Interreg North Sea
Co-funded by the European Union
WaterWarmth

PRODUCT SHEET

FEASIBILITY STUDY

QUICKSCAN → PRE-FEASIBILITY → FEASIBILITY

What is a feasibility study?

An aquathermal energy feasibility study is a detailed study evaluating the technical, legal and financial viability of the project. Its main aim is to provide the project owner with all the information needed to make an investment decision.
A feasibility study provides an answer to the following questions:

1. What is the thermal impact on the water body of the project?
2. What is the best technical concept for aquathermal energy? Stand-alone or combined with other technologies? Which configuration is most suited?
3. Can the public water authorities and the environmental agency give a 'pre-agreement' for this project?
4. What will be the financial situation of the project (in comparison with alternative scenarios)?

While the Quickscan and pre-feasibility studies aim to discover the potential of a project, the feasibility study provides an in-depth analysis on the technical and economical requirements for a successful aquathermal project.

The study should be performed by a practiced expert in aquathermal energy. The deliverable of this study is a decision report, a document that should outline all technical, legal, and financial conditions of the project. This document lets the project owner make a funded investment decision.

Essential parts of the study

1. Site visit (if no pre-feasibility study was conducted)

To truly evaluate the feasibility of a possible project location it is essential to visit the site.

Includes:

- Pictures of current situation or schematics of future situation
- Data collection of building(s): heat and/or cold demand, required supply temperatures, space availability, function/use
- Data collection of the waterbody: depth, flow, flow variations, structure and material of the shore, bathymetry, water quality (temperature, salinity, turbidity, pollutant load). When higher risk is expected and no public data is available, it is advised to launch a measurement campaign.

2. Thermal impact study

Extracting heat or cold from the waterbody changes its temperature. It is important that the temperature change stays within the legal limits. To accurately predict temperature changes in the water a thermal impact study is required. The level of detail of the thermal study is dependent on the waterbody and heat demand. In a pre-feasibility study a non-dynamic thermal impact study (level 1) might suffice for projects with low heat/cold demand in comparison to the total potential of the waterbody. In a regular feasibility study however, a level 2 and level 3 study will always be required since most waterbody regulators demand a thorough impact analysis.

Level 2 thermal study: 1-dimensional dynamic impact study

How? The thermal impact on the waterbody is calculated using specialized software. A digital twin of the waterbody is created and the hourly temperature difference in the waterbody caused by the potential installation is calculated. This software needs to take into account the natural regeneration of heat/cold by weather, soil, … The required input is an hourly thermal load profile of building(s).

Level 3 thermal study: 3-dimensional dynamic impact study

How? Water and heat flows or accumulation of thermal impact are modelled in all directions in the waterbody using specialized software. A digital twin is created and the thermal impact on different parts of the waterbody is simulated. This software needs to take into account the natural regeneration of heat/cold by weather, soil, …

3. Technical concept

A lot of technical options are available for harnessing heat or cold from waterbodies. Typically, two types of systems are distinguished: Closed loop and open loop systems. Within these systems a very broad range of options is available. During the feasibility study choices need to be made in order to come up with one or more feasible concepts. Parameters influencing these choices are:

- Water quality: natural water temperature, turbidity, pollutant load, salinity, algae concentrations, … ;
- Available depth and space;
- Flow and tidal dynamics;
- Structure of the wall of the waterbody and possible mounting points;
- …

The company designing the aquathermal concept needs to look for the best solution in terms of efficiency, ease of use and ease of maintenance, while also respecting the demands of the waterbody authorities.

For projects with multiple heat sources the aquathermal concept needs to be compatible with the other heat sources in terms of temperature, availability and redundancy.

Measuring water quality

When no information on water quality is available a measuring campaign is highly recommended.

How? Some parameters can be measured continuously, over a long period (1 year or more), with sensors, while others will need to be measured by taking samples and analysing these in the lab.

Recommended continuously measured parameters:

- Depth in m
- Turbidity in NTU
- Temperature in °C

Recommended lab-analysed parameters:

- Particle size/distribution of suspended solids
- Concentration of suspended solids in mg/L
- Acidity (pH)
- Chlorine concentrations, Cl- in ppm
- Algae presence

4. Permit screening

In most countries a permit is required for building and operating aquathermal energy infrastructure. Therefor it is important to involve the authorities, who will eventually have to grant these permits, as soon as possible. The aim should be to get a pre-agreement for the project from the authorities, or even to submit a permit request at the end of the feasibility study.

How? Start by finding the right person at the waterbody authority. This is preferably someone who can evaluate and grant permits. Then, perform the thermal impact study and concept design and present this to the contact at the waterbody authority. Collect feedback and optimize the design. Repeat until an agreement can be found on the concept design.

5. Financial analysis

A financial analysis of an aquathermal energy project consists of these steps:

1. Calculate costs
   a. Capital Expenditures (CAPEX)
      The Capital Expenditures of a project are the initial investment costs for designing and building the installation. If a project consists of multiple energy sources, the CAPEX also includes the investment costs for these technologies.
   b. Operational Expenditures (OPEX)
      The Operational Expenditures of a project are all costs during operation of the installation: maintenance, insurance, energy consumption, …

c. Replacement Expenditures (REPEX)
The various components have a certain expected lifespan, and at some point during the operational period of the installation, they will need to be replaced. The Replacement Expenditures estimate the total cost of replacements during the total lifetime of the project and translate this to a yearly cost for replacement parts and working hours.

2. Calculate revenue
   a. Energy savings or energy sales
   The revenue of a project can be expressed as a saving on energy costs or as return from the sale of energy, depending on who is investing in the project. If the investor is also the user of the heat/cold, the return consists of avoided energy costs. If a third party invests in the energy concept and subsequently sells heat/cold, the return is the sum of all purchased energy and any other charged amounts.
   b. Subsidies and other incentives
   In most European countries subsidies exist for sustainable heating projects. Some common forms of subsidies are: investment grants, operational subsidies and innovation subsidies. Other financial incentives exist, for example tax credits or reductions, low-interest loans and emission certificates.
   These subsidies and incentives must be investigated and, if relevant, included in the financial calculation.

3. Calculate financial parameters
The aim of an investment project is that it is at least financially attractive to the party making the investment. What this exactly means depends on the goals of the possible investor. Typically the financial trigger for a third party is higher than for an end consumer investing in their own installation. Different parameters exist for evaluating the financial results of an investment.

a. Net Present Value (NPV)
b. Internal Rate of Return (IRR)
c. Levelized Cost of Heat (LCOH)

Net Present Value (NPV) is a financial metric used to evaluate the profitability of an investment. It calculates the difference between the present value of expected cash inflows and the present value of cash outflows over the life of a project. A positive NPV means the investment is expected to generate more value than it costs, while a negative NPV indicates a loss. NPV takes into account the time value of money, meaning that future cash flows are worth less than immediate ones.

The Internal Rate of Return (IRR) is the discount rate at which the Net Present Value (NPV) of an investment becomes zero. In other words, it's the rate of return at which the present value of future cash flows equals the initial investment. A higher IRR means a more attractive investment. It's often used to compare different projects or investment options.

The Levelized Cost of Heat (LCOH) is the average cost per unit of heat (in €/MWh) generated over the lifetime of a heating system. It includes all relevant costs—such as investment, operation and maintenance, energy consumption, and financing—spread out over the total heat output. LCOH is a useful metric for comparing different heating technologies or projects on a consistent basis, regardless of scale or timing.

4. Sensitivity analysis
   A sensitivity analysis involves testing how changes in key assumptions affect the project's financial outcomes. For example, it examines how variations in energy prices, investment costs, subsidies, interest rates, or heat demand impact metrics like Net Present Value (NPV), Internal Rate of Return (IRR), or Levelized Cost of Heat (LCOH). This helps identify which factors have the most influence on profitability and where potential risks or uncertainties lie.

5. Scenario comparison
   A financial analysis is carried out for the concept that the aquathermal expert assumes to be the best option. To verify this, it is useful to also examine and calculate alternative concepts. This allows different scenarios to be compared, enabling the potential investor to make the best possible choice.

6. Additional added value

A financial analysis of an aquathermal installation can often be supplemented by an analysis of other forms of added value. For the user of the installation this added value can be a selling point, even when the aquathermal installation is not the cheapest option.

Some examples of added value:

- The installation can greatly reduce the emission of greenhouse gases. It is advised to always calculate CO_2-emmision savings.
- Often aquathermal installations are less visible than aerothermal installations, or require less ground works than geothermal installations.
- In general, aquathermal installations make less noise than aerothermal installations. For residential areas or for schools and offices this can be an important aspect in decision making.

Deliverables

1. Thermal impact report
2. Concept design
    a. Description of the concept design
    b. List of components
    c. Drawings of the design in the waterbody, with spatial dimensions
3. Permit assessment report
4. Financial feasibility report with clear CAPEX and OPEX numbers
5. Scenario analysis, taking into account added value

Requirements for aquathermal expert

The aquathermal expert performing the feasibility study should have a very profound understanding of aquathermal energy and the needs to be sufficiently qualified for performing the feasibility studies. Usually, these kinds of studies will be performed by a team of multiple experts. The minimal requirements for the team performing the feasibility study are:

1. At least 5 years of technical, financial and legal expertise in aquathermal energy;
2. For concepts with multiple energy sources: at least one expert with specific expertise on other (sustainable) energy sources and hydraulic configurations to combine these sources;
3. Profound knowledge of local and national regulations on aquathermal energy is a must. Having active contacts with the significant legal authorities is a big advantage;
4. Able to present at least 5 relevant reference cases