other measures. The installation of the second water supply pipe DN 1000 mm can be planned only after the hydraulic hammer protection equipment is installed and if there is a sufficient budget.

4.9.2 Reconstruction of WWTP (1st stage of construction)

The wastewater treatment plant (WWTP) was built in 1981 and currently the condition of its facilities is poor. All equipment and pumps operate inefficiently and consume a lot of electricity compared to modern equipment. The main element of the WWTP is a biological reactor (aeration tanks), where biological processes of decomposition of sewage pollutants take place. These processes require oxygen, which is introduced with special equipment - aerators. Currently, the aeration system works very inefficiently, and the air supply blowers are the biggest consumer of electricity in the wastewater treatment plant.

It is planned to replace the aeration system with modern efficient devices in 2 aeration tanks. The aeration system can only function properly with perfect mechanical pretreatment of the wastewater. Currently, proper mechanical cleaning is absent, so in order to change the aeration system, it is

necessary to install suitable mechanical cleaning equipment. We propose to build a new mechanical treatment building and install 2 units of combined wastewater pre-treatment units with a total capacity of 2500 m^3/hour.

After the reconstruction of 2 aeration tanks, the replacement of 2 blowers will optimize the performance of the aeration system and reduce operational costs.

Aeration accounts for about half of a wastewater treatment plant's energy bill—the largest component of energy consumption in the entire plant—and can consume significant maintenance resources. Reducing these operating costs is essential for KhVK today. Again, without more detail specially designed investigations, it is impossible to calculate the savings of the project. But, according to Consultant's rough estimate, energy consumption would be reduced as a result of aeration reconstruction by 20%.

At the same time introduction of mechanical treatment (absent by now) will:

- reduce suspended solids (SS) in the effluent by some 10% (approximately by 1000 t/year[9]). At the same time it will reduce the amount of processed sludge after aeration stage, so in *summa summarum* it will balance the energy consumption
- COD and BOD will be also reduced but in an insignificant amount of 1-2% (approximately by 350 t/year and 190 t/year accordingly[10])
- increase WWTP's energy consumption balancing in some extent the savings from aeration reconstruction. According to existing design documents new mechanical treatment facility will consume 174 MWh of energy each year.

Combined wastewater pre-treatment units will not remove Ntot, Ptot from wastewater. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

WWTP reconstruction is important also from the environmental point of view as many cities (incl. Vinnitsa) below the stream (to which treated water is discharged) are taking in their own drinking water from the very same river of Southern Bug.

4.9.3 Water Transmission Main

Today due to frequent accidents in the water supply system, the supply of drinking water to the city is often interrupted.

The completion of installation of a second water supply pipe DN 1000 mm in a 5 km section would increase the reliability of water supply, effect of which cannot be monetarised. But it would not eliminate hydraulic hammer. In this complex water supply system, the causes of hydraulic hammer can be various and detailed system calculations must be performed to determine them.

4.9.4 Installation of SPP

Initial Data:

- Annual energy production: 981 MWh (which covers 4% of total energy consumed by water utility).
- CO_2 emissions reduction: 785 tons per year.
- Estimated cost of the solar power plant: 626 000 € (excl. VAT).

[9] According to Consultant's rough estimate which is based on the figures of raw WW quality and flow rate received from KhmVK

[10] According to Consultant's rough estimate which is based on the figures of raw WW quality and flow rate received from KhmVK

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 981 MWh, savings on electricity are estimated in Chapter 4.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 785 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 626 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 4.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

4.10 Financial Analysis

Total budget for reconstruction (1st stage of reconstruction) of existing wastewater treatment plant (WWTP) and installation of SPP at WWTP (notably Khm-2 project) in Khmelnytskyi is 2 514 000 € (without VAT).

Potential savings from installation of SPP (e.g. estimated production of electric energy from Solar PV at WWTP) are as following:

- SPP – production of solar energy from panels at WWTP is **981** MWh per year.

Therefore, total saving from production of solar energy for enterprise´s internal purposes and therefore substituting energy purchase from networks is **156 960 €** (electricity price estimated to be 0.16 € per kWh or 160 € per MWh, without VAT).

Regarding investment other savings, they cannot be monetarised in reasonable extent as they are not substantial in estimating cost effectiveness of investment.

Therefore, **payback time without grant** for the whole investment would be **19 years**, which is too long time span of investment in terms of economic risks and depreciation of assets.

Therefore, additional grant is needed for economic viability of investment. Considering requested co-financing rate (16.5 %) for municipal water enterprise funds the **payback time** will be much shorter – **3.2 years** for equity invested, which is within economically acceptable limits for water enterprise.

5 Lutsk

5.1 Existing Water Supply and Wastewater Services

5.1.1 Lutsk General Information

Lutsk is a city on the Styr River in north-western Ukraine. It is the administrative centre of the Volyn Oblast and the administrative centre of the surrounding Lutsk region within the oblast, although itself it is not a part of the region. Lutsk is an important centre of industry.

Lutsk is the core of the Lutsk industrial hub, which also includes the city of Kivertsi. Main industries: factories producing cars, shoes, bearings, furniture, machines and electronics, as well as steel mills and a chemical plant are located in the area:

- The leading industry is "mechanical engineering and metalworking" (plants: Lutsk automobile, Lutsk repair plant "Motor", enterprise "Modern-Expo", bearing, electrical apparatus, communal machine-building and utility equipment, production-scientific association "Electrothermometry") independent stainless steel and aluminium rolled trader "Metal-Alliance".
- There are enterprises of the "chemical industry", represented by a factory of plastic products;
- Enterprises of the "construction industry" ("Volyn steel concrete", factories of large-panel house construction, cardboard-roofing and silicate).
- "Light industry" (production and trade silk association and production sewing association "Volyn", shoe factory, synthetic leather factory).
- "Woodworking industry" (furniture and barrel and barrel factories).
- "Food industry" (in particular, a cannery, "Kharcheprodukt", a foodstuff factory, bread, milk and butter factories).

Population of the city is 212 557 inhabitants. Number of IDP-s who were forced to leave their homes due to russian aggression has been reported to be 26 800.

5.1.2 WS and WW Services

KP "Lutskvodokanal" (LtVK) is one of the oldest enterprises in the city of Lutsk, which began its life at least 90 years ago when the first centralized water supply system began to develop in the ancient city. AT 1925 “Lutskvodokanal” was established. Centralized water supply and water supply services are provided to 213 thousand residents, of which the population is 212.6 thousand, legal entities - 1.9 thousand. More than 178.2 thousand are paying for water supply and wastewater services.

Source of drinking water supply area is an underground aquifer. Treatment and supply of water to the site takes place at three water treatment facilities: Dubnivsky, Omelyanivsky and Hnidavskyi. All water treatment sites have a complex of raw water purification and treatment facilities with 12 clean water tanks. with a total volume of 51.3 thousand m^3.

Wastewater system in the city of Lutsk is carried out according to a separate scheme. In the central part of the city, there is an all-alloy system, in the north - partially separate and all-alloy, in the east and west - full separate. The WW system of KP "Lutskvodokanal" includes wastewater collection networks - 207.3 km, wastewater pumping stations (WWPS) - 18 units and a wastewater treatment plant (WWTP).

5.1.3 Measures completed by NIP I Water Programme

NIP Water Programme, financed by NIP (the Neighbourhood Investment Platform – EU financing initiative), is aimed at increasing of energy efficiency of water supply and sewage sector in 6 cities –

Lutsk, Khmelnytskyi, Lubny, Horishni Plavni, Fastiv and Berdychiv. Implementation of Project Component 1 began in 2019 and is under implementation.

The planned investments are targeted in increasing the energy efficiency and in increasing the stability and efficiency in operation of water supply and sewage systems. The planned investments were the following:

- replacement of old and inefficient pumps at 19 water booster pumping stations (BPS) including valves and provision the pumps with frequency converters;
- replacement of pumps in four wastewater pumping stations (WWPS) including replacement of existing valves and screens;
- installation of 300 water meters in the apartment blocks and connection to remote control system.

The contract for water meters was fully completed by December 2021.

The contract for reconstruction of BPS and WWPS was signed but due to russian aggression and consecutive increase of prices the scope of works was reduced. Reconstruction of wastewater pumping stations was removed from the contract (though preparation of design documents for WWPS remained in the scope). By the end of May 2024, the contract (of reduced scope) was completed by 95%.

5.2 Preliminary Proposed investment Programme

At the kick-off meeting (see MoM in Annex 1.2) Lutsk Water Utility (LtVK) and Municipality (LtM) proposed the following investment programme:

- Replacement of main equipment at four wastewater pumping stations: WWPS 1, WWPS 2, WWPS 3 and WWPS 5. Proposed works include:
    - Replacement of main pumps
    - Replacement of drainage pumps
    - Replacement of valves
    - Repla cement of mechanical screens and other solid waste treatment equipment
    - Replacement of power supply and control equipment
    - Replacement of lifting equipment at WWPS 1 and WWPS 3
    - Replacement of gravity and pressure collectors, site improvement and building repair works at WWPS 5
    - Install flow meters
- Installation of SPP at locations of Hnidavskyi 2-nd lift PS (800 kW) and at Wastewater Treatment Plant (WWTP) (1000 kW).

5.3 Data collection

Consultant issued the Questionnaires concerning technical issues (at 16.04.24 and 23.04.24) and Social and Economic issues (at 16.04.24).

5.4 Analysis of Collected Data

Three of WWPS (no: 1, 2 and 5) are pumping wastewater to the treatment plant (WWTP) through one common pressure pipe system.

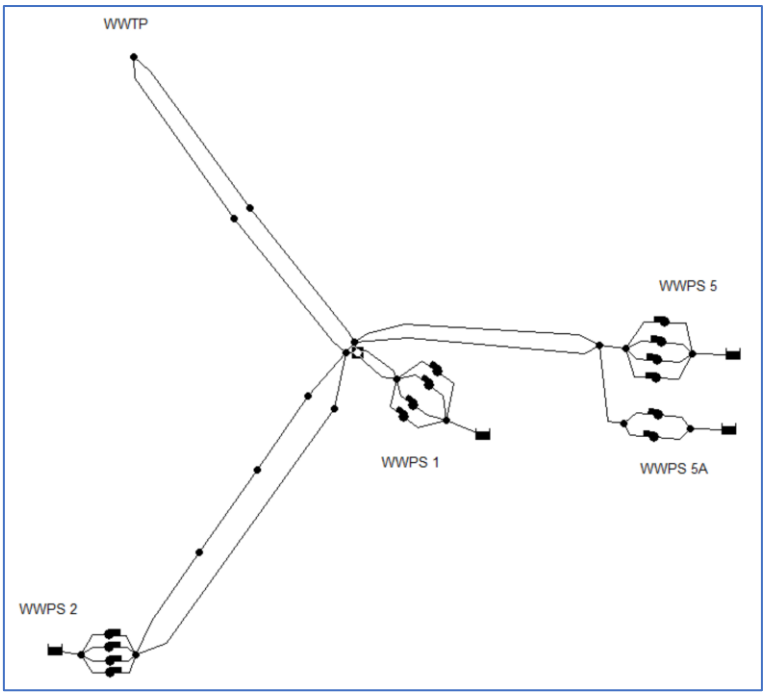


Figure 6: Lutsk; WWPS 1, 2 and 5. Pressure Sewer System

The preliminary pump capacity calculations were done first time in November 2019[11], when this replacement programme was initiated by NEFCO (see also Chapter 5.1.3). This modelling was theoretical, meaning that Lutsk Vodokanal (LtVK) did not undertake the measurement campaign to verify the initial data of the pressure pipes. The main result of this theoretical modelling was that existing pumps at all three WWPS had too large raising head.

Table 20: Lutsk; WWPS Modelling and Design Results

	Existing raising head	Designed raising head	Modelled		
			Raising head	Difference with existing	Difference with designed
WWPS 1	33	27	24	9	6
WWPS 2	53	40	35	18	13
WWPS 5	33	28	21	12	5

So, by installing pumps with lower raising head at all three WWPS, should allow to reduce the pumping power significantly. However, at that time it was impossible to take the decision on pump size just based on theoretical modelling. Therefore, to the Employer's Requirements (ER) was included requirement for the Contractor to perform the measurement campaign and based on that review pumps sizes for all WWPS. The tender was published, Contractor selected and Contract signed.

Because of russian aggression the contract scope was reduced and reconstruction of WWPS was excluded from the contract. The design of WWPS was decided to finalize but without measurement campaign. Today the designs are not ready yet, but are at the finalisation stage. According to the provided information the following pumps are installed now and will be installed as per existing design documentation (see table below).

[11] Моделирование совместной работы КНС 1, 2 и 5. Report prepared by Madis Maddison in November 2019. See Annex 5.

Table 21: Lutsk; WWPS 1, 2 and 5. Existing and Designed Pumps

	Pump type	Nominal flow, m³/h	Nominal raising head, m	Year of installation	New designed pump	Remarks
WWPS 1						
Pump 1	ФГ 800/33	800	33	1982	Hydro-Vacuum FZC.6.22.1.4110, 75 kW	Day time pump
Pump 2	ДФ 500/33	500	33	2007		
Pump 3	GRUNDFOS S1.80.125.400.4	270	35	2024		
Pump 4	ДФ 500/33	500	33	2007		
WWPS 2						
Pump 1	ДФ 1000-53	1000	53	2005		
Pump 2	ДФ 1000-53	1000	53	2005		
Pump 3	ДФ 1000-53	1000	53	2005 (overhaul 2024)	Hydro-Vacuum FZF.7.50.1.4110, 160 kW	Day time pump
Pump 4	KCM250TA+1800042N/RF (CAPRARI)	1000	53	2017	Hydro-Vacuum FZC.6.20.1.4110, 75 kW	Night time pump
WWPS 5						
Pump 1	ДФ 1000-53	800	33	2005		
Pump 2	*dismounted*				Hydro-Vacuum FZC.8.12.1.4110, 132 kW	Day time pump
Pump 3	ДФ 1000-33	800	33	2005		
Pump 4	*dismounted*				Hydro-Vacuum FZC.7.22.1.4110, 75 kW	Night time pump
Pump 5	ДФ 1000-33	1000	33	2005		

According to the design the following pumps are installed and will be installed as per design documentation to WWPS 3 (see table below).

Table 22: Lutsk; WWPS 3. Existing and Designed Pumps

	Pump type	Nominal flow, m³/h	Nominal raising head, m	Year of installation	New designed pump	Remarks
WWPS 3						
Pump 1	ФГ-450/22,5	450	22	1982	Hydro-Vacuum FZC.6.24.1.4110, 55 kW	Day time pump
Pump 2	ДФ700/23	700	23	2005	Hydro-Vacuum FZC.6.24.1.4110, 55 kW	Day time pump
Pump 3	*dismounted*					
Pump 4	ДФ700/23	700	23	2005		
Pump 5	ДФ700/23	700	23	2005		

In the table below the analysis of energy consumption by all four WWPS is given. In Consultant's opinion LtVK has overestimated the pumped water volume. Results of calculation of **Ph5** energy consumption (kWh/m³/100m)[12]: unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m. As it can be

[12] Key performance Indicator (KPI) recommended by IWA-PI (International Water Association Performance Indicator)

seen from the Table below, existing pumps at WWPS 1, 2 and 3 are unbelievably efficient (Ph5 being well below 0.5 kWh/m³/100 m). Therefore, assuming that Ph5 should be over 0.6 kWh/m³/100m, Consultant estimated lower values for pumped water which was taken for a baseline in benefit calculations (see Chapter 5.9.1). Estimated flows

Table 23: Lutsk; Energy Consumption Analysis

Parameter	Unit	Total	WWPS 1	WWPS 2	WWPS 5	WWPS 3
Existing baseline (LtVK estimate)						
Existing total flow in 2023	m³/year	22 082 500	3 102 500	6 570 000	7 300 000	5 110 000
Existing raising head	m w. g.	36	33	53	33	22
Consumed power	kWh/year	3 864 561	217 906	1 591 403	1 739 727	315 525
	kWh/m³	0.18	0.07	0.24	0.24	0.06
Ph5	kWh/m³/100m	0.48	0.21	0.46	0.72	0.28
Existing baseline (Consultant's estimate)						
Existing total flow (Consultant's estimate)	m³/year	13 200 833	1 034 167	4 380 000	6 083 333	1 703 333
	m³/h	1 507	118	500	694	194
Existing raising head	m w. g.	38	33	53	33	22
Consumed power	kWh/year	3 864 561	217 906	1 591 403	1 739 727	315 525
	kWh/m³	0.29	0.21	0.36	0.29	0.19
Ph5	kWh/m³/100m	0.77	0.64	0.69	0.87	0.84

5.5 Reviewed Investment Programme

Consultant proposed (at the meeting on 24.05.2024, see Annex 3.2) the following Reviewed Investment Programme, consisting from one project:

1. Measurement campaign for pressure sewers
2. Reconstruction of WWPS 3
3. Reconstruction of WWPS 2
4. Reconstruction of WWPS 1
5. Reconstruction of WWPS 5
6. Reconstruction of Central Valve Chamber on wastewater system
7. New Central SCADA system
8. Installation of SPP:
    - Installation of SPP at Hnidavskyi 2-nd lift PS (664 kW)
    - Installation of SPP at WWTP (640 kW)

Measures 1, 6 and 7 were proposed by the Consultant in addition to the preliminary proposed programme by LtVK.

5.6 Dimensioning of the Investment Programme

Below the dimensioning of the pumps is given. This dimensioning is preliminary and used only for compilation of cost estimates. More detail and precise parameters of investment programme components (i. e. pump capacity, pipe diameter etc) will be established at the next design stage.

5.6.1 Replacement of Main Equipment at 4 WWPS

Dimensioning of WWPS no: 1, 2 and 5

In the Table below the comparison of designed and modelled pumps is given. The calculated scenario reflects simultaneous operation of one new pump at each WWPS. Total inflow to WWTP at this scenario for modelled pumps is 174% higher than average baseline flow (see Table 23).

Table 24: Lutsk; Comparison of Designed and Modelled Pumps

	Modelled pumps		Designed pumps	
	Flow	Pressure	Flow	Pressure
	m³/h	m w. g.	m³/h	m w. g.
WWTP inflow	**2 286**		**2 844**	
Line 1	874		1 087	
Line 2	1 412		1 757	
WWPS 1				
Pump 1	**361**	**25**	**640**	**27**
WWPS 2				
Pump 3	**856**	**36**	**996**	**40**
WWPS 5				
Pump 2	**1 070**	**25**	**1 209**	**28**

Also, the estimated pumping energy for modelled pumps will be lower than with designed pumps: 270 kW *v.* 372 kW.

Therefore, Consultant recommends to install pumps with modelled nominal capacities:

- WWPS 1 pump 1 with Q = 93 l/s and H = 26 mw.g.
- WWPS 2 pump 3 with Q = 220 l/s and H = 38 mw.g.
- WWPS 5 pump 2 with Q = 255 l/s and H = 28 mw.g.

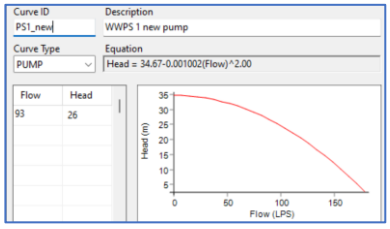


Figure 7: Lutsk; Modelled WWPS 1 pump

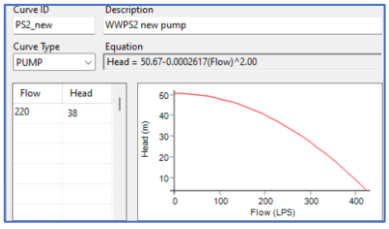


Figure 8: Lutsk; Modelled WWPS 2 pump

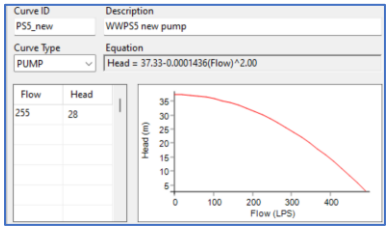


Figure 9: Lutsk; Modelled WWPS 5 pump

Dimensioning of WWPS 3

In the Table below the comparison of designed and modelled pumps is given. The calculation assumes one operational pump (Pump 1 or Pump 2) at average daytime scenario. Maximum flow would be

Table 25: Lutsk; Dimensioning of WWPS 3

		Modelled pumps		Designed pumps	
	Flow	Flow	Pressure	Flow	Pressure
	l/s	m³/h	m w. g.	m³/h	m w. g.
WWPS 3					
Pump 1	139	500	13	500	22

Also, the estimated pumping energy for modelled pumps will be lower than with designed pumps: 27 kW *v.* 45 kW.

Therefore, Consultant recommends to install pumps with modelled nominal capacities:

- WWPS 3 pumps 1 and 2 with Q = 139 l/s and H = 15 mw.g.

5.6.2 Installation of SPP at Hnidavskyi 2-nd Lift PS and at WWTP

Installation of a solar power plant (SPP) at the water utility will help reduce electricity costs and improve the environmental safety of the enterprise. This chapter describes the site where the solar power plant is planned to be installed, the initial data for calculations, and the results of the calculations.

SPP Located at Hnidavskyi 2-nd Lift PS

Description of the Site

The location for installing the solar power plant (SPP) is situated on LtVK premises. The area is extensive, up to 9000 m². However, the terrain is uneven, albeit moderately level, with the presence of small trees and other obstacles that may create shadows.

LtVK expressed a desire to install panels across the entire area, employing a ballast system (commonly used for rooftop installations), although there's no experience in Ukraine with such ground-mounted systems. Considering the client's wish, more panels would fit on the site, but this entails significant costs. In Consultant's professional opinion, certain provisions need to be made: providing access roads for heavy equipment during the construction phase, as practiced in Europe and Ukraine; ensuring fire access paths according to Ukrainian standards. Comparative table of net present value (NPV) of ballasted panel attachment systems proposed by LtVK and the standard above-ground system is given in the table below.

Table 26: Lutsk; NPV of Ballasted Panel Attachment Systems and Standard Above-Ground System

	Discount rate	4%																				
Ground-Mounted SPP (Standard Construction 1000 kW)																						
Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total NPV	**626 335**																					
CAPEX	**591 000**	600 000																				
OPEX	**35 335**		2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600	2600
Ballasted Solar Power Plant for 1000 kW																						
Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total NPV	**1 079 996**																					
CAPEX	**1 021 558**	1 062 420																				
OPEX	**58 438**		4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300	4300

Additionally, constructing a solar power station on standard structures where the economic and technical benefits are much greater. Consultant recommends to proceed with standard above-ground system as more cheaper in CAPEX and OPEX. Nevertheless, these comments and calculations shall be reconsidered at the next design stage by the design consultant.

Overall, the area receives ample sunlight throughout the day, which is crucial for the efficient functioning of the solar power station. The average distance from the SPP locations to the distribution substation (0.4 kV) is 65 meters. Power cable laying can be done using either underground or overhead methods, which the next consultant should determine through the project.

Figure 10: Lutsk; Location of Hnidavskiy 2-nd Lift PS SPP

Initial Data and Key Characteristics of the Site:

- Geographical Location: Hnidavskyi 2-nd Lift PS
- Solar Insolation in the region of Lutsk City: 1189 W/m².

The following initial data were used for the calculations:

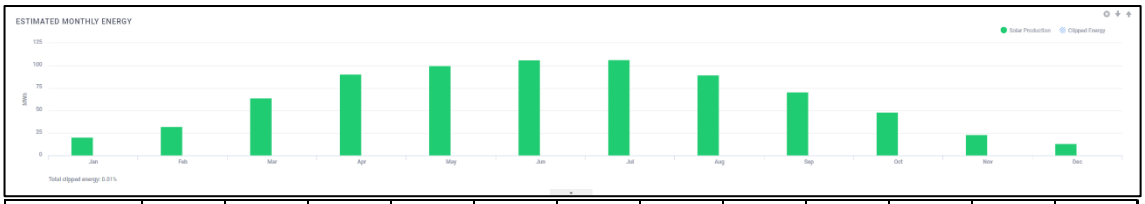
- Area available for solar panel installation: 9000 m²
- Allowed power capacity of the transformer station: 800 kW
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: Grid-tied with generation control system.

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 27: Lutsk; Hnidavskyi 2-nd Lift PS SPP Calculation Results

Installed capacity of solar panels	664 kWp
Maximum AC power output	600 kW
Estimated annual energy production	763 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	20,199	32,01	63,819	90,608	99,948	105,94	106,34	89,357	70,598	48,37	23,308	13,238

Figure 11: Lutsk; Hnidavskyi 2-nd Lift PS SPP Estimated Generation Schedule

SPP Located at Lutsk WWTP

Description of the Site

WWTP for the installation of solar power plant (SPP) is situated within the territory owned by LtVK. The area is large, up to 8500 m². Remarks and characteristics of the site are the same as those of the Hnidavskiy 2-nd Lift PS.
The average distance from SPP locations to the distribution substation 0.4 kV is 300 meters. Power cable laying can be carried out by two methods, underground or overhead on poles.

Figure 12: Lutsk; Location of WWTP SPP

Initial Data and Key Characteristics of the Site:

- Geographical location: Lutsk WWTP
- Solar insolation in the region of Lutsk city: 1189 W/m².

The following initial data were used for the calculations:

- Area available for solar panel installation: 8500 m²
- Allowed power capacity of the transformer station: 1000 kW

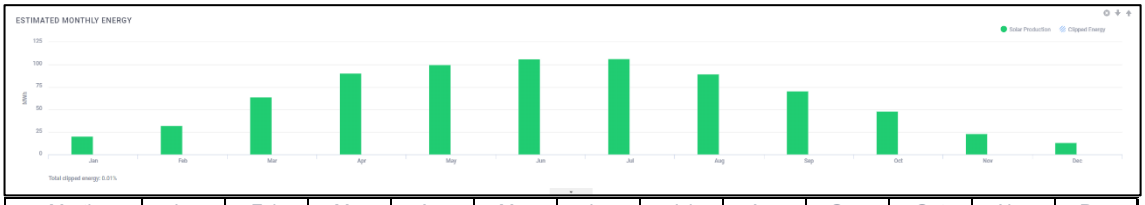
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: Grid-tied with generation control system.

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 28: Lutsk; WWTP SPP Calculation Results

Installed capacity of solar panels	640 kWp
Maximum AC power output	600 kW
Estimated annual energy production	724 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	18,26	29,45	60,07	86,62	96,03	101,8	102,2	85,57	66,95	45,06	20,64	11,83

Figure 13: Lutsk; WWTP SPP Estimated Generation Schedule

5.7 Estimated Budget

Preliminary budget below is based on:

- the Consultant's experience and in-house data for contemporary price level in Ukraine; and
- tender prices of the similar scope for reconstruction of the same four WWPS (from 2019) increased by price correction coefficient 1.5.

Miscellaneous works in the tables below are estimated to 5% of sum of other works.

5.7.1 Measurement campaign for pressure wastewater pipelines

Total cost of measurement campaign for pressure wastewater pipelines is estimated to 50 000 € (excl. VAT), considering:

- two weeks assignment for two international experts and two local experts
- installation of five flow meters and seven pressure sensors each equipped with data loggers.

5.7.2 Reconstruction of WWPS 1

Total cost of reconstruction of WWPS 1 is estimated to 213 000 € (excl. VAT).

Table 29: Lutsk; Detail Cost Estimate of Reconstruction of WWPS 1 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.3	**Reconstruction of WWPS 1**					**213 000**
Lt-1.3.1	Pump: Q=500 m³/h, H=30 m	pcs	1	27 000	9 000	36 000
Lt-1.3.2	Suction and pressure pipelines and valves	lumpsum	1	3 750	1 500	5 250
Lt-1.3.3	Drainage pumps and pressure pipes	pcs	2	3 000	1 500	9 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.3.4	Screening conveyor, press and container	lumpsum	1	15 000	7 500	22 500
Lt-1.3.5	Flow meters	pcs	2	6 000	1 500	15 000
Lt-1.3.6	Electrical works, power supply	lumpsum	1	19 500	7 500	27 000
Lt-1.3.7	Automatic control and SCADA	lumpsum	1	10 500	6 000	16 500
Lt-1.3.8	Civil works	lumpsum	1	40 000	30 000	70 000
Lt-1.3.9	Miscellaneous, 5%	lumpsum	1	7 000	4 000	11 000

5.7.3 Reconstruction of WWPS 2

Total cost of reconstruction of WWPS 2 is estimated to 518 000 € (excl. VAT).

Table 30: Lutsk; Detail Cost Estimate of Reconstruction of WWPS 2 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.2	**Reconstruction of WWPS 2**					**518 000**
Lt-1.2.1	Pump (daytime): Q=900 m³/h, H=42 m	pcs	1	69 000	15 000	84 000
Lt-1.2.2	Pump (nighttime): Q=500 m³/h, H=38 m	pcs	1	25 500	7 500	33 000
Lt-1.2.3	Suction and pressure pipelines and valves	lumpsum	1	15 000	6 000	21 000
Lt-1.2.4	Drainage pumps and pressure pipes	pcs	2	3 000	1 500	9 000
Lt-1.2.5	Electric hoist	pcs	1	7 500	1 500	9 000
Lt-1.2.6	Mechanical screens	pcs	2	30 000	7 500	75 000
Lt-1.2.7	Screening conveyour, press and container	lumpsum	1	15 000	7 500	22 500
Lt-1.2.8	Flow meters	pcs	2	6 000	1 500	15 000
Lt-1.2.9	Electrical works, power supply	lumpsum	1	51 000	22 500	73 500
Lt-1.2.10	Automatic control and SCADA	lumpsum	1	13 500	7 500	21 000
Lt-1.2.11	Replacement of iron steps and platforms	lumpsum	1	45 000	15 000	60 000
Lt-1.2.12	Civil works	lumpsum	1	40 000	30 000	70 000
Lt-1.2.13	Miscellaneous, 5%	lumpsum	1	18 000	7 000	25 000

5.7.4 Reconstruction of WWPS 5

Total cost of reconstruction of WWPS 5 is estimated to 849 000 € (excl. VAT).

Table 31: Lutsk; Detail Cost Estimate of Reconstruction of WWPS 5 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.2	**Reconstruction of WWPS 5**					**849 000**
Lt-1.2.1	Pump (daytime): Q=950 m³/h, H=32 m	pcs	1	82 500	15 000	97 500
Lt-1.2.2	Pump (nighttime): Q=550 m³/h, H=28 m	pcs	1	27 000	7 500	34 500
Lt-1.2.3	Suction and pressure pipelines and valves	lumpsum	1	33 000	13 500	46 500
Lt-1.2.4	Drainage pumps and pressure pipes	pcs	2	3 000	1 500	9 000
Lt-1.2.5	Electric hoist	pcs	2	10 500	3 000	27 000
Lt-1.2.6	Mechanical screens	pcs	2	37 500	15 000	105 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.2.7	Screening conveyour, press and container	lumpsum	1	33 000	13 500	46 500
Lt-1.2.8	Flow meters	pcs	2	9 000	1 500	21 000
Lt-1.2.9	Electrical works, power supply	lumpsum	1	55 500	15 000	70 500
Lt-1.2.10	Automatic control and SCADA	lumpsum	1	13 500	7 500	21 000
Lt-1.2.11	Reconstruction of facades	lumpsum	1	37 500	15 000	52 500
Lt-1.2.12	Other civil works	lumpsum	1	40 000	30 000	70 000
Lt-1.2.13	Reconstruction of gravity sewer (incl. chambers)	lumpsum	1	99 000	15 000	114 000
Lt-1.2.14	Reconstruction of pressure sewers (incl. chambers)	lumpsum	1	37 500	10 500	48 000
Lt-1.2.15	Site works	lumpsum	1	30 000	15 000	45 000
Lt-1.2.16	Miscellaneous, 5%	lumpsum	1	31 000	10 000	41 000

5.7.5 Reconstruction of WWPS 3

Total cost of reconstruction of WWPS 3 is estimated to 358 000 € (excl. VAT).

Table 32: Lutsk; Detail Cost Estimate of Reconstruction of WWPS 3 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.1	**Reconstruction of WWPS 3**					**358 000**
Lt-1.1.1	Pumps: Q=500 m³/h, H=22 m	pcs	2	19 500	9 000	57 000
Lt-1.1.2	Suction and pressure pipelines and valves	lumpsum	1	12 000	6 000	18 000
Lt-1.1.3	Drainage pumps and pressure pipes	pcs	2	3 000	1 500	9 000
Lt-1.1.4	Mechanical screens	pcs	2	30 000	13 500	87 000
Lt-1.1.5	Screening conveyour, press and container	lumpsum	1	15 000	7 500	22 500
Lt-1.1.6	Flow meters	pcs	2	6 000	1 500	15 000
Lt-1.1.7	Electrical works, power supply	lumpsum	1	30 000	13 500	43 500
Lt-1.1.8	Automatic control and SCADA	lumpsum	1	10 500	7 500	18 000
Lt-1.1.9	Civil works	lumpsum	1	40 000	30 000	70 000
Lt-1.1.10	Miscellaneous, 5%	lumpsum	1	12 000	6 000	18 000

5.7.6 Reconstruction of Central Valve Chamber on Wastewater System

Total cost of reconstruction of central valve chamber is estimated to 182 000 € (excl. VAT).

Table 33: Lutsk; Detail Cost Estimate of Reconstruction of Central Valve Chamber (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.5	**Reconstruction of Central Valve Chamber on Wastewater System**					**182 000**
Lt-1.5.1	Valve chamber	pcs	1	7 500	4 500	12 000
Lt-1.5.2	Pressure pipelines and valves	lumpsum	1	100 000	25 000	125 000
Lt-1.5.3	Other civil works	lumpsum	1	3 000	7 500	10 500
Lt-1.5.4	Electrical works, power supply	lumpsum	1	7 500	4 500	12 000
Lt-1.5.5	Automatic control and SCADA	lumpsum	1	7 500	4 500	12 000
Lt-1.5.6	Miscellaneous, 5%	lumpsum	1	7 000	3 000	10 000

5.7.7 New Central SCADA system

Total cost of new central SCADA system is estimated to 200 000 € (excl. VAT).

5.7.8 Installation of SPP at Hnidavskiy 2-nd Lift PS and at WWTP

Assessing the cost not only allows for accurate determination of financial expenses but also ensures the economic efficiency of the project. Below Consultant's considers the cost assessment process based on his personal experience and current average prices in the Ukrainian market. Additionally, the developed cost calculations for the SPP have been approved by the water utility, adding further reliability to the obtained results.

The main components of a solar power station include:

- Solar panels - converting sunlight into direct current;
- Inverters - converting the direct current generated by the panels into alternating current, which can be used in the electrical grid;
- Mounting systems - structures for panel mounting;
- Cables and connectors - for component connection;
- Monitoring and control systems - for tracking and managing SPP operation;
- Civil and site works.

To assess the cost, average prices in the Ukrainian market are used.

Total cost of installation of SPP is estimated to 972 000 € (excl. VAT).

Table 34: Lutsk; Detail Cost Estimate of Installation of SPP at Hnidavskiy 2-nd lift PS and at WWTP (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lt-1.7.1	**Installation of solar panels at Hnidavskiy 2-nd lift PS (664 kW)**					**486 000**
Lt-1.7.1.1	Civil works	lumpsum	1	90 000	34 500	124 500
Lt-1.7.1.2	PV panels [664 kW]	pcs	1145	140	30	194 650
Lt-1.7.1.3	Inverters [600 kW]	lumpsum	1	37 700	3 700	41 400
Lt-1.7.1.4	Electrical works, power supply	lumpsum	1	38 000	16 000	54 000
Lt-1.7.1.5	Automatic control and SCADA	lumpsum	1	7 500	4 000	11 500
Lt-1.7.1.6	Site works	lumpsum	1	24 000	11 500	35 500
Lt-1.7.1.7	Miscellaneous, 5%	lumpsum	1	18 000	6 000	24 000
Lt-1.7.2	**Installation of solar panels at WWTP (640 kW)**					**486 000**
Lt-1.7.2.1	Civil works	lumpsum	1	86 000	33 000	119 000
Lt-1.7.2.2	PV panels [640 kW]	pcs	1105	140	30	187 850
Lt-1.7.2.3	Inverters [600 kW]	lumpsum	1	37 700	3 700	41 400
Lt-1.7.2.4	Electrical works, power supply	lumpsum	1	48 000	19 500	67 500
Lt-1.7.2.5	Automatic control and SCADA	lumpsum	1	7 500	4 000	11 500
Lt-1.7.2.6	Site works	lumpsum	1	23 000	11 000	34 000
Lt-1.7.2.7	Miscellaneous, 5%	lumpsum	1	18 000	6 000	24 000

5.8 Final Reviewed Investment Programme

At the Investment Programme meeting on 24.05.2024 (see MoM in Annex 3.2) it was agreed that Reviewed Proposed Investment Programme (see Chapter 5.5) by the Consultant will be accepted.

Nevertheless, at the follow-up meeting on 29.05.2024 LtVK decided to reduce from proposed reviewed investment programme measurement campaign for pressure sewers, i.e. pump parameters shall be according to the design documents.

And moreover, because of budget restrictions reconstruction of WWPS 3 and WWPS 5 were moved under the 2nd priority project Lt-2. So, the 1st Priority Project Lt-1 will have total cost estimate of 2 711 000 € (excl. VAT).

Table 35: Lutsk; Total Cost Estimate of the 1st Priority Project Lt-1

No	Item	Cost Estimate, EUR
Lt-1.1	Reconstruction of WWPS 2	518 000
Lt-1.2	Reconstruction of WWPS 1	213 000
Lt-1.3	Reconstruction of Central Valve Chamber	182 000
Lt-1.4	New Central SCADA system	200 000
Lt-1.5	Installation of alternative power sources	972 000
Lt-1.5.1	Installation of solar panels at Hnidavskiy 2-nd lift PS (664 kW)	486 000
Lt-1.5.2	Installation of solar panels at WWTP (640 kW)	486 000
Lt-1.6	**Subtotal**	**2 085 000**
Lt-1.7	Design and cost estimate documentation 10%	209 000
Lt-1.8	Contingency 20%	417 000
Lt-1.9	**Total**	**2 711 000**

Table 36: Lutsk; Total Cost Estimate of the 2nd Priority Project Lt-2

No	Item	Cost Estimate, EUR
Lt-2.1	Reconstruction of WWPS 3	358 000
Lt-2.2	Reconstruction of WWPS 5	849 000
Lt-2.3	**Subtotal**	**1 207 000**
Lt-2.4	Design and cost estimate documentation 10%	121 000
Lt-2.5	Contingency 20%	241 000
Lt-2.6	**Total**	**1 569 000**

5.9 Investment Programme Benefits and Savings

Below the benefits and savings of finally proposed project (Lt-1) are established.

5.9.1 Benefits and Savings of 1st Priority Project Lt-1

Reconstruction of WWPS 1 and WWPS 2

By installing new, more efficient (and more precisely selected) pumps, the pumping efficiency at two WWPS is expected to be improved by 54%. For comparison of pumping efficiency International Water Association (IWA**)** recommends to use **Ph5 energy consumption** (kWh/m³/100 m)[13]: unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m. For the reference of new efficient pumps, the value of 0.41 kWh/m³ is used in Table 37 below.

Potential annual savings in power consumption compared to the baseline (i. e. pumping of the same amount of water) for WWPS 1 and WWPS 2 are estimated to 984 327 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

Table 37: Lutsk; Savings on Pump Efficiency Improvement

Parameter	Unit	Total	WWPS 1	WWPS 2	WWPS 5	WWPS 3
Existing baseline (Consultant's estimate, see Chapter)						
Existing total flow (Consultant's estimate)	m³/year	13 200 833	1 034 167	4 380 000	6 083 333	1 703 333
	m³/h	1 507	118	500	694	194
Existing raising head	m w. g.	38	33	53	33	22
Consumed power	kWh/year	3 864 561	217 906	1 591 403	1 739 727	315 525
	kWh/m³	0.29	0.21	0.36	0.29	0.19
	kWh/m³/100m	0.77	0.64	0.69	0.87	0.84

[13] Key performance Indicator (KPI) recommended by IWA-PI (International Water Association Performance Indicator)

Designed pumps						
Designed raising head	m w. g.	31	27	40	28	22
Pumping flow	m^3/h		640	996	1 209	500
Pumping power	kW		72	161	139	45
Pumping time	h/year		1 616	4 399	5 034	3 407
Consumed power	kWh/year	1 677 873	115 655	709 327	699 719	153 172
	kWh/m^3	0.13	0.11	0.16	0.12	0.09
	$kWh/m^3/100m$	0.41	0.41	0.40	0.41	0.41
Savings compared to existing baseline	kWh/year	**2 186 688**	102 251	882 076	1 040 008	162 353
	€/year[14]	**349 870**	16 360	141 132	166 401	25 976

The power savings at two WWPS described above will result in annual reduction of CO_{2eqv} in the amount of 788 000 kg/year. The CO_{2eqv} reduction was calculated considering 0.8 kg/kWh carbon intensity of Ukraine's power mix.

5.9.2 Installation of SPP at Hnidavskyi 2-nd Lift PS

Initial Data:

- Annual energy production: 763 MWh (which covers 4.3% of total energy consumed by water utility. Both SPPs will cover 8.4%).
- CO_2 emissions reduction: 610 tons per year.
- Estimated cost of the solar power plant: 486 000 € (excl. VAT).

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 763 MWh, savings on electricity are estimated in Chapter 5.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 610 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 486 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 5.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

[14] Monetary value of savings is calculated with assumed power tariff 0.16 €/kWh.

5.9.3 Installation of SPP at WWTP

Initial Data:

- Annual energy production: 724 MWh (which covers 4.1% of total energy consumed by water utility. Both SPPs will cover 8.4%).
- CO_2 emissions reduction: 580 tons per year.
- Estimated cost of the solar power plant: 486 000 € (excl. VAT).

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 724 MWh, savings on electricity be estimated in Chapter 5.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 580 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 486 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 5.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

5.10 Financial Analysis

Total budget for reconstruction of two wastewater pumping stations and installing of alternative power sources in Lutsk is **2.711 M€** (without VAT).

Potential savings in electric energy from more efficient pumping stations (WWPS 1 and 2) is accounted for **984 MWh** per year, which makes total annual saving as of 0.157 M€ (energy price estimated to be 0.16 € per kWh, without VAT).

Potential savings from installation of solar panels (e.g estimated production of electric energy from SPP at Hnidavskyi 2-nd lift PS and WWTP) are as following:

- SPP1 – production of solar energy from panels at Hnidavskyi 2-nd lift PS is 763 MWh per year.
- SPP2 – production of solar energy from panels at WWTP is 724 MWh per year.

That means that in total production of electric energy from solar panels is 1 487 MWh per year. Therefore, total saving from production of solar energy for enterprise´s internal purposes and

therefore substituting energy purchase from networks is 0.238 M€ (energy price estimated to be 0.16 € per kWh or 160 € per MWh, without VAT).

Combining both factors of electric energy savings, we can estimate total impact on enterprise`s energy consumption to be as much as **0.395 M€ per year**.

Regarding investment other savings cannot be monetarised in reasonable extent as they are not substantial in estimating cost effectiveness of investment.

Therefore, **payback time without grant** for the whole investment would be **6.9 years**, which is considered too long in terms of economic risks associated with on-going war and average time span of commercial loans.

Therefore, additional grant is needed for economic viability of investment. Considering co-financing rate (20 %) for municipal water enterprise funds the **payback time** will be much shorter – **1.4 years** for equity invested, which is economically reasonable for water enterprise.

6 Lubny

6.1 Existing Water Supply and Wastewater Services

6.1.1 Lubny General Information

Lubny is a city in the Poltava region of Ukraine. Administrative center of Lubensky district. Until 2020, it was a city of regional subordination, part of the Lubensky City Council. The city of Lubny is located on the right bank of the Sula River. The city was founded more than 1000 years ago.

The largest enterprises: machine tool plant, machine-building plant, pharmaceutical factory, brick factory, Lubny Dairy Plant, Lubny Bread Factory, there is also a printing house "Lubny". The city's economy is based on small businesses, entrepreneurs, trade and tourism.

The population of Lubny is 44 089. During the russian aggression war, it has received 9 842 internally displaced persons (IDP).

6.1.2 WS and WW Services

Centralized water supply services to the population are provided around the clock.

The first water supply system was founded in the city in 1912.

The city of Lubny has one source of water supply - underground artesian wells. Domestic and drinking water is taken in by 42 bore wells from the Buchachko-Kaniv aquifer. The average depth of which is from 100 to 190 m. The average productivity of water intake is 6.4 thousand m^3/day.

The city's water supply system includes 3 water intakes and pumping stations (WPS) and 5 booster pumping stations of the third lift (BPS).

The total length of water supply networks is 122 km.

The wastewater system in the city of Lubny consists of 12 wastewater pumping stations (WWPS). With a total capacity of 7130 m^3/d and wastewater treatment plants (WWTP) No: 1 and No: 2. Total length of pressure and gravity sewage collectors is 58 km.

The design capacity of WWTP no: 1 is 6600 m^3/d, while actual loading today is 1700 – 1800 m^3/d. The design capacity of WWTP no: 2 is 5680 m^3/d. while actual loading today is - 1200 - 1300 m^3/d.

Wastewater treatment is carried out at WWTP no: 1 according to the following scheme: receiving chamber - sand traps - primary settling tanks - clarifiers - aeration tanks - secondary settling tanks - chlorination plant - discharge collector - discharge channel - Sula river.

Wastewater treatment is carried out at WWTP no: 2 according to the following scheme: receiving chamber - sand traps - primary settling tanks - biofilters - secondary settling tanks - chlorination plant - discharge collector - discharge channel - Sula river.

Disinfection of wastewater at treatment facilities is carried out with sodium hypochlorite, which is produced during the operation of block electrolysis plant "Flame -2".

To date, the treatment facilities of KP "Lubny-vodokanal" (LbVK) receive household wastewater from the population of the city of Lubny with a higher concentration of orthophosphates and ammonium nitrogen, and therefore it is necessary to carry out tertiary treatment of wastewater at the WWTP No: 1 and No: 2. Since the commissioning, no reconstruction of treatment facilities of KP "Lubny-Vodokanal" was carried out (WWTP no: 1 - put into operation in 1976, WWTP no: 2 - 1968).

After treatment, the wastewater is discharged through a discharge reinforced concrete collector into a discharge channel with a length of about 6 km, built in the 1970s and 80s on the site of the old natural channel (brooks, streams) of the Sula River. The collector and canal, outside the city of Lubny, passes through the territory of the village. Terny Canal flows into the Sula River between the village of Thorns and Vyazok, Lubensky district.

In the process of operation, the discharge channel became polluted with wastewater sediments, in some places it is overgrown with bushes, and it was covered with fallen trees. Channel capacity has slowed down. Wastewater, passing through the channel in the hot summer season, rots, polluting the environment. Measures to clean the discharge channel and bring it to a proper sanitary condition have not been taken in recent decades.

There is equipment (pumps, shut-off valves, combs, etc.) in operation at the WWPS that is more than 20 years old and which is already obsolete both in the moral sense and in the physical plan. The energy consumption of this equipment significantly exceeds the indicators of modern equipment.

6.1.3 Measures completed by NIP I Water Programme

NIP Water Programme, financed by NIP (the Neighbourhood Investment Platform – EU financing initiative), is aimed at increasing of energy efficiency of water supply and sewage sector in 6 cities – Lutsk, Khmelnytskyi, Lubny, Horishni Plavni, Fastiv and Berdychiv. Implementation of Project Component 1 began in 2019 and is under implementation.

The planned investments are targeted in increasing the energy efficiency and in increasing the stability and efficiency in operation of water supply system. The planned investments were the following:

- Reconstruction of bore wells and 2nd lift water supply pumping stations, including replacement of water supply pumps
- Reconstruction of water distribution networks
- Installation of power cable.

The works were tendered and contract was signed. However, no work was commenced before 24 February 2022, beginning of the russian aggression against Ukraine. Due to consequent price increase reconstruction of water distribution networks and installation of power cable were removed from the scope of work.

The remaining scope of reconstruction of bore wells and 2nd lift water supply pumping stations was fully completed by the end of May 2024.

6.2 Preliminary Proposed investment Programme

At the kick-off meeting (see MoM in Annex 1.3) Lubny Water Utility (LbVK) and Municipality (LbM) proposed the following investment programme:

- Replacement of main process equipment (pumps, valves, screens etc) on the 12 wastewater pumping stations (WWPS);
- Installation on these WWPS soft starters and automatic control units;
- Reconstruction of structures of these WWPS;
- Installation of alternative power sources (solar panels) at these WWPS and at wastewater treatment plant (WWTP);
- Installation of SCADA system and integration of it with existing SCADA;
- Cleaning of WWTP's discharge channel (length appr. 6 km) in accordance with existing sanitary standards.

6.3 Data Collection

Consultant issued the Questionnaires concerning technical issues (at 08.04.24, 26.04.24) and Social and Economic issues (at 08.04.24).

6.4 Analysis of Collected Data

Cleaning of WWTP's discharge channel was not considered as part of the investment programme, because:

- it does not correspond to the objectives of the programme;
- it is more of an operational activity than an investment;
- the primary measure should be the modernization of WWTP plants and only then the installation of the outlet.

According to the information received from LbVK the pressure sewers are as following:

- WWPS 1 has two operational parallel pressure sewers DN 250 (material: cast iron). Each with length 2090 m. Both constructed in 1972;
- WWPS 2 has pressure sewer DN 250 (material: cast iron), length 1380 m. Constructed in 1972;
- WWPS 3 has pressure sewer DN 200 (material: cast iron), length 407 m. Constructed in 1972;
- WWPS 3A has pressure sewer DN 300 (material: cast iron), length 875 m. Constructed in 1972;
- WWPS 4 has pressure sewer DN 400 (material: cast iron), length 1320 m. Constructed in 1972;
- WWPS 4A has pressure sewer DN 300 (material: cast iron), length 1090 m. Constructed in 1972;
- WWPS 5 has two operational parallel pressure sewers DN 150 (material: cast iron). Each with length 1270 m. Both constructed in 1972;
- WWPS 6 has two operational parallel pressure sewers DN 150 (material: cast iron). Each with length 1134 m. Both constructed in 1972;
- WWPS 7 has pressure sewer DN 100 (material: cast iron), length 491 m. Constructed in 1972;
- WWPS 8 has pressure sewer DN 200 (material: PVC), length 1061 m. Constructed in 1972;
- WWPS 9 has pressure sewer DN 200 (material: cast iron), length 361 m. Constructed in 1972;
- WWPS 10 has two operational parallel pressure sewers DN 250 (material: cast iron). Each with length 1359 m. Both constructed in 1972;

The total accident rate of pressure and gravity collectors is 40-50 accidents per year.

Table 38: Lubny; Parameters and operational data of WW pumps

WWPS	Pressure, m	Amount of WW to be pumped t. m^3/ year	Electricity consumption, MWh/year
WWPS 1 (КНС №1)	15	87.4	24.0
WWPS 2 (КНС №2)	15	40.8	11.5
WWPS 3 (КНС №3)	15	557.1	153.6
WWPS 4 (КНС №4)	15	657.0	180.0
WWPS 5 (КНС №5)	15	41.5	11.6
WWPS 6 (КНС №6)	15	14.8	6.0
WWPS 7 (КНС №7)	15	19.8	0.84
WWPS 8 (КНС №8)	15	102.6	24.0
WWPS 9 (КНС №9)	15	7.1	3.0
WWPS 10 (КНС №10)	15	37.8	10.5
WWPS 3A (КНС №3A)	15	328.5	88.8
WWPS 4A (КНС №4A)	15	474.5	129.6

For comparison of pumping efficiency International Water Association (IWA) recommends to use **Ph5** energy consumption (kWh/m³/100 m): unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m.

As it can be seen from the Table below, installed wastewater pumps are very much inefficient[15]. Only standard energy consumption of WWPS 7 is close to ideal. The average efficiency 1.18 kWh/m³/100 m is three times more than it should be.

Table 39: Lubny; Pumping Effiency Analysis

	Pumped water volume	Average pressure	Consumed power	Unitary energy consumption	Standard energy consumption
	m³/year	m	kWh/year	kWh/m³	kWh/m³/100 m
Total	**2 368 900**	**26.24**	**732 240**	**0.31**	**1.18**
WWPS 10 (KHC-10)	37 800	22.20	10 500	0.28	1.25
WWPS 2 (KHC-2)	40 800	23.60	11 500	0.28	1.19
WWPS 5 (KHC-5)	41 500	37.20	11 600	0.28	0.75
WWPS 1 (KHC-1)	87 400	35.20	24 000	0.27	0.78
WWPS 9 (KHC-9)	7 100	11.10	3 000	0.42	3.81
WWPS 8 (KHC-8)	102 600	14.80	24 000	0.23	1.58
WWPS 7 (KHC-7)	19 800	10.00	840	0.04	0.42
WWPS 3 (KHC-3)	557 100	30.50	242 400	0.44	1.43
WWPS 4 (KHC-4)	657 000	23.20	180 000	0.27	1.18
WWPS 4A (KHC-4A)	474 500	31.00	129 600	0.27	0.88
WWPS 6 (KHC-6)	14 800	45.00	6 000	0.41	0.90
WWPS 3A (KHC-3A)	328 500	19.30	88 800	0.27	1.40

6.5 Reviewed Investment Programme

Because the maximum limit of the project cost 5 M€ should not be exceeded, the Consultant proposed to divide the preliminary scope into 2 projects:

- **1st priority project Lb-1** with total cost estimate 4.997 M€ (excl. VAT):
  - Reconstruction of WWPS 10 (incl. reconstruction of pressure sewer), 1 (incl. reconstruction of pressure sewer), 8, 3, 3A, 4 and 4A
  - Installation of SPP:
    - SPP at WWPS 10 near WPS3 (260 kW)
    - SPP at WWTP (400 kW)
- **2nd priority project Lb-2** with total cost estimate 2.892 M€ (excl. VAT):
  - Reconstruction of WWPS 5 (incl. reconstruction of pressure wastewater pipeline), 9 (incl. reconstruction of pressure wastewater pipeline), 7, 6 (incl. reconstruction of pressure wastewater pipeline) and 2 (incl. reconstruction of pressure wastewater pipeline).

6.6 Dimensioning of the Investment Programme

Below the dimensioning of the pumps is given. This dimensioning is preliminary and used only for compilation of cost estimates. More detail and precise parameters of investment programme components (i. e. pump capacity, pipe diameter etc) will be established at the next design stage.

[15] Of course the volume of pumped water is estimated based on pumping hours, therefore the calculated efficiency should be treated with reservation

Pumping capacity (second column in the Table below) has been taken as it was for year 2023. This value was declared by LbVK and it has been estimated based on pump's working hours. For dimensioning value, the annual flow was taken and multiplied by maximum flow coefficients: maximum day 2.0 and maximum hour at maximum day 3.0. All together maximum hour flow is 6 times higher than the annual average.

Table 40: Lubny; Dimensioning of WWPS

	Pumping capacity, l/s	Pressure sewer DN	Pressure sewer length, m	Flow Velocity, m/s	Pumping head, m	Pressure losses, m	Geodetic head, m	Pumping power, kW
WWPS 10 (KHC-10)	8.33	100 (250)	1359	0.88	22.2	16.7	5.5	4
it is suggested not to use the second pipe		250	1359					
WWPS 2 (KHC-2)	8.33	100 (250)	1380	0.88	23.6	17.6	6.0	4
WWPS 5 (KHC-5)	8.33	100 (150)	1270	0.88	37.2	16.2	21.0	6
it is suggested not to use the second pipe		150	1270					
WWPS 1 (KHC-1)	16.63	150 (250)	2090	0.94	35.2	20.2	15.0	11
it is suggested not to use the second pipe		250	2090					
WWPS 9 (KHC-9)	5.00	90 (200)	361	0.75	11.1	5.1	6.0	1
WWPS 8 (KHC-8)	19.52	200	1061	0.62	14.8	4.8	10.0	6
WWPS 7 (KHC-7)	5.00	90 (100)	491	0.79	10.0	6.0	4.0	1
WWPS 3 (KHC-3)	105.56	200	407	3.37	34.1	23.6	10.5	71
WWPS 4 (KHC-4)	125.00	400	1320	0.99	23.2	11.2	12.0	57
WWPS 4A (KHC-4A)	92.22	300	1090	1.32	32.0	20.0	12.0	58
WWPS 6 (KHC-6)	5.00	90 (150)	1134	0.79	45.0	14.0	31.0	4
it is suggested not to use the second pipe		150	1134					
WWPS 3A (KHC-3A)	92.22	300	875	1.32	22.8	12.3	10.5	41

6.6.1 Reconstruction of 12 WWPS

in Lubny Wastewater pumping stations were built between 1972 and 1993 according to Soviet typical design. The pumping stations consist of an underground cylindrical part, which contains a sewage receiving tank and a pump room, and an above-ground building.

The condition of all the WWPS is very poor - the structures are damaged, the ventilation equipment is worn out, the pipelines are damaged by corrosion. This was also confirmed by the Consultant's at the site visit. There is no SCADA system in the WWPS.

The consultant recommends installing prefabricated pumping stations in the existing underground reservoirs of pumping stations, where submersible pumps would be installed.

At the WWPS 3, 3A, 4, 4A it is recommended to also install wastewater grinders, which can be installed in separate PE tanks / chambers. It is proposed to demolish the above-ground pumping station buildings.

It is recommended to reconstruct large diameter pressure lines into smaller diameter ones - PE pipes to be added to the existing pipeline to ensure adequate flow rates.

WWPS 3A pumps are proposed to move into WWPS 3 well. Gravity and pressure sewers should be switched accordingly.

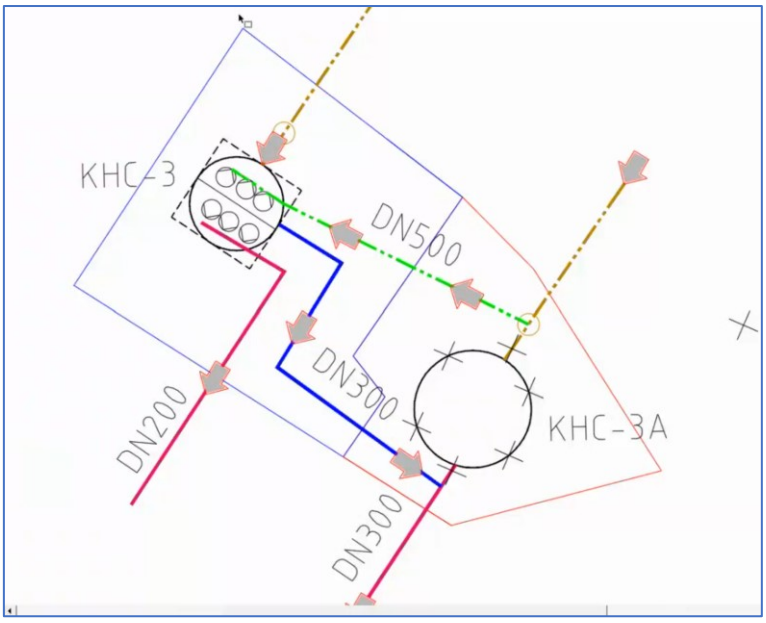


Figure 14: Lubny; Reconstruction of WWPS 3 and 3A

Smaller WWPS will have 2 pumps installed in parallel (one operational, the other stand-by). Larger WWPS (nos: 3, 3A, 4 and 4A) will have 3 pumps (2 operational, the third stand-by).

Despite the Consultant's calculations (see Table 40) LbVK suggests to increase the planned capacity to the following values:

- WWPS 3 - 200 m³/h;
- WWPS 3a - 175 m³/h;
- WWPS 4 - 230 m³/h;
- WWPS 4a - 175 m³/h.

6.6.2 Installation of SCADA

During the reconstruction of WS bore wells and 2nd lift pumping stations (see Chapter 6.1.3) the SCADA system was installed. The SCADA for reconstructed WWPS should be integrated into this existing system. This SCADA system should not only collect and display operational data from WWPS but also should provide the capability for active process management, i.e. control of pumps, valves, ventilation systems etc.

6.6.3 Installation of SPP at WWPS 10 and at WWTP

Due to the need to reduce energy costs and implement energy-saving technologies, the water utility has decided, with the consultant's advice, to install solar power stations. This initiative will contribute to reducing electricity expenses and enhancing the environmental safety of the enterprise.

WWTP site for installing the solar power plant (SPP) is situated within the water utility's territory. The designated area spans 4000 m². The terrain is moderately flat, but there are small trees and other obstacles present that may cast shadows. Overall, the area receives ample sunlight throughout the day, which is crucial for the effective operation of the solar power station. The average distance from the SPP locations to the distribution substation (DS) of 0.4 kV is 50 meters. Power cable laying can be done using two methods: underground or overhead on poles; the choice will be determined by the subsequent consultant through the project.

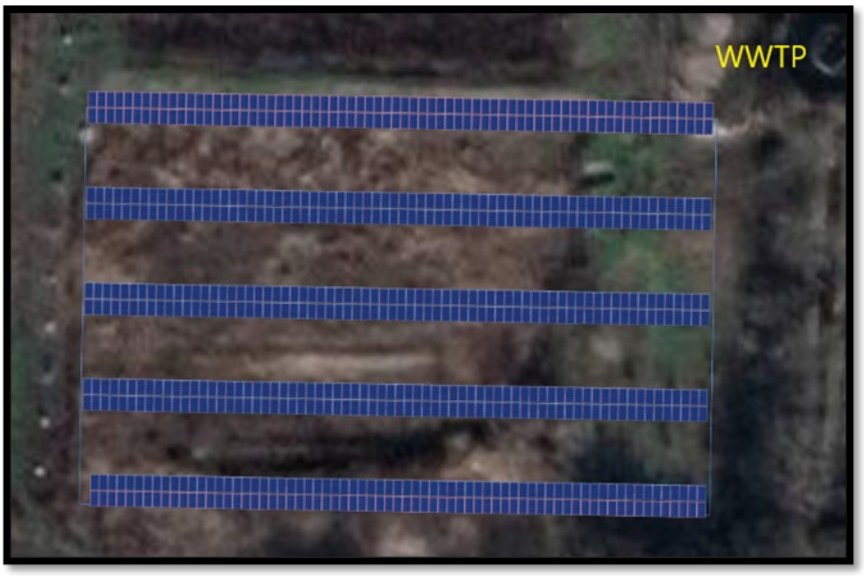


Figure 15: Lubny; Location of WWTP SPP

After reviewing the WWPS facilities proposed by the water utility in the city of Lubny, it was decided to install a solar power station only at two locations: WWTP and WWPS 10. It has been found that other facilities, including 12 pcs of WWPS, have limited potential for such measures due to their age and poor roof condition. Before installing solar power stations, a thorough technical assessment of the roof condition is required, as many of them require reconstruction and relocation of ventilation shafts. Additionally, factors such as limited area and shading from surrounding buildings and trees need to be taken into account. Therefore, the decision was made not to install solar power stations at each WWPS, as this is not a viable and cost-effective step.

At the WWPS 10 (near WPS 3) location, backup power supply needs to be provided as it is critical for the city. WPS 3 has 4 pumps: one operating at night, two during the day, and one reserve pump. Ensuring power supply to this pump group is critical. The daytime pumps have a total power of 44 kW, the nighttime pump – 12 kW, and the reserve pump – 45 kW. A decision was made, given its importance to the city, to propose a hybrid system that can minimize power outages for 11 hours and ensure the operation of daytime pumps, without considering panel generation. Considering overcast days and snow-covered panels, which generate very little, it was decided to install hybrid inverters of 200 kW, battery systems of 480 kWh, and 260 kW peak panels. This system will be able to continuously supply these pumps and cover consumption not only for WPS 3 but also for WWPS 10.

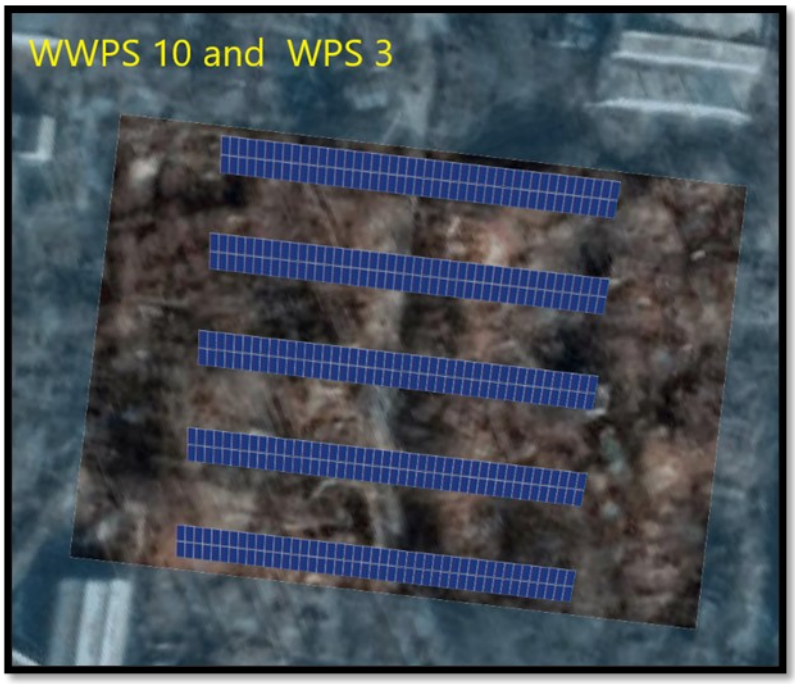


Figure 16: Lubny; Location of WWPS 10 SPP

Input Data and Main Object Characteristics:

- Geographical Location: WWTP
- Solar Insolation in the region of Lubny City: 1210 W/m²

For the calculations, the following input data were used:

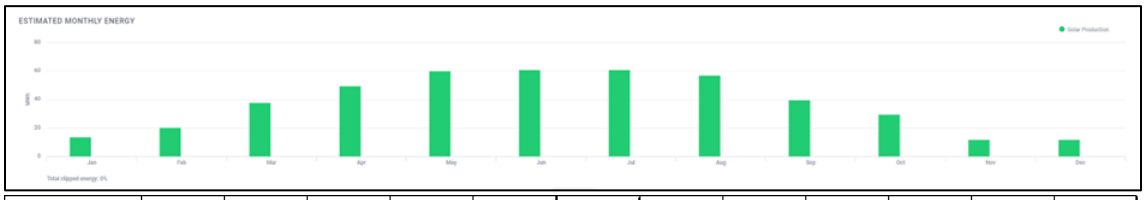
- Area available for solar panel installation: 4000 m²
- Allowed power capacity of the transformer station: 360 kW
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: Grid-tied with generation control system

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 41: Lubny; WWTP SPP Calculation Results

Installed capacity of solar panels	400 kWp
Maximum AC power output	350 kW
Estimated annual energy production	452 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	13,73	20,26	37,83	49,47	59,87	60,93	60,75	56,87	29,41	29,41	12,06	12,04

Figure 17: Lubny; WWTP SPP Estimated Generation Schedule

Input Data and Main Object Characteristics:

- Geographical Location: WWPS 10 (near WPS 3)
- Solar Insolation in the region of Lubny City: 1210 W/m²

For the calculations, the following input data were used:

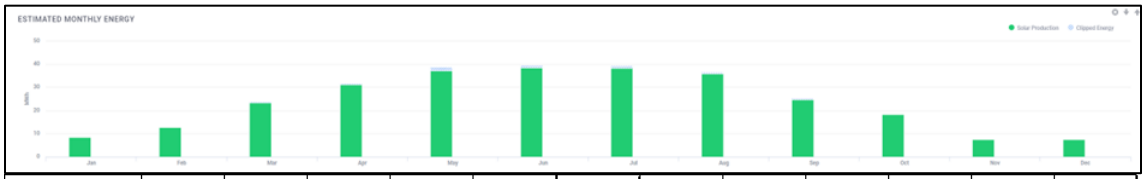
- Area available for solar panel installation: 6 400 m²
- Allowed power capacity of the transformer station: 200 kW
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: hybrid system with generation and backup power management system.

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 42: Lubny; WWTP SPP Calculation Results

Installed capacity of solar panels	260 kWp
Maximum AC power output	200 kW
Battery Pack	480 kWh
Critical reserve time	11 h
Estimated annual energy production	282 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	8,441	12,64	23,392	31,203	37,066	38,429	38,154	35,741	24,633	18,202	7,424	7,49

Figure 18: Lubny; WWPS 10 SPP Estimated Generation Schedule

More detailed calculations should be taken into account by the next consultant in the project.

6.7 Estimated Budget

Preliminary budgets below are based on the Consultant's experience and in-house data for contemporary price level in Ukraine.

Miscellaneous works in the tables below are estimated to 5% of sum of other works.

6.7.1 Reconstruction of 12 WWPS

Below detail cost estimates for each WWPS is given.

Table 43: Lubny; Detail Cost Estimate of construction of WWPS 3 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-1.1	**Total**					**434 000**
Lb-1.1.1	**Construction of new WWPS at the same site**					**434 000**
Lb-1.1.1.1	Civil works	lumpsum	1	30 000	65 000	95 000
Lb-1.1.1.2	Pumps: Q=200 m³/h, H=34 m, 71 kW	pcs	3	22 000	6 000	84 000
Lb-1.1.1.3	Other mechanical works	lumpsum	1	40 000	28 000	68 000
Lb-1.1.1.4	Electrical works, power supply	lumpsum	1	40 000	18 000	58 000
Lb-1.1.1.5	Automatic control and SCADA	lumpsum	1	20 000	15 000	35 000
Lb-1.1.1.6	HVAC	lumpsum	1	0	0	0
Lb-1.1.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-1.1.1.8	Site works	lumpsum	1	20 000	38 000	58 000
Lb-1.1.1.9	Dismounting of existing WWPS	lumpsum	1	0	15 000	15 000
Lb-1.1.1.10	Miscellaneous, 5%	lumpsum	1	11 000	10 000	21 000

Table 44: Lubny; Detail Cost Estimate of reconstruction of WWPS 3A (excl. VAT)

Pos. No.	Item	Unit	Quan -tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-1.4	**Total**					**413 000**
Lb-1.4.1	**New equipment is being installed in the reconstructed pumping station KHC-3. The pump is dismantled. Pipelines are switched.**					**276 000**
Lb-1.4.1.1	Civil works	lumpsum	1	0	15 000	15 000
Lb-1.4.1.2	Pumps: Q=175 m³/h, H=23m, 41,0 kW	pcs	3	18 000	6 000	72 000
Lb-1.4.1.3	Other mechanical works	lumpsum	1	35 000	20 000	55 000
Lb-1.4.1.4	Electrical works, power supply	lumpsum	1	30 000	18 000	48 000
Lb-1.4.1.5	Automatic control and SCADA	lumpsum	1	7 000	5 000	12 000
Lb-1.4.1.6	HVAC	lumpsum	1	0	0	0
Lb-1.4.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-1.4.1.8	Site works	lumpsum	1	0	35 000	35 000
Lb-1.4.1.9	Dismounting of existing WWPS	lumpsum	1	0	25 000	25 000
Lb-1.4.1.10	Miscellaneous, 5%	lumpsum	1	7 000	7 000	14 000
Lb-1.4.2	**Switching of sewage networks (DN500-300)**	**m**	**200**	**260**	**425**	**137 000**

Table 45: Lubny; Detail Cost Estimate of construction of WWPS 4 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate,
Lb-1.2	**Total**					**448 000**
Lb-1.2.1	**Construction of new WWPS at the same site**					**448 000**
Lb-1.2.1.1	Civil works	lumpsum	1	30 000	65 000	95 000
Lb-1.2.1.2	Pumps: Q=230 m³/h, H=25m, 57,0 kW	pcs	3	22 000	6 000	84 000
Lb-1.2.1.3	Other mechanical works	lumpsum	1	40 000	30 000	70 000
Lb-1.2.1.4	Electrical works, power supply	lumpsum	1	42 000	25 000	67 000
Lb-1.2.1.5	Automatic control and SCADA	lumpsum	1	22 000	15 000	37 000
Lb-1.2.1.6	HVAC	lumpsum	1	0	0	0
Lb-1.2.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-1.2.1.8	Site works	lumpsum	1	20 000	38 000	58 000
Lb-1.2.1.9	Dismounting of existing WWPS	lumpsum	1	0	15 000	15 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate,
Lb-1.2.1.10	Miscellaneous, 5%	lumpsum	1	11 000	11 000	22 000

Table 46: Lubny; Detail Cost Estimate of construction of WWPS 4A (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-1.3	**Total**					**420 000**
Lb-1.3.1	**Construction of new WWPS at the same site**					**420 000**
Lb-1.3.1.1	Civil works	lumpsum	1	30 000	65 000	95 000
Lb-1.3.1.2	Pumps: Q=175 m³/h, H=32 m, 58,0 kW	pcs	3	20 000	6 000	78 000
Lb-1.3.1.3	Other mechanical works	lumpsum	1	35 000	28 000	63 000
Lb-1.3.1.4	Electrical works, power supply	lumpsum	1	37 000	18 000	55 000
Lb-1.3.1.5	Automatic control and SCADA	lumpsum	1	20 000	15 000	35 000
Lb-1.3.1.6	HVAC	lumpsum	1	0	0	0
Lb-1.3.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-1.3.1.8	Site works	lumpsum	1	20 000	38 000	58 000
Lb-1.3.1.9	Dismounting of existing WWPS	lumpsum	1	0	15 000	15 000
Lb-1.3.1.10	Miscellaneous, 5%	lumpsum	1	11 000	10 000	21 000

Table 47: Lubny; Detail Cost Estimate of construction of WWPS 10 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.6	**Total**					**379 000**
Lb-2.6.1	**Construction of new WWPS at the same site**					**154 000**
Lb-2.6.1.1	Civil works	lumpsum	1	3 000	15 000	18 000
Lb-2.6.1.2	Pumps: Q=30 m³/h, H=23 m, 4,0 kW	pcs	2	6 000	1 000	14 000
Lb-2.6.1.3	Other mechanical works	lumpsum	1	15 000	12 000	27 000
Lb-2.6.1.4	Electrical works, power supply	lumpsum	1	15 000	10 000	25 000
Lb-2.6.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.6.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.6.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.6.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.6.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.6.1.10	Miscellaneous, 5%	lumpsum	1	4 000	4 000	8 000
Lb-2.6.2	**Reconstruction of pressure pipeline (DN100/250)**	**m**	**1360**	**35**	**130**	**225 000**

Table 48: Lubny; Detail Cost Estimate of construction of WWPS 2 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.5	**Total**					**382 000**
Lb-2.5.1	**Construction of new WWPS at the same site**					**154 000**
Lb-2.5.1.1	Civil works	lumpsum	1	3 000	15 000	18 000
Lb-2.5.1.2	Pumps: Q=30 m³/h, H=23 m, 4,0 kW	pcs	2	6 000	1 000	14 000
Lb-2.5.1.3	Other mechanical works	lumpsum	1	15 000	12 000	27 000
Lb-2.5.1.4	Electrical works, power supply	lumpsum	1	15 000	10 000	25 000
Lb-2.5.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.5.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.5.1.7	Plumbing and sanitation	lumpsum	1	0	0	0

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.5.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.5.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.5.1.10	Miscellaneous, 5%	lumpsum	1	4 000	4 000	8 000
Lb-2.5.2	**Reconstruction of the pressure pipeline (DN100/250)**	**m**	**1380**	**35**	**130**	**228 000**

Table 49: Lubny; Detail Cost Estimate of construction of WWPS 5 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.1	**Total**					**367 000**
Lb-2.1.1	**Construction of new WWPS at the same site**					**157 000**
Lb-2.1.1.1	Civil works	lumpsum	1	3 000	15 000	18 000
Lb-2.1.1.2	Pumps: Q=30 m³/h, H=38 m, 6,0 kW	pcs	2	6 000	1 000	14 000
Lb-2.1.1.3	Other mechanical works	lumpsum	1	16 000	14 000	30 000
Lb-2.1.1.4	Electrical works, power supply	lumpsum	1	15 000	10 000	25 000
Lb-2.1.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.1.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.1.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.1.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.1.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.1.1.10	Miscellaneous, 5%	lumpsum	1	4 000	4 000	8 000
Lb-2.1.2	**Reconstruction of the pressure pipeline (DN100/150)**	**m**	**1270**	**35**	**130**	**210 000**

Table 50: Lubny; Detail Cost Estimate of construction of WWPS 1 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.7	**Total**					**644 000**
Lb-2.7.1	**Construction of new WWPS at the same site**					**209 000**
Lb-2.7.1.1	Civil works	lumpsum	1	5 000	18 000	23 000
Lb-2.7.1.2	Pumps: Q=60 m³/h, H=36 m, 11,0 kW	pcs	3	8 000	1 500	28 500
Lb-2.7.1.3	Other mechanical works	lumpsum	1	18 000	16 000	34 000
Lb-2.7.1.4	Electrical works, power supply	lumpsum	1	25 000	14 000	39 000
Lb-2.7.1.5	Automatic control and SCADA	lumpsum	1	15 000	10 000	25 000
Lb-2.7.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.7.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.7.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.7.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.7.1.10	Miscellaneous, 5%	lumpsum	1	6 000	5 000	11 000
Lb-2.7.2	**Reconstruction of the pressure pipeline (DN150/250)**	**m**	**2090**	**55**	**153**	**435 000**

Table 51: Lubny; Detail Cost Estimate of construction of WWPS 9 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.2	**Total**					**212 000**
Lb-2.2.1	**Construction of new WWPS at the same site**					**154 000**
Lb-2.2.1.1	Civil works	lumpsum	1	3 000	15 000	18 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.2.1.2	Pumps: Q=18 m³/h, H=12m, 2,0 kW	pcs	2	4 500	1 000	11 000
Lb-2.2.1.3	Other mechanical works	lumpsum	1	18 000	16 000	34 000
Lb-2.2.1.4	Electrical works, power supply	lumpsum	1	10 000	10 000	20 000
Lb-2.2.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.2.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.2.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.2.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.2.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.2.1.10	Miscellaneous, 5%	lumpsum	1	4 000	5 000	9 000
Lb-2.2.2	**Reconstruction of the pressure pipeline (DN90 /200)**	**m**	**361**	**33**	**126**	**58 000**

Table 52: Lubny; Detail Cost Estimate of construction of WWPS 8 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.8	**Total**					**256 000**
Lb-2.8.1	**Construction of new WWPS at the same site**					**256 000**
Lb-2.8.1.1	Civil works	lumpsum	1	5 000	18 000	23 000
Lb-2.8.1.2	Pumps: Q=70 m³/h, H=15 m, 6,0 kW	pcs	2	35 000	2 000	74 000
Lb-2.8.1.3	Other mechanical works	lumpsum	1	18 000	16 000	34 000
Lb-2.8.1.4	Electrical works, power supply	lumpsum	1	25 000	14 000	39 000
Lb-2.8.1.5	Automatic control and SCADA	lumpsum	1	15 000	10 000	25 000
Lb-2.8.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.8.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.8.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.8.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.8.1.10	Miscellaneous, 5%	lumpsum	1	8 000	5 000	13 000

Table 53: Lubny; Detail Cost Estimate of construction of WWPS 7 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.3	**Total**					**154 000**
Lb-2.3.1	**Construction of new WWPS at the same site**					**154 000**
Lb-2.3.1.1	Civil works	lumpsum	1	3 000	15 000	18 000
Lb-2.3.1.2	Pumps: Q=18 m³/h, H=10m, 2,0 kW	pcs	2	4 500	1 000	11 000
Lb-2.3.1.3	Other mechanical works	lumpsum	1	18 000	16 000	34 000
Lb-2.3.1.4	Electrical works, power supply	lumpsum	1	10 000	10 000	20 000
Lb-2.3.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.3.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.3.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.3.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.3.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.3.1.10	Miscellaneous, 5%	lumpsum	1	4 000	5 000	9 000

Table 54: Lubny; Detail Cost Estimate of construction of WWPS 6 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-2.4	**Total**					**349 000**
Lb-2.4.1	**Construction of new WWPS at the same site**					**161 000**
Lb-2.4.1.1	Civil works	lumpsum	1	3 000	15 000	18 000
Lb-2.4.1.2	Pumps: Q=18 m³/h, H=45m, 4,0 kW	pcs	2	4 500	1 000	11 000
Lb-2.4.1.3	Other mechanical works	lumpsum	1	18 000	16 000	34 000
Lb-2.4.1.4	Electrical works, power supply	lumpsum	1	15 000	12 000	27 000
Lb-2.4.1.5	Automatic control and SCADA	lumpsum	1	8 000	6 000	14 000
Lb-2.4.1.6	HVAC	lumpsum	1	0	0	0
Lb-2.4.1.7	Plumbing and sanitation	lumpsum	1	0	0	0
Lb-2.4.1.8	Site works	lumpsum	1	15 000	23 000	38 000
Lb-2.4.1.9	Dismounting of existing WWPS	lumpsum	1	0	10 000	10 000
Lb-2.4.1.10	Miscellaneous, 5%	lumpsum	1	4 000	5 000	9 000
Lb-2.4.2	**Reconstruction of the pressure pipeline (DN90/150)**	**m**	**1134**	**35**	**130**	**188 000**

6.7.2 Installation of SPP at WWPS and at WWTP

Assessing the cost not only allows for accurate determination of financial expenses but also ensures the economic efficiency of the project. Below Consultant's considers the cost assessment process based on his personal experience and current average prices in the Ukrainian market. Additionally, the developed cost calculations for the SPP have been approved by the water utility, adding further reliability to the obtained results.

The main components of a solar power station include:

- Solar panels - converting sunlight into direct current;
- Inverters - converting the direct current generated by the panels into alternating current, which can be used in the electrical grid;
- Mounting systems - structures for panel mounting;
- Cables and connectors - for component connection;
- Monitoring and control systems - for tracking and managing SPP operation;
- Civil and site works.

To assess the cost, we use average prices in the Ukrainian market. Based on an analysis of prices for the main components, the average cost of installing 1 kW of capacity for WWTP 745 € (excl. VAT). At WWPS 10 location it is not possible to calculate the cost of a hybrid station per 1 kW, since the capacities of the panels, inverter and batteries are particularly different. In accordance with the task, the average cost of such a station was determined based on the ratio with simple grid-tie stations and is indicatively 1438 € (excl. VAT).

Total cost of installation of PV SPP is estimated to 672 000 € (excl. VAT).

Table 55: Lubny; Detail Cost Estimate of construction of installation of SPP at WWPS and at WWTP (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-1.5.1	**Installation of SPP at WWPS 10 and WPS 3 (PV 260 kW, Battery 480 kW)**					**374 000**
Lb-1.5.1.1	Civil works	lumpsum	1	33 000	13 000	46 000
Lb-1.5.1.2	PV panels, [260 kW]	pcs	450	140	30	76 500
Lb-1.5.1.3	Inverters hybrid, [200 kW]	lumpsum	1	26 000	4 000	30 000
Lb-1.5.1.4	Battery rack, [480 kWh]	lumpsum	1	162 000	4 000	166 000

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
Lb-1.5.1.5	Electrical works, power supply	lumpsum	1	10 000	6 000	16 000
Lb-1.5.1.6	Automatic control and SCADA	lumpsum	1	9 000	5 000	14 000
Lb-1.5.1.7	Site works	lumpsum	1	4 000	2 000	6 000
Lb-1.5.1.8	Miscellaneous, 5%	lumpsum	1	16 000	3 000	19 000
Lb-1.5.2	**Installation of SPP at WWTP (400 kW)**					**298 000**
Lb-1.5.2.1	Civil works	lumpsum	1	55 000	20 000	75 000
Lb-1.5.2.2	PV panels, [400 kW]	pcs	690	140	30	117 300
Lb-1.5.2.3	Inverters, [350 kW]	lumpsum	1	22 000	3 000	25 000
Lb-1.5.2.4	Electrical works, power supply	lumpsum	1	18 000	7 000	25 000
Lb-1.5.2.5	Automatic control and SCADA	lumpsum	1	5 000	3 000	8 000
Lb-1.5.2.6	Site works	lumpsum	1	18 000	14 000	32 000
Lb-1.5.2.7	Miscellaneous, 5%	lumpsum	1	11 000	4 000	15 000

6.8 Final Reviewed Investment Programme

At the Investment Programme meeting on 23.05.2024 (see MoM in Annex 3.3) it was agreed that Reviewed Proposed Investment Programme (see Chapter 6.5) by the Consultant will stay divided into two projects. However, due to budget restrictions, it was decided to move reconstruction of WWPS 3 and WWPS 3A under the 2nd priority project Lb-2. So, 1st priority project Lb-1 would include reconstruction of WWPS 4 and WWPS 4A and aöso installation of SPPs at WWPS 10 and WWTP.
The cost estimates were reviewed with the following result:

- **1st Priority Project Lb-1** with total cost estimate of 2 002 000 € (excl. VAT)
- 2nd Priority Project Lb-2 with total cost estimate of 4 667 000 € (excl. VAT).

Table 56: Lubny; Total Cost Estimate of the 1st Priority Project Lb-1 (excl. VAT)

No	Item	Cost Estimate, €
Lb-1.2	Reconstruction of WWPS 4 (KHC-4)	448 000
Lb-1.2.1	Construction of new WWPS at the same site	448 000
Lb-1.3	Reconstruction of WWPS 4A (KHC-4A)	420 000
Lb-1.3.1	Construction of new WWPS at the same site	420 000
Lb-1.5	Installation of alternative power sources	672 000
Lb-1.5.1	Installation of solar panels at WWPS 10 and WPS 3 (PV 260 kW, Battery 480 kW)	374 000
Lb-1.5.2	Installation of solar panels at WWTP (400 kW)	298 000
Lb-1.6	**Subtotal**	**1 540 000**
Lb-1.7	Design and cost estimate documentation 10%	154 000
Lb-1.8	Contingency 20%	308 000
Lb-1.9	**Total**	**2 002 000**

Table 57: Lubny; Total Cost Estimate of the 2nd Priority Project Lb-2 (excl. VAT)

No	Item	Cost Estimate, €
Lb-1.1	Reconstruction of WWPS 3 (KHC-3)	434 000
Lb-1.1.1	Construction of new WWPS at the same site	434 000
Lb-1.4	Reconstruction of WWPS 3A (KHC-3A)	413 000
Lb-1.4.1	New equipment is being installed in the reconstructed pumping station KHC-3. The pump is dismantled and eliminated. Pipelines are switched.	276 000
Lb-1.4.2	Switching of sewage networks (DN500-300)	137 000
Lb-2.1	Reconstruction of WWPS 5 (KHC-5)	367 000
Lb-2.1.1	Construction of new WWPS at the same site	157 000
Lb-2.1.2	Reconstruction of the pressure pipeline (DN100 /150)	210 000
Lb-2.2	Reconstruction of WWPS 9 (KHC-9)	212 000
Lb-2.2.1	Construction of new WWPS at the same site	154 000
Lb-2.2.2	Reconstruction of the pressure pipeline (DN90 /200)	58 000

No	Item	Cost Estimate, €
Lb-2.3	Reconstruction of WWPS 7 (KHC-7)	154 000
Lb-2.3.1	Construction of new WWPS at the same site	154 000
Lb-2.4	Reconstruction of WWPS 6 (KHC-6)	349 000
Lb-2.4.1	Construction of new WWPS at the same site	161 000
Lb-2.4.2	Reconstruction of the pressure pipeline (DN90/150)	188 000
Lb-2.5	Reconstruction of WWPS 2 (KHC-2)	382 000
Lb-2.5.1	Construction of new WWPS at the same site	154 000
Lb-2.5.2	Reconstruction of the pressure pipeline (DN100 /250)	228 000
Lb-2.6	Reconstruction of WWPS 10 (KHC-10)	379 000
Lb-2.6.1	Construction of new WWPS at the same site	154 000
Lb-2.6.2	Reconstruction of pressure pipeline (DN100 /250)	225 000
Lb-2.7	Reconstruction of WWPS 1 (KHC-1)	644 000
Lb-2.7.1	Construction of new WWPS at the same site	209 000
Lb-2.7.2	Reconstruction of the pressure pipeline (DN150/250)	435 000
Lb-2.8	Reconstruction of WWPS 8 (KHC-8)	256 000
Lb-2.8.1	Construction of new WWPS at the same site	256 000
Lb-2.9	**Subtotal**	**3 590 000**
Lb-2.10	Design and cost estimate documentation 10%	359 000
Lb-2.11	Contingency 20%	718 000
Lb-2.12	**Total**	**4 667 000**

6.9 Investment Programme Benefits and Savings

Below the benefits and savings of finally proposed project Lb-1 is calculated.

6.9.1 Benefits and Savings of 1st Priority Project Lb-1

By installing new, more efficient (and more precisely selected) pumps, the pumping efficiency at main WWPS 4 and 4A is expected to be improved by 52%. For comparison of pumping efficiency International Water Association (IWA) recommends to use **Ph5** energy consumption (kWh/m³/100m): unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m.

Potential annual savings in power consumption compared to the baseline (i. e. pumping of the same amount of water) are estimated to 165 376 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

Table 58: Lubny; Savings of 1st Priority Project Lb-1

Parameter	Unit	Total	WWPS 4	WWPS 4A
Existing baseline				
Existing total flow	m³/year	1 131 500	657 000	474 500
	m³/h	129	75	54
Existing raising head	m w. g.	15	15	15
Consumed power	kWh/year	309 600	180 000	129 600
	kWh/m³	0.27	0.27	0.27
	kWh/m³/100m	1.82	1.83	1.82
New pumps				
Designed raising head	m w. g.	27	23.2	32
Pumping flow	m³/h		450	332
Pumping power	kW		57	58
Pumping time	h/year		1 460	1 429
Consumed power	kWh/year	165 824	83 071	82 753
	kWh/m³	0.15	0.13	0.17
	kWh/m³/100m	0.55	0.55	0.55
Effect compared to existing baseline	**kWh/year**	143 776	96 929	46 847

The power savings at WWPS 4 and 4A described above will result in annual reduction of CO_{2eqv} in the amount of 115 002 kg/year. The CO_{2eqv} reduction was calculated considering 0.8 kg/kWh carbon intensity of Ukraine's power mix.

6.9.2 Installation of SPP at WWPS 10 and at WWTP

Initial Data for WWPS 10 SPP:

- Annual energy production: 282 MWh (which covers 8.7% of total energy consumed by water utility. Both SPPs will cover 22.7%).
- CO_2 emissions reduction: 225 tons per year.
- Estimated cost of the solar power plant: 374 000 € (excl. VAT).

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 282 MWh, savings on electricity are estimated in Chapter 6.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 225 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 374 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 6.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

6.9.3 Installation of SPP at WWTP

Initial Data for WWTP:

- Annual electricity production: 452 MWh (which covers 14% of total energy consumed by water utility. Both SPPs will cover 22.7%).
- CO_2 emissions reduction: 362 tons per year.
- Estimated cost of the solar power plant: 298 000 € (excl. VAT).

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 452 MWh, savings on electricity are estimated in Chapter 6.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 362 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 298 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 6.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

6.10 Financial Analysis

Total budget for reconstruction of wastewater pumping stations and installing of SPP in Lubny is **2 002 000 €** (without VAT).

Potential savings in electric energy from more efficient pumping stations is accounted for 143 776 kWh per year, which makes total annual saving as of **23 004** € (with energy price estimated to be 0.16 € per kWh, without VAT). For more details see Table 58 above.

Potential savings from installation of solar panels (e.g. estimated production of electric energy from solar panels at WWPS 10 and WWTP) are as following:

- SPP1 – production of solar energy from panels in WWPS 10 is 282 MWh per year.
- SPP2 – production of solar energy from panels in WWTP is 452 MWh per year.

That means that in total production of electric energy from solar panels is **734** MWh per year. Therefore, total saving from production of solar energy for own purposes and therefore substituting energy purchase from networks is **117 440 €** (energy price estimated to be 0.16 € per kWh or 160 € per MWh, without VAT).

Combining both factors of electric energy savings, we can estimate total impact on enterprise`s annual energy consumption to be as much as **140 444 €**.

Regarding investment other savings cannot be monetarised in reasonable extent as they are not substantial in estimating cost effectiveness of investment.

Therefore, payback time **without grant** for the whole investment will be **14.25 years**, which is too long in terms of depreciation of assets and average time span of commercial loans. Therefore, additional grant is needed for economic viability of investment.

Considering minimum co-financing rate requested (16.5 %) for municipal funds the payback time will be much shorter – **2.35 years** for equity invested, which is within economically reasonable limits for water enterprise.

7 Horishni Plavni

7.1 Horishni Plavni Existing Water Supply and Wastewater Services

7.1.1 Horishni Plavni General Information

Horishni Plavni (before known as Komsomolsk) is a relatively small industrial city in Poltava oblast, which is located on the left bank of the river Dnipro.

The city is famous for big iron ore deposits and its mining and extraction enterprise. Founded in 1960 as Komsomolsk-na-Dnipri, the city was purposely planned and built as the residential and civic area for the Poltava Mining and Extraction Combinate - the most important iron ore-mining company in Ukraine. Approximately 80% of the city residents are employed by the mining industry. The specifics of the city are determined by the mining and knitting and clothing industries. Structurally, the industry consists of 7 industries: mining, chemical, mechanical engineering, woodworking, construction materials, light and food industries. One of the largest enterprises in the city is the private joint-stock company (PJSC) Poltava Mining and Processing Plant (PGOC), founded on the basis of a powerful iron ore mining complex and producing 12 million tons of pellets per year. The city is also home to the Ryzhevsky, Redutsky and Shmatkovsky granquarries, knitting factories, a waste tire processing plant, and various agricultural farms.

Population of the city is 52 597 inhabitants. Number of IDP-s who were forced to leave their homes due to russian aggression has been reported to be 8 999.

7.1.2 WS and WW Services

The source of the centralized water supply of the city is a surface source, namely the "Richishche" strait, which has a water exchange with the Dnipro River. The water intake is located at the end of a channel with a length of about 2 km, which actually acts as a natural settling tank. The average productivity of the water intake is 14 000 m^3/day.

The water supply system consists of the water treatment plant with a design capacity of 50 000 m^3/day, 2nd and 3rd lift water pumping stations (WPS) and 8 water tanks with a total volume of 27 000 m^3. Water treatment involves two-stage purification: settling and filtering. Due to the under-loading of WTP and due to the large filter area, the filtering velocity is low, which causes imperfect operation of the backwash pumps with increased energy consumption.

Distribution water networks in the city as a whole have a length of 115 km. Of these, 15% of the pipes are classified as emergency and in need of immediate renovation, which causes frequent accidents, large losses of water, interruptions in water supply, pressure drop and secondary water pollution.

Booster pumping stations (BPS) are used to provide drinking water to high-rise buildings. On the balance sheet of the enterprise there are 11 BPS and 3 heat exchange boiler stations.

The wastewater system consists of gravity collectors, 16 wastewater pumping stations No: 1B, No: 8, No: 9, No: 10, No: 13, No: 14, No:15, No: 16, No: 17, No: 18, No: 19, No: 20, No: 21; No: 22; No: 23, No: 24, pressure pipelines and wastewater Treatment Plant.

Wastewater is collected through gravity collectors into 15 wastewater pumping stations, and then into the main wastewater pumping station No: 1B. The main wastewater pumping station No: 1B pumps wastewater directly to wastewater treatment plant (WWTP) with two steel pipelines with a diameter of 500 to 1000 mm.

Wastewater treatment plant consist of a complex of structures for mechanical and complete biological treatment of wastewater with subsequent post-treatment using biofilters. Treated wastewater is

discharged into the second compartment of the tailings dump of PJSC Poltava Mining and Processing Plant. WWTP design capacity is 35 thousand m³/day. Currently, on average, 8.6 thousand m³ of wastewater is treated per day. The city's wastewater collection system, which transports domestic wastewater to treatment plants, is separate from storm water system. The total length of the city's wastewater networks, which are accounted for and maintained, is 93 625 km of wastewater networks (of which 5.97 km are main collectors). Approximately 16 km of pipelines are in unsatisfactory condition and need immediate replacement. Due to the high degree of clogging of the internal cross-section of wastewater gravity pipelines and the growth of roots of trees planted many years ago, frequent back flow occurs.

A significant part of the pumping and power equipment of the wastewater pumping stations and wastewater treatment plant has expired its depreciation period and requires replacement with modern energy-efficient analogues. Reviewing the state of the wastewater system of the city of Horishni Plavni, one cannot fail to note a large number of urgent and serious problems, which in the future could lead to disruptions in the city's wastewater system, as well as cause negative environmental consequences.

7.1.3 Measures completed by NIP I Water Programme

NIP Water Programme, financed by NIP (the Neighbourhood Investment Platform – EU financing initiative), is aimed at increasing of energy efficiency of water supply and sewage sector in 6 cities – Lutsk, Khmelnytskyi, Lubny, Horishni Plavni, Fastiv and Berdychiv. Implementation of Project Component 1 began in 2019 and is under implementation.

The planned investments are targeted in increasing the energy efficiency and in increasing the stability and efficiency in operation of water supply system. The planned investments were the following:

- Replacement of five pumps at 2nd lift WPS including installation of switchboards with frequency converters; installation of cabinets for pressure control (at control points) at the pumping station outlet; replacement of shutoff valves
- Replacement of pumps at of the 3rd lift WPS including installation of switchboards with frequency converters; installation of cabinets for pressure control (at control points) at the pumping station outlet; replacement of shutoff valves.

The contract was signed in January 2022. Though no work was commenced before 24 February 2022, beginning of the russian aggression against Ukraine. All works were fully completed by the end of May 2024.

7.2 Preliminary Proposed investment Programme

At the kick-off meeting (see MoM in Annex 1.4) Horishni Plavni Water Utility (HPVK) and Municipality (HPM) proposed the following investment programme:

- Replacement (new construction) of the wastewater pumping station no: 1B (WWPS 1B);
- Reconstruction of the two wastewater pumping stations (WWPS 8 and WWPS 9). There are design documents prepared for these WWPS. The proposed works include:
    - Replacement of main process and electrical equipment (pumps, valves, screens etc)
    - Reconstruction of structures of these WWPS;
    - Cleaning of gravity and pressure wastewater pipelines before and after WWPS.
- Installation of SPP at all three WWPS (existing designs do not cover this);
- Installation of SPP at first lift water supply pumping station to supply main process pumps.

7.3 Data Collection

Consultant issued the Questionnaires concerning technical issues (at 06.04.24, 26.04.24 and 30.04.24) and Social and Economic issues (at 06.04.24).

7.4 Analysis of Collected Data

Cleaning of gravity and pressure wastewater pipelines is not considered as part of the investment programme, because:

- it does not correspond to the objectives of the programme;
- it is more of an operational activity than an investment; and
- it is objective is to prepare further wastewater system reconstruction/renovation programme.

According to the information received from HPVK the pressure sewers are as following:

- WWPS 8 has two operational parallel pressure wastewater pipelines DN 300 (material: steel, cast iron and reinforced concrete). Each with length 900 m. Both constructed in 1972;
- WWPS 9 has two operational parallel pressure wastewater pipelines and one out of operation:
    - Operational DN 500 (material: steel, cast iron and reinforced concrete) on the street Heroiv Dnipro. Length 1770 m. Constructed in 1973;
    - Operational DN 500 (material: steel, cast iron and reinforced concrete) on the street Konstitutsiy. Length 3110 m. Constructed in 1973;
    - Out of operation DN 300 (material: HDPE) on the street Konstitutsiy. Constructed 30 years ago with very poor quality and therefore not used;
- WWPS 1B has two operational parallel pressure wastewater pipelines (material: steel). Each parallel line has DN 500 of length 700 m and DN 1000 of length 1800 m (total length 2500 m). Both constructed in 1978.

HPVK did not report any recent pipe breaks on the pressure sewers of WWPS in question, which indicates an adequate quality. Moreover, Consultant's calculations showed that pipe diameters are sufficient to maintain the minimum self-cleaning flow velocity. Therefore, reconstruction (or replacement) of pressure sewers was not proposed to include into the programme.

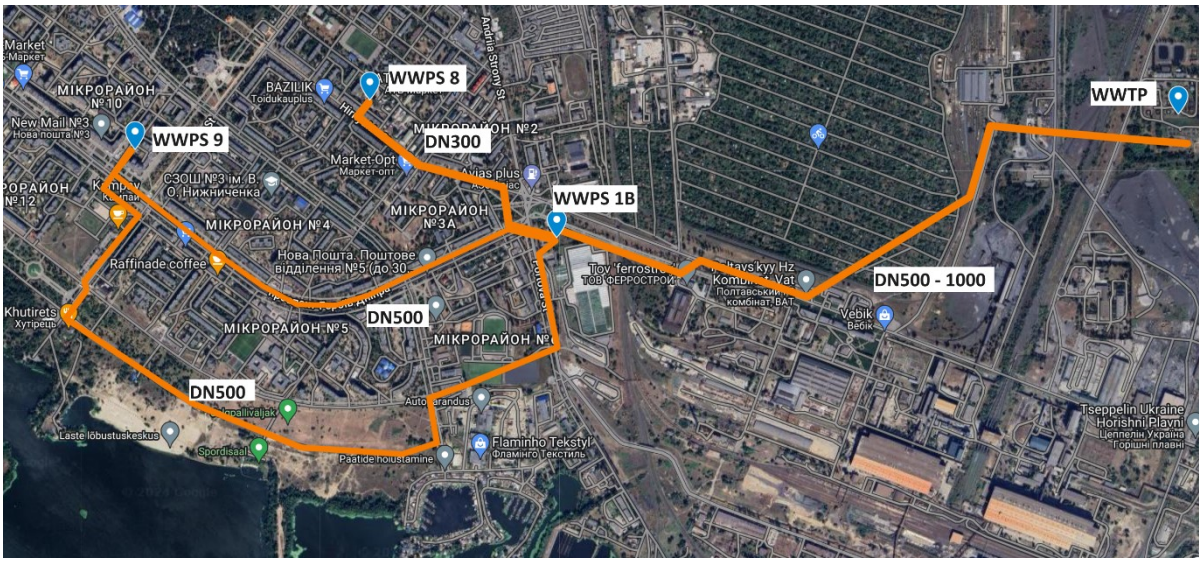


Figure 19: Horishni Plavni; Location of WWPS and the Pressure Sewers

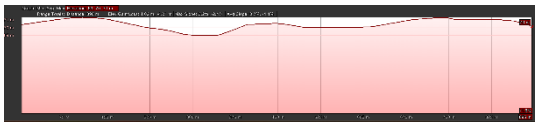


Figure 20: Horishni Plavni; WWPS 1B Pressure Sewer Longitudinal Profile

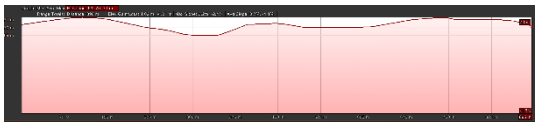


Figure 21: Horishni Plavni; WWPS 8 Pressure Sewer Longitudinal Profile

Figure 22: Horishni Plavni; WWPS 9 Pressure Sewer on Heroiv Dnipro Street Longitudinal Profile

Figure 23: Horishni Plavni; WWPS 9 Pressure Sewer on Konstitutsiy Street Longitudinal Profile

Replacement of pumps in WWPS 1B will have significant savings on used pumping power. But at WWPS 8 it will be quite small and at WWPS 9 (as the pumps there are very new, installed last years) there will not be and effect at all. Therefore, Consultant does not recommend pump replacement at WWPS 9.

Average operational pressure measured at the WWPS was reported as following:

- WWPS 1B – 24 m. w. g.
- WWPS 8 – 25.8 m. w. g.
- WWPS 9 – 25.4 m. w. g.

For comparison of pumping efficiency International Water Association (IWA) recommends to use **Ph5** energy consumption (kWh/m³/100 m)[16]: unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m. As it can be seen from the Table below, existing pumps at WWPS 8 and 9 are quite efficient already.

Table 59: Horishni Plavni; Pumping Effiency Analysis

	BEFORE PROJECT				
	Pumped water volume	Average pressure	Consumed power	Unitary energy consumption	Standard energy consumption
	m³/year	m	kWh/year	kWh/m³	kWh/m³/100 m
Total	**3 317 563**		**368 330**		
WWPS 1B	1 658 782	24,0	239 600	0,14	0,60
WWPS 8	485 481	25,8	53 310	0,11	0,43
WWPS 9	1 173 301	25,4	75 420	0,06	0,25

7.5 Reviewed Investment Programme

Because the maximum limit of the project cost 5 M€ is not exceeded, the Consultant proposed only one project HP-1 with total cost estimate 4.31 M€ (excl. VAT):

- Replacement (new construction) of WWPS 1B
  - Construction of new WWPS at the same site
  - Renovation of gravity sewer collector
- Reconstruction of WWPS 8
- Reconstruction of WWPS 9

[16] Key performance Indicator (KPI) recommended by IWA-PI (International Water Association Performance Indicator)

- Installation of SPP
    - Installation of SPP at WWPS 1B (260 kW)
    - Installation of SPP at WTP (60 kW)

7.6 Dimensioning of the Investment Programme

Below the dimensioning of the pumps is given. This dimensioning is preliminary and used only for compilation of cost estimates. More detail and precise parameters of investment programme components (i. e. pump capacity, pipe diameter etc) will be established at the next design stage.

Pumping capacity (second column in the Table below) has been established as maximum value of the pumped water at four last years (2020 – 2023). This value was declared by HPVK and it has been estimated based on pump's working hours. For dimensioning value, the maximum observed annual flow was taken and multiplied by maximum flow coefficients: maximum day 2.0 and maximum hour at maximum day 3.0. All together maximum hour flow is 6 times higher than the annual average.

Table 60: Horishni Plavni; Dimensioning of WWPS

	Pumping capacity, l/s	Pressure sewer DN	Pressure sewer length, m	Flow Velocity, m/s	Total pumping head, m	Pressure losses, m	Geodetic head, m	Pumping power, kW
WWPS 1B	436		2500		21.3	2.3	19.0	182
	436	500	700	1,11	1.8	1.8		
	436	1000	1800	0,56	0.5	0.5		
WWPS 8	148	300	900	1,05	18.9	3.9	15.0	55
WWPS 9	291				17.7	2.7	15.0	101
	166	500	1770	0,84	4.6	2.6	2.0	
	125	500	3110	0,64	4.7	2.7	2.0	

Based on the analysis below, Consultant recommends the following pumping capacities for the WWPS in question (which shall be recalculated in more detail at the next design stage)**:**

- **WWPS 1B: flow 1620 m³/h (450 l/s), raising head 22 m.w.g. with pumping power 200 kW. 3 operational + 1 stand-by pump, each with capacity 700 m³/h;**
- **WWPS 8: flow 450 m³/h (150 l/s), raising head 20 m.w.g. with pumping power 60 kW. 2 operational + 1 stand-by pump, each with capacity 260 m³/h;**
- **WWPS 9: flow 900 m³/h (300 l/s), raising head 18 m.w.g. with pumping power 110 kW. 2 operational + 1 stand-by pump, each with capacity 500 m³/h**

7.6.1 Replacement (new construction) of WWPS 1B

WWPS 1B is the main pumping station, which pumps all the Horishni Plavni wastewater to treatment plant (WWTP). The gravity collector before the WWPS is laid unusually deep (12 m). Consequently, the PS itself is also deep (appr. 15 m from the ground level).

According to HPVK existing WWPS 1B (constructed in 1978) civil structures, process equipment, pipelines, power supply and ventilation systems etc have been totally degraded. This was also confirmed by the Consultant's at the site visit. Therefore, Consultant confirms the full replacement of the pumping station as the cheaper option than the reconstruction. It is suggested to construct new wet well with three submersible pumps. Two pumps will be operational and one in reserve.

Operational pumps working in parallel shall pump maximum day maximum hour WW flow. Though at the maximum flow third pump could be switched on as well. All process valves and flow meters will be located in the separate in-situ concrete underground chamber.

The overground operator's building (accommodating also powers supply, automatic control and SCADA systems) of light sandwich construction will stand separately.

WWPS 1B has two operational parallel pressure wastewater pipelines (material: steel). Each parallel line has DN 500 of length 700 m and DN 1000 of length 1800 m (total length 2500 m). Both constructed in 1978. HPVK did not report any recent pipe breaks on the pressure sewers of WWPS in question, which indicates an adequate quality.

As it can be seen from the Table 60 above, the velocity in the pressure wastewater pipes of DN 500 pipes is 1.11 m/s which is above 0.7 m/s[17]. Only in the pressure wastewater pipes with diameter 1000 mm the velocity Is much less. Consultant recommends to use only one of the parallel DN 1000 pipes in operation (or at least alternate them) then the velocity would be close to 0.6 m/s.

The gravity wastewater pipeline before the WWPS is also in an unsatisfactory condition. During the site visit Consultant witnessed the collapse of the pipe just before the wet well. HPVK did repair the actual pipe break but the wastewater needs renovation. Replacement of 300 m has been included into the investment programme.

Altogether the following works have been included into the investment programme:

- Civil works
- Installation of pumps, grinders, mechanical automated screens and other mechanical works
- Electrical works, power supply
- Reconstruction of 0.4 kV switch board
- Automatic control and SCADA
- HVAC, plumbing and sanitation
- Site works
- Dismounting of existing WWPS
- Other miscellaneous works.

7.6.2 Reconstruction of WWPS 8 and WWPS 9

WWPS 8 and 9 are pumping wastewater to main WWPS 1B (see location on Figure 19 above). Both WWPS were built in 1972-73. According to HPVK existing civil structures, process equipment, pipelines, power supply and ventilation systems etc are severely degraded. This was also confirmed by the Consultant's at the site visit. Full reconstruction has been proposed by HPVK, to which the Consultant agrees.

As analysis of power consumption data shows (see Chapter 7.4) that pumps in both WWPS are operating quite well. The standard energy consumption:

- For WWPS 8 was 0.43 kWh/m³/100 m
- For WWPS 9 was 0.25 kWh/m³/100 m.

These low efficiency figures show that pump replacement at WWPS 9 cannot be recommended.

[17] 0.7 m/s is internationally recognised minimum which does not cause WW sedimentation. In some country standards the miinimum allwed velocity is 0.6 m/s.

HPVK did not report any recent pipe breaks on the pressure wastewater pipelines of WWPS 8 and 9 in question, which indicates an adequate quality. As per Table 60 above the velocity in the pressure wastewater pipes of WWPS 8 and 9 will be above 0.7 m/s.

The gravity wastewater pipelines before both WWPS are in an unsatisfactory. During the site visit Consultant witnessed the collapse of the pipe just before the wet well. HPVK did repair the actual pipe break but the wastewater pipeline needs renovation. Replacement of 300 m has been included into the investment programme.

The following works have been included into the investment programme:

- WWPS 8:
    - Reconstruction of inlet chamber (wet well) and other civil works
    - Installation of pumps, grinders, mechanical automated screens and other mechanical works
    - Electrical works, power supply
    - Automatic control and SCADA
    - HVAC, plumbing and sanitation
    - Site works
    - Other miscellaneous works
    - Replacement of gravity wastewater pipeline before the WWPS (50 m)
- WWPS 9:
    - Reconstruction of inlet chamber (wet well) and other civil works
    - Installation of mechanical automated screens and other mechanical works
    - Electrical works, power supply
    - Automatic control and SCADA
    - HVAC. plumbing and sanitation
    - Site works
    - Other miscellaneous works
    - Replacement of gravity wastewater pipeline before the WWPS (80 m).

7.6.3 Installation of SPP at WWPS 1B

Installation of a solar power plant (SPP) at the water utility will help reduce electricity costs and improve the environmental safety of the enterprise. This chapter describes the site where the solar power plant is planned to be installed, the initial data for calculations, and the results of the calculations.

Description of the Site

Initially, four locations were selected for the installation of the SPPs:

- WWPS 1B and its adjacent territory, as well as the new territory belonging to WWPS 1B
- WWPS 8 and its adjacent territory
- WWPS 9 and its adjacent territory
- Location near WTP.

It is not possible to install a solar power plant at WWPS 8 and WWPS 9 due to shading from nearby buildings. The roofs of WWPS 8 and WWPS 9 are in poor condition and require reconstruction and relocation of the ventilation system. Additionally, the roof areas are too small. It has been concluded that installation of SPP at these sites is not economically feasible.

There is a possibility to install a 50 kW SPP between the first and second water lifts. However, the water utility company indicates there is an issue with land ownership, and they cannot lease this land for longer time period. Conclusion: the SPP will not be planned for this location neither.

The site chosen for the SPP installation is WWPS 1B, as it has newly privatized land owned by the water utility company. To place the solar power plant here, it is necessary to clear the area of small bushes and trees, and to dismantle the old non-operational building on the new territory of WWPS 1B. The SPP area is 2 700 m². The average distance from the solar power plant locations to the 0.4 kV transformer station is 65 meters. The placement was done approximately, so the next consultant should take these remarks into account for the project planning.

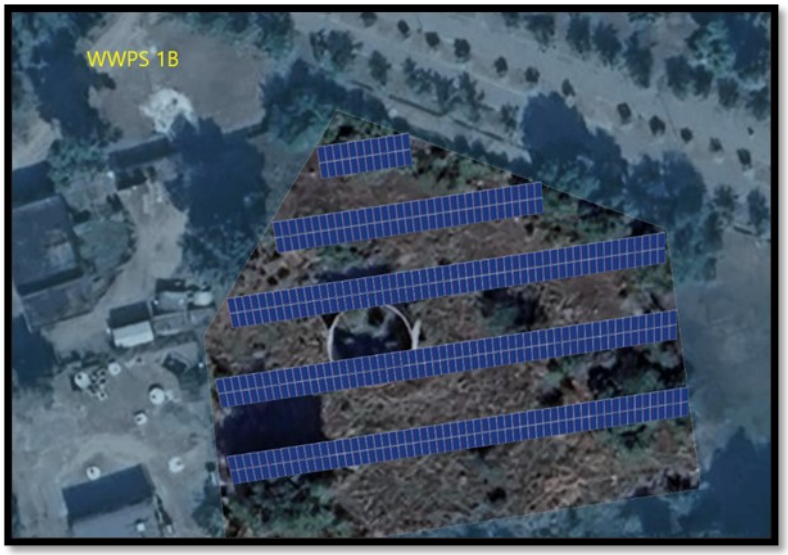


Figure 24: Horishni Plavni; Location of WWPS 1B SPP

Initial Data and Key Characteristics of the Site:

- Geographical Location: Horishni Plavni WWPS 1B
- Solar insolation in the Khmelnytskyi region: 1249 W/m².

The following initial data were used for the calculations:

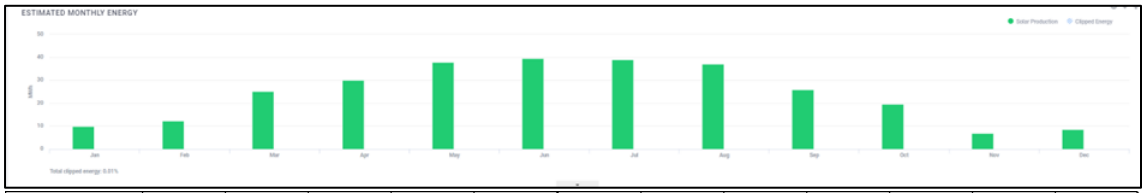
- Area available for solar panel installation: 2700 m²
- Allowed power capacity of the transformer station: 400 kW
- Efficiency of solar panels: 22%
- Type of structure: Above-ground
- Type of inverter: Grid-tied with generation control system.

Calculation results:

Based on the provided initial data, calculations were conducted to determine the potential capacity and electricity production of the solar power plant.

Table 61: Horishni Plavni; WWPS 1B SPP Calculation Results

Installed capacity of solar panels	260 kWp
Maximum AC power output	250 kW
Estimated annual electricity production	291 MWh



Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar Production (kWh)	9,921	12,338	25,136	30,063	37,863	39,496	39,026	37,133	25,976	19,581	6,821	8,575

Figure 25: Horishni Plavni; WWPS 1B SPP Estimated Generation Schedule

7.7 Estimated Budget

Preliminary budget below is based on the Consultant's experience and in-house data for contemporary price level in Ukraine.

Miscellaneous works in the tables below are estimated to 5% of sum of other works.

7.7.1 Replacement (new construction) of WWPS 1B

Total cost of construction of new WWPS 1B is estimated to 2 639 000 € (excl. VAT) and reconstruction of its gravity wastewater pipeline is estimated to 600 000 € (excl. VAT).

Table 62: Horishni Plavni; Detail Cost Estimate of Construction of New WWPS 1B (excl. VAT)

Pos. No.	Item	Unit	Qua-ntity	Equipment and materials, €	Works, €	Cost Estimate, €
HP-1.1	**Total**					**3 239 000**
HP-1.1.1	**Construction of new WWPS at the same site**					**2 639 000**
HP-1.1.1.1	Civil works	lumpsum	1	300 000	900 000	1 200 000
HP-1.1.1.2	Pumps: Q=700 m³/h, H=20 m, 75 kW	pcs	4	40 000	5 000	180 000
HP-1.1.1.3	Grinders	pcs	2	35 000	5 000	80 000
HP-1.1.1.4	Mechanical automated screens	pcs	3	45 000	5 000	150 000
HP-1.1.1.5	Other mechanical works	lumpsum	1	150 000	50 000	200 000
HP-1.1.1.6	Electrical works, power supply	lumpsum	1	100 000	30 000	130 000
HP-1.1.1.7	Reconstruction of 0,4 kV switch board	lumpsum	1	45 000	15 000	60 000
HP-1.1.1.8	Automatic control and SCADA	lumpsum	1	120 000	50 000	170 000
HP-1.1.1.9	HVAC	lumpsum	1	200 000	50 000	250 000
HP-1.1.1.10	Plumbing and sanitation	lumpsum	1	15 000	2 000	17 000
HP-1.1.1.11	Site works	lumpsum	1	40 000	10 000	50 000
HP-1.1.1.12	Dismounting of existing WWPS	lumpsum	1	10 000	15 000	25 000
HP-1.1.1.13	Miscellaneous, 5%	lumpsum	1	68 000	59 000	127 000
HP-1.1.2	**Renovation of gravity sewer collector**	**m**	**300**	**1 200**	**800**	**600 000**

7.7.2 Reconstruction of WWPS 8 and WWPS 9

Total cost of reconstruction of WWPS 8 and 9 (including reconstruction of gravity wastewater pipelines) is estimated to 1 814 000 €.

Table 63: Horishni Plavni; Detail Cost Estimate of reconstruction of WWPS 8 and 9 (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
HP-2.1	**Reconstruction of WWPS 8**					**865 000**
HP-2.1.1	**Reconstruction of WWPS 8**					**805 000**
HP-2.1.1.1	Reconstruction of inlet chamber (wet well)	lumpsum	1	150 000	50 000	200 000
HP-2.1.1.2	Other civil works	lumpsum	1	30 000	20 000	50 000
HP-2.1.1.3	Pumps: Q=260 m³/h, H=18 m, 25 kW	pcs	3	13 000	5 000	54 000
HP-2.1.1.4	Mechanical automated screens	pcs	2	45 000	5 000	100 000
HP-2.1.1.5	Other mechanical works	lumpsum	1	70 000	30 000	100 000
HP-2.1.1.6	Electrical works, power supply	lumpsum	1	50 000	20 000	70 000
HP-2.1.1.7	Automatic control and SCADA	lumpsum	1	70 000	30 000	100 000
HP-2.1.1.8	HVAC	lumpsum	1	50 000	10 000	60 000
HP-2.1.1.9	Plumbing and sanitation	lumpsum	1	15 000	2 000	17 000
HP-2.1.1.10	Site works	lumpsum	1	10 000	5 000	15 000
HP-2.1.1.11	Miscellaneous, 5%	lumpsum	1	29 000	10 000	39 000
HP-2.1.2	**Renovation of gravity sewer collector**	**m**	**50**	**800**	**400**	**60 000**
HP-2.2	**Reconstruction of WWPS 9**					**949 000**
HP-2.2.1	**Reconstruction of WWPS 9**					**853 000**
HP-2.2.1.1	Reconstruction of inlet chamber (wet well)	lumpsum	1	250 000	50 000	300 000
HP-2.2.1.2	Other civil works	lumpsum	1	30 000	20 000	50 000
HP-2.2.1.3	Mechanical automated screens	pcs	2	45 000	5 000	100 000
HP-2.2.1.4	Other mechanical works	lumpsum	1	70 000	30 000	100 000
HP-2.2.1.5	Electrical works, power supply	lumpsum	1	30 000	10 000	40 000
HP-2.2.1.6	Automatic control and SCADA	lumpsum	1	70 000	30 000	100 000
HP-2.2.1.7	HVAC	lumpsum	1	70 000	20 000	90 000
HP-2.2.1.8	Plumbing and sanitation	lumpsum	1	15 000	2 000	17 000
HP-2.2.1.9	Site works	lumpsum	1	10 000	5 000	15 000
HP-2.2.1.10	Miscellaneous, 5%	lumpsum	1	32 000	9 000	41 000
HP-2.2.2	**Reconstruction of gravity sewer collector**	**m**	**80**	**800**	**400**	**96 000**

7.7.3 Installation of SPP at WWPS 1B

Assessing the cost not only allows for accurate determination of financial expenses but also ensures the economic efficiency of the project. Below the Consultant considers the cost assessment process based on his personal experience and current average prices in the Ukrainian market. Additionally, the developed cost calculations for the SPP have been approved by the water utility, adding further reliability to the obtained results.

The main components of a solar power station include:

- Solar panels - converting sunlight into direct current;
- Inverters - converting the direct current generated by the panels into alternating current, which can be used in the electrical grid;
- Mounting systems - structures for panel mounting;
- Cables and connectors - for component connection;
- Monitoring and control systems - for tracking and managing SPP operation;
- Civil and site works.

To assess the cost, average prices in the Ukrainian market are used.

Total cost of installation of solar panels at WWTP is estimated to 194 000 € (excl. VAT).

Table 64: Horishni Plavni; Detail Cost Estimate of PV Panels at WWPS 1B (excl. VAT)

Pos. No.	Item	Unit	Quan-tity	Equipment and materials, €	Works, €	Cost Estimate, €
HP-1.2.1	**Installation of solar panels at WWPS 1B (260 kW)**					**194 000**
HP-1.2.1.1	Civil works	lumpsum	1	33 000	13 000	46 000
HP-1.2.1.2	PV panels [260 kW]	pcs	450	140	30	76 500
HP-1.2.1.3	Inverters [250 kW]	lumpsum	1	15 000	1 000	16 000
HP-1.2.1.4	Electrical works, power supply	lumpsum	1	15 000	7 000	22 000
HP-1.2.1.5	Automatic control and SCADA	lumpsum	1	4 000	2 000	6 000
HP-1.2.1.6	Site works	lumpsum	1	14 000	3 000	17 000
HP-1.2.1.7	Miscellaneous, 5%	lumpsum	1	8 000	2 000	10 000

7.8 Final Reviewed Investment Programme

At the Investment Programme meeting on 23.05.2024 (see MoM in Annex 3.4) it was agreed that Reviewed Proposed Investment Programme (see Chapter 7.5) by the Consultant will be divided into two projects. However, due to budget restrictions, reconstruction of gravity sewer collector of WWPS 1B will be moved under the 2nd priority project.

Therefore, the final projects were as following:

- **1st Priority Project HP-1** with total cost estimate of 3 683 000 € (excl. VAT)
- 2nd Priority Project HP-2 with total cost estimate of 3 138 000 € (excl. VAT).

Installation of solar panels at WTP (60 kW) was excluded from the programme as the land ownership of the proposed location was not clear. There was a dispute between two owners (HPM and the private person), who both pledge the ownership of a plot of land with overlapping boundaries.

Table 65: Horishni Plavni; Total Cost Estimate of the 1st Priority Project HP-1

No	Item	Cost Estimate, EUR
HP-1.1	Construction of WWPS 1B	2 639 000
HP-1.1.1	Construction of new WWPS at the same site	2 639 000
HP-1.2	Installation of alternative power sources	194 000
HP-1.2.1	Installation of solar panels at WWPS 1B (260 kW)	194 000
HP-1.3	**Subtotal**	**2 833 000**
HP-1.4	Design and cost estimate documentation 10%	283 000
HP-1.5	Contingency 20%	567 000
HP-1.6	**Total**	**3 683 000**

Table 66: Horishni Plavni; Total Cost Estimate of the 2nd Priority Project HP-2

No	Item	Cost Estimate, EUR
HP-1.1	Construction of WWPS 1B	600 000
HP-1.1.2	Renovation of WWPS 1 B gravity sewer collector	600 000
HP-2.1	Reconstruction of WWPS 8	865 000
HP-2.1.1	Reconstruction of WWPS 8	805 000
HP-2.1.2	Renovation of gravity sewer collector	60 000
HP-2.2	Reconstruction of WWPS 9	949 000
HP-2.2.1	Reconstruction of WWPS 9	853 000
HP-2.2.2	Renovation of gravity sewer collector	96 000
HP-2.3	**Subtotal**	**2 414 000**
HP-2.4	Design and cost estimate documentation 10%	241 000
HP-2.5	Contingency 20%	483 000
HP-2.6	**Total**	**3 138 000**

7.9 Investment Programme Benefits and Savings

Below the benefits and savings of each finally proposed projects (HP-1 and HP-2) are established separately.

7.9.1 Benefits and Savings of 1st Priority Project HP-1

Replacement (new construction) of WWPS 1B

By installing new, more efficient (and more precisely selected) pumps, the pumping efficiency at WWPS 1B is expected to be improved by 6%. For comparison of pumping efficiency International Water Association (IWA**)** recommends to use **Ph5 energy consumption** (kWh/m³/100 m)[18]: unitary energy consumption for pumping of 1 m³ multiplied by the pump head and divided by 100 m. In another words it is the average amount of energy consumed per m³ at a standard pump head of 100 m. It is normally in the order of 0.5 kWh/m³ at 100 m. For the reference of new efficient pumps, the value of 0.35 kWh/m³ is used in Table 67 below.

Potential annual savings in power consumption compared to the baseline (i. e. pumping of the same amount of water) are estimated to 100 262 kWh. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

Table 67: Horishni Plavni; Savings on Pump Efficiency Improvement

	Pumped water volume	Average pressure	Standard energy consumption	Potential annual saving	
	m³/year	m	kWh/m³/100 m	kWh/year	€
Total	**3 317 563**			**109 733**	**17 494**
WWPS 1B	1 658 782	24,0	0,60	100 262	15 984
WWPS 8	485 481	25,8	0,43	9 471	1 510
WWPS 9	1 173 301	25,4	0,25	no savings	no savings

The power savings at WWPS 1B described above will result in annual reduction of CO_{2eqv} in the amount of 80 210 kg/year. The CO_{2eqv} reduction was calculated considering 0.8 kg/kWh carbon intensity of Ukraine's power mix.

7.9.2 Benefits and Savings of 2nd Priority Project HP-2

Reconstruction of WWPS8 and WWPS9

The pumps at both WWPS are already operating quite efficient (see Table 67 above). Therefore, no significant savings can be estimated:

- WWPS 8 will give a saving in 9 500 kWh annually;
- WWPS 9 will not give a power saving effect at all. Which is quite logical as there are new efficient pumps installed recently (years 2020 – 2023).

The power savings at WWPS 8 described above will result in annual reduction of CO_{2eqv} in the amount of 7 600 kg/year. Other effects are not generated within the project (or have very insignificant not worth mentioning effects).

[18] Key performance Indicator (KPI) recommended by IWA-PI (International Water Association Performance Indicator)

7.9.3 Benefits and Savings of SPP at WWPS 1B

Initial Data:

- Annual energy production: 291 MWh (which covers 7.2% of total energy consumed by water utility).
- CO_2 emissions reduction: 233 tons per year.
- Estimated cost of the solar power plant: 194 000 € (excl. VAT).

Economic Benefits:

- Reduction in electricity costs: The solar power plant enables the production of self-generated electricity, reducing dependency on traditional energy sources and lowering electricity expenses. Considering the annual energy production of 291 MWh, savings on electricity are estimated in Chapter 7.10.

Environmental Benefits:

- Reduction in CO_2 emissions: The installation of a solar power plant reduces CO_2 emissions by 233 tons per year. This significantly improves the environmental situation and reduces the negative impact on the environment. Lower emissions contribute to combating climate change and improving air quality.

Social Benefits:

- Increase in energy independence: The solar power plant contributes to the region's or country's energy independence, reducing reliance on imported energy resources.
- Job creation: Renewable energy projects create new jobs during the installation, maintenance, and management phases of the power plant.

Savings:

- Depreciation and return on investment: The cost of installing the solar power plant is 194 000 € (excl. VAT). The payback period for the investment depends on the savings on electricity costs and is calculated in Chapter 7.10 below.
- Reduction in operating costs: Solar power plants have relatively low maintenance costs compared to traditional energy sources, further reducing long-term expenses.

7.10 Financial Analysis

Total budget for from construction of new WWPS 1B and installing of alternative power source in Horishni Plavni is **3 683 000 €** (without VAT).

Potential savings in electric energy from construction of new WWPS at the same site with more efficient pumps is accounted for 100 262 kWh per year, which makes total annual saving as of 15 984 € (energy price estimated around 0.16 € per kWh, without VAT).

Potential savings from installation of solar panels (e.g. estimated production of electric energy from solar panels at WWPS 1B) are as following:

SPP – production of solar energy from panels at WWPS 1B is 291 MWh per year.

Therefore, total saving from production of solar energy for enterprise´s internal purposes and therefore substituting energy purchase from networks is 46 560 € (energy price estimated to be 0.16 € per kWh or 160 € per MWh, without VAT).

Combining both factors of electric energy savings, we can estimate total impact on enterprise`s energy consumption to be as much as 62 602 € per year.

Regarding investment other savings cannot be monetarised in reasonable extent as they are not substantial in estimating cost effectiveness of investment.

Therefore, payback time **without grant** for the whole investment will be **58.8 years**, which is way beyond reasonable time span of investment in terms of economic risks. Therefore, additional grant is needed for economic viability of investment.

Considering **co-financing** rate proposed by the city (24.44 %) for municipal funds the payback time will be much shorter – **14.4** years for equity invested, which is within economically acceptable limits for water enterprise.

8 Investment Programme Summary

After Consultant's review of preliminary proposed programme and approval of it by local communities the final investment programme (as stipulated in the table below) was formulated. 1st priority projects summarise to 10.91 M€ (excl. VAT), which considering higher than requested minimum co-financing by Lutsk and Horishni Plavni municipalities is fitting initially reserved budget of 10.5 M€ (excl. VAT).

Total co-financing from the communities is summarising to 20.05%.

Table 68: Investment Programme Summary (excl. VAT)

Pos.	City	Unit	Khmelnitskyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate	M€	2.514	2.711	2.002	3.683	10.910
3	of total	%	23%	25%	18%	34%	100%
4	incl. co-financing	M€	0.415	0.542	0.330	0.900	2.187
5		%	16.50%	20.00%	16.50%	24.44%	20.05%
6	2nd Priority Projects		Khm-1	Lt-2	Lb-2	HP-2	
7	Cost Estimate	M€	5.478	1.569	4.052	3.264	14.363
8	3rd Priority Projects		Khm-3				
9	Cost Estimate	M€	13.000				13.000
10	Total Cost Estimate	M€	20.992	4.280	6.054	6.947	38.273
11	of total	%	55%	11%	16%	18%	100%

1st priority project estimated savings are summarised in the table below. In total four projects should save 4 547 MWh annually.

By far Lt-1 has the best savings numbers, which are explained with much larger (more energy consuming) equipment. Energy savings from efficiency improvement for Khmelnytskyi are negative, as new process unit for WWTP is introduced by the project.

Table 69: 1st Priority Project Savings Summary

Pos.	City	Unit	Khmelnyts-kyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate (excl. VAT)	M€	2.514	2.711	2.002	3.683	**10.910**
3	Total Energy savings	MWh/a	807	2 471	878	391	**4 547**
4	Energy savings from efficiency improvement	MWh/a	-174	984	144	100	**1 054**
5	Generated energy by SPP	MWh/a	981	1 487	734	291	**3 493**
6	Total CO_2 emission savings	t/a	646	1 977	702	313	**3 638**
7	from efficiency improvement	t/a	-139	787	115	80	**843**
8	from SPP energy generation	t/a	785	1 190	587	233	**2 794**

Total savings of all four projects expressed in monetary value are estimated to 0,728 M€/year, which summarises in payback period of 15 years (while considering only co-financing component of the investment the summary payback period is estimated to 3 years).

Table 70: 1st Priority Project Monetary Savings Summary (excl. VAT)

Pos.	City	Unit	Khmelnyts-kyi	Lutsk	Lubny	Horishni Plavni	Total
1	1st Priority Projects		Khm-2	Lt-1	Lb-1	HP-1	
2	Cost Estimate	M€	2.514	2.711	2.002	3.683	10.910
3	incl. cofinancing	M€	0.415	0.542	0.330	0.900	2.187

Pos.	City	Unit	Khmelnyts-kyi	Lutsk	Lubny	Horishni Plavni	Total
4	Total energy savings	MWh/a	807	2 471	878	391	4 547
5	Energy savings from efficiency improvement	MWh/a	-174	984	144	100	1 054
6	Total generated energy by SPP	MWh/a	981	1 487	734	291	3 493
7	Total savings	M€/year	0.129	0.395	0.140	0.063	0.728
8	Energy savings from efficiency improvement	M€/year	-0.028	0.157	0.023	0.016	0.169
9	Total generated energy by SPP	M€/year	0.157	0.238	0.117	0.047	0.559
10	Total payback time	year	19	7	14	59	15
11	Cofinancing payback time	year	3	1	2	14	3

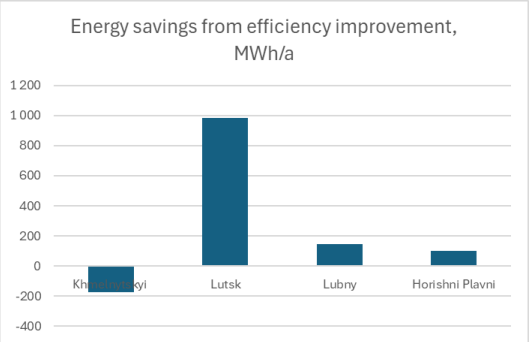


Figure 26: Summary; Energy Savings from Efficiency Improvement

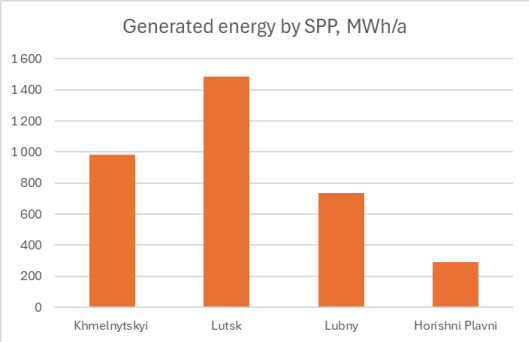


Figure 27: Summary; Estimated Generated Energy by SPP

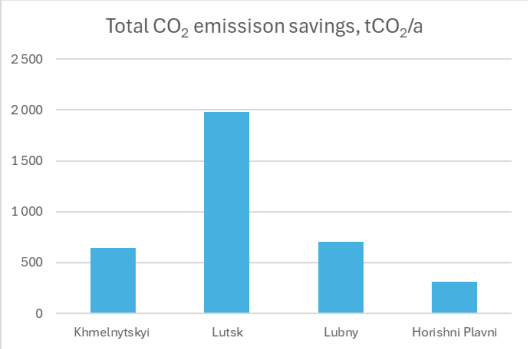


Figure 28: Summary; Estimated Total CO_2 Emissison Savings

APPENDIX 2

Lutskvodokanal (LVK)

Simulation of joint operation of WWPS 1, 2 and 5

1 General

The pump performance calculations given below are preliminary and their results allow for the preparation of a procurement plan and preliminary cost estimates. It is assumed that a more precise determination of the operating points of each pump will be made after connection to the existing consumption level and lift height.

2 Initial data

The initial data on pumping stations and pressure lines were provided by LVK.

Table 1: Elevation marks

	Absolute altitude, m
WWPS No.1, pump axis	178
WWPS No.2, pump axis	170
WWPS No.5, pump axis	181
WWPS No.5A, pump axis	181
Pipe axis at the switching point on WWPS No.1	185
Wastewater inlet into the receiving chamber of the WWTP	199

Table 2: Pressure pipes

	Length, m	Diameter, mm	Material tube	Roughness coefficient (Hazen - Williams)
From switching of the WWPS1 pre-chamber, line 1	45	1020	Steel	30
From switching of the WWPS1 pre-chamber, line 2	45	1020	Steel	30
From switching of the WWPS2 pre-chamber, line 1	2210	720	Steel	30
From switching of the WWPS2 pre-chamber, line 2	305	720	Steel	30
	1200	630	PE	100
	705	720	Steel	30
From switching of the WWPS5 pre-chamber, line 1	1050	720	Steel	30
From switching of the WWPS5 pre-chamber, line 2	1050	720	Steel	30
Switching chamber to OSK, line 1	3320	1200	reinforced concrete	30
Switching chamber to OSK, line 2	3320	1000	reinforced concrete	30

Table 3: Existing pumps

	Brand	Nominal flow rate, m3/hour	Lifting height, m	Notes*
WWPS No.1				

	Brand	Nominal flow rate, m3/hour	Lifting height, m	Notes*
Pump 1	FG 800/33	800	33	Replaced with a new one
Pump 2	DF 500/33	500	33	Operated
Pump 3				Dismantled
Pump 4	DF 500/33	500	33	Operated
WWPS No.2				
Pump 1	DF 1000-53	1000	53	Stand by
Pump 2	DF 1000-53	1000	53	Stand by
Pump 3	DF 1000-53	1000	53	Replaced with a new one
Pump 4	KSM250TA+1800042N/RF (CAPRAR)	1000	53	Replaced with a new one
WWPS No.5				
Pump 1	DF 1000-53	800	33	Replaced with a new one
Pump 2	HYDRO-VACUUM FZE.8	1000	33	Replaced with a new one
Pump 3	DF 1000-33	800	33	Stand by
Pump 4				Replaced with a new one
Pump 5	DF 1000-33	1000	33	Stand by
WWPS No.5A				
Pump 1				Dismantled
Pump 2	DF 1000-33	1000	33	Operated
Pump 3	FG-800/33	800	33	Operated
Pump 4	FG-800/33	800	33	Stand by

**** Information on the actual situation is subject to clarification by the LVK during the preparation of feasibility study***

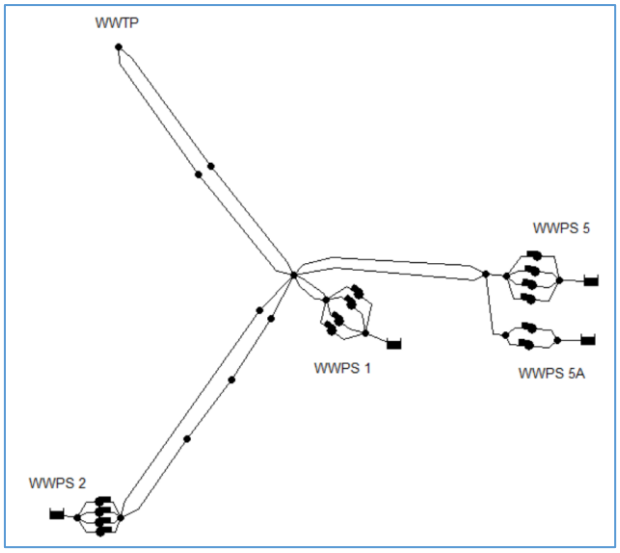
Table 4: Required pumping station capacity

	Average, m3/ day	Maximum, m3/ day
WWPS No.1	8,000	12,000
WWPS No.2	19,000	28,000
WWPS No.5	22,000	35,000
Total is received by USC	49,000	75,000

3 Calculations

3.1 Provisional Hydraulic model

The calculation was carried out using a hydraulic model built on the basis of the EPANET 2.0 software application, which included all pumps and pipes.



Drawing 1: Configuration of hydraulic model.

3.2 Methodology

First of all, pumps were selected to operate in the average flow mode, based on the fact that this flow is pumped by one new pump.

Table 5: Average operating mode of pumps

	Pump	Necessary consumption		Operating flow, m3/hour	Working lifting height, m w.c.	Pump speed
		M3/ day	m3/hour			
WWPS No.1	Pump 1	8000	333	346	24	100%
WWPS No.2	Pump 1	19,000	792	810	35	100%
WWPS no.5	Pump 1	22,000	917	936	21	100%
Total		49,000	2,042	2,092		

Next, it was checked how the selected pumps operate in the maximum flow mode, when at least two pumps operate in each pumping station. The calculation results show that the pumps selected for the average mode in pumping stations 1 and 2 could not operate in parallel with the existing old pumps, since the pressure of the new ones is significantly less than that of the old ones. But, at the same time, one old pump pumped the full maximum flow without the help of a new pump. The maximum mode occurs only during a long rainy period and during snowmelt. Estimated at about 10% of the total number of pump operating hours.

Table 6: Maximum operating mode of pumps

	Pump	Necessary consumption		Operating flow, m3/hour	Working lifting height, m w.c.	Pump speed
		m3/ day	m3/hour			
WWPS No.1	Pump 3	12,000	500	554	30	100%
WWPS No.2	Pump 3	8,000	1,167	1,282	35	100%
	Pump 1	35,000	1,458	1,548	21	100%

	Pump	Necessary consumption		Operating flow, m3/hour	Working lifting height, m w.c.	Pump speed
		m3/ day	m3/hour			
WWPS No.5	Pump 3					100%
Total		75,000	3,125	3,384		

It is much more expedient to replace two pumps in WWPS1 and WWPS2, so that the new pumps can operate in maximum mode. In this case, the nominal lifting height of the new pumps will be only two to three meters higher, and their speed will need to be slightly reduced by sound frequency converters.

Table 4: Recommended pumps

	Pump	Necessary consumption		Operating flow, m3/hour	Working lifting height, m w.c.	Pump speed
		m3/ day	m3/hour			
Average consumption mode						
WWPS No.1	Pump 1	8000	333	346	24	98%
WWPS No.2	Pump 1	19,000	792	817	35	98%
WWPS No.5	Pump 1	22,000	917	929	23	94%
Total		49,000	2,042	2,092		
Maximum flow mode						
WWPS No.1	Pump 1 and 3	12,000	500	540 (270 each)	29	100%
WWPS No 2	Pump 1 and 2	28,000	1,167	1,202 (601 each)	43	100%
WWPS No.5	Pump 1 and 3	35,000	1,458	1,468 (734 each)	31	100%
Total		75,000	3,125	3,211		

Based on the above it is suggested replacing at least two pumps at each pumping station:

- **At WWPS1 pumps 1 and 3**
- **At WWPS2 pumps 1 and 2**
- **At WWPS5 pumps 1 and 3 and do not store the new pump 4.**

APPENDIX 3

Results framework template

Programme: Rehabilitation of wastewater services in four cities of Ukraine: Horishni Plavni, Lubny, Lutsk, Khmelnytskyi

Project objective and results framework

Project Title			
Outcome			
Outcome indicator			
Baseline	Year		
Target	Year		

Output 1			
Output indicator			
Baseline	Year		
Target	Year 1		
Target	Year 2		

Output 2			
Output indicator			
Baseline	Year		
Target	Year 1		
Target	Year 2		

Output "n"			
Output indicator			
Baseline	Year		
Target	Year 1		
Target	Year 2		

Annex 3

Securedmail manuals

How to send a secure message to a Securedmail user *procurement@nefco.int*:

Go to the website *www.securedmail.eu*.

Type recipient's email address **procurement@nefco.int** into the field “Send a secure message to a recipient” and click "Send".

Alternatively, you can attach this link to your browser:
https://www.securedmail.eu/message/procurement@nefco.int

A display for composing the secured message opens. Type your own e-mail address in the uppermost field. A delivery confirmation request will be sent to this address to verity your identity. Type the subject, message and include attachment(s). You can accept the suggested random password or replace it and enter your own password. The password is delivered automatically to the recipient's mobile phone via SMS.

Click “Send”.

You will receive a confirmation request from the Securedmail server to your e-mail address, and you’ll have to confirm it by clicking a link in the message. **The message will not be sent to the recipient until you have clicked the confirmation!**

In case you do not succeed in sending the proposal though the system, please contact the responsible person at Nefco or *procurement@nefco.int* or *nelly.eriksson@nefco.int* for further assistance before the deadline of submission.