EIB Advisory - JASPERS Energy

District Heating

JASPERS Guide to District Heating Decarbonisation

Francesco Angelini, Sarunas Bruzge, Kaido-Paul Kranfeldt

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European Commission

Jaspers

Joint Assistance to Support Projects in European Regions

European Investment Bank

Purpose and scope of the Guide

JASPERS Guide to decarbonisation of district heating systems:

- Purpose of the Guide is to:
  - Support the assessment of alternative DH decarbonisation options
  - Facilitate the decision-making process for investment in the decarbonisation of DH systems
- Builds on JASPERS and EIB experience with planning and appraisal of DH projects
- It includes systematic, practical advice covering areas where JASPERS most frequently receives requests for assistance from beneficiaries, such as:
  - analysis of the existing situation (e.g., technical, economic, institutional)
  - objective setting
  - options analysis
  - determination of an optimised set of measures
  - compliance with EU financing criteria and State aid rules
  - scoping of the required feasibility studies (Terms of Reference)

District heating decarbonisation – methodological approach

Contribution to strategic options analysis

Market

Policy & strategies

Simplified CBA

Techno-economic performance

Analysis of existing situation

Objectives

Option Analysis

Measures

Investment projects

Institutional set-up

"SWOT"

Multi-criteria Analysis

"Levelised" cost of heat
Local environmental impact
Social acceptance

Security of supply
GHG emissions
Risks

The levelized cost indicator

- The "**levelized cost**" is a commonly used concept in energy economics, particularly when comparing alternative technologies
- This is calculated as the ratio between:
  - (i) the *present value* of the project costs over its life cycle and
  - (ii) the *present value* of the supplied power/heat over the same reference period
- By adding to the project costs the **shadow cost of 'externalities'**, the levelized cost can also be estimated in socioeconomic terms
- The use of levelized costs can be particularly useful at the stage of **option analysis**, e.g., to compare different energy decarbonisation options
- It can be used for **simplified cost-benefit analysis**, e.g., comparing the project levelized costs against the next-best alternative (levelized cost of counterfactual)

The levelized cost of heat

The levelized cost of heat (LCOH) can be estimated in:

- **Financial** terms (at market prices): to check affordability and competitiveness (*promoter*'s point of view)
- **(Socio-)economic** terms: to identify most economically viable solutions (*society*'s point of view)

Financial LCOH	Economic LCOH
+ CAPEX	+ CAPEX
+ O&M costs	+ O&M costs
+ Fuel costs (if relevant)	+ Fuel costs (if relevant)
+ CO_2 Emission Trading System (ETS) allowance costs (if relevant)	+ Social cost of CO_2 emissions
	+ Social cost of SO_2, NO_x and PM
	+ Security-of-supply cost
– Revenue from power sales (if relevant)	– Economic value of power sales (if relevant)
= Net LCOH (financial)	= Net LCOH (economic)

A worked example

Estimate the LCOH for a new 20 MW_{th} biomass heat-only boiler for a DH system

- **Economic life**: 15 years of operations; **Heat demand,** long term forecast
- **Investment cost**: EUR 9m; (social) opportunity **cost of capital**: 5%
- **O&M costs**: 3% of investment cost p.a.; **fuel cost**: 20 EUR/MWh_f
- **Load factor**: 66%; **efficiency**: 85%
- **Shadow cost of CO2**: EIB CBR; Environmental **externalities** (airborne pollutants): 4.30 EUR/MWh_{th}

EUR	**NPV@ 5%**	**2021**	**2022**	**2023**	**2024**	**2025**	**…**	**2030**	**…**	**2037**
Investment cost	8,367,347	4,500,000	4,500,000							
Fuel costs	25,614,953	-	-	2,720,753	2,720,753	2,720,753		2,720,753		2,720,753
Other O&M costs	2,541,957	-	-	270,000	270,000	270,000		270,000		270,000
Total costs (excl. "externalities")	**36,524,257**	**4,500,000**	**4,500,000**	**2,990,753**	**2,990,753**	**2,990,753**		**2,990,753**		**2,990,753**
Shadow cost of CO2 emissions	-	-	-	-	-	-		-		-
Shadow cost of airborne pollutants	4,646,360	-	-	493,524	493,524	493,524		493,524		493,524
Total socio-economic cost	**41,170,616**	**4,500,000**	**4,500,000**	**3,484,277**	**3,484,277**	**3,484,277**		**3,484,277**		**3,484,277**
Heat Produced (MWh)	1,088,635	-	-	115,632	115,632	115,632		115,632		115,632

A worked example

- **Financial LCOH** = EUR 36,524,257 / 1,088,635 MWh = 34 EUR/MWh
- **Economic LCOH** = EUR 41,170,616 / 1,088,635 MWh = 38 EUR/MWh
- By dividing the net present value (NPV) of the single cost components by the NPV of the energy generated, the levelized cost subcomponents can also be estimated
- By adding the DH distribution cost (network – take losses into account too) one can compare the competitiveness against individual heating solutions (e.g. Vs. LCOH of an individual heat pump)

LCOH example – Biomass boiler (EUR/MWh)	
Capital cost	8
Fuel cost	24
Other operating and maintenance costs	2
LCOH – financial	**34**
Shadow cost of CO_2 emissions	-
Shadow cost of airborne pollutants	4
LCOH – economic	**38**

Disclaimer: the costs do not reflect current market conditions!
The example is taken from the European Commission' Economic Appraisal Vademecum (see Annex II on Renewable Energy).

Taking decisions – Multi-Criteria Analysis

- Multi-Criteria Analysis is one of the decision-making tools, allowing **to compare** different **options** based on several **different criteria** (considering trade-offs).
- It allows to **tailor the decision** to the specific situation by selecting the **appropriate criteria** (e.g. price, environmental, social, political aspects).
- Criteria can be added different weights factoring their **different importance** for the decision making.
- Multi-Criteria Analysis allows to take into account the interests of different stakeholders

Multi-Criteria Analysis – main steps

Objective
- Description of the main objective

Criteria
- Identification of criteria against which the options will be evaluated

Importance of the criteria
- Setting up the criteria weights

Normalisation
- Making data comparable

Scoring and evaluation
- Setting the values for the options against criteria, calculating the multicriteria score

Multi-Criteria Analysis - example

Options	Evaluation criteria				MCA score	Ranking
	LCOH	GHG emissions	Efficient DH system	Lock-in effect		
Option A	8	5	5	8	218	3
Option B	7	6	5	5	200	4
Option C	9	10	5	4	254	1
Option D	5	8	5	9	224	2
Criteria weight (1 - 10)	10	10	8	6		

Starting the process – Feasibility Study (FS)

- Should be looked in the context of overall ***Project Life Cycle*** and Project Management
- Objective is ***to help decision makers*** to determine whether or not a proposed investment is likely to be successful
- Difference between ***pre-feasibility and feasibility study*** is how deep the analysis will be. Sometimes it is feasible to prepare more general type of study before spending substantial resources for comprehensive study.

Source: UNIDO.

Starting the process – Feasibility Study (FS)

- FS study may be conducted by a team of organisation’s specialists and managers. If they lack expertise or they have no time to do the work internally, it maybe outsourced to ***external consultant.***
- In order to procure the feasibility study, the important part is the ***good Terms of Reference*** (ToR).
- There is no uniform template for ToR, but it always includes ***scope of work*** to be performed by the consultant, which are ***project specific***.
- We have developed ***sample template*** what decarbonisation FS report could include as ***Annex I of the DH Guide***

1) Abbreviations
2) Definitions
3) Executive summary
4) Introduction
5) Policy, legal and institutional framework
6) General description of the municipality and urban area(s)
7) Heating supply service provider
8) Analysis of the current heating system
9) Assessment of the current state of the district heating system
10) Heat demand analysis and forecast
11) Setting decarbonisation objectives
12) Description of potential decarbonisation measures
13) Developing decarbonisation scenarios and options
14) Comparison of decarbonisation scenarios and options
15) Detailed development, description and evaluation of the preferred realistic options
16) Levelised cost of heat calculation for selected options
17) Description of the optimal decarbonisation action plan
18) Recommendations and next steps

Starting the process – Feasibility Study (FS)

- **Competitive DH system:** suitable cheap heat sources, demands from the heat market, pipes that connects the demands and the sources.
- DH systems, often build in 20 century, were designed for past operating conditions. Existing DH systems typically operate at high temperatures (about 100 0C) and rely on centralised heat production through fuel combustion
  - ➢ Waste and renewable heat sources like geothermal, solar as well and heat pump and storage solutions assume **lower temperatures**
  - ➢ Transition to the sustainable future proof and resilient DH system is complex task and **holistic approach** is necessary.
  - ➢ Techno-economical **modelling and simulation tools** (software) are necessary
- Multiple stakeholder's (including building's owners) perspectives should be part of the transition: the proposed solutions should take into account also **transitional phase**, social dynamics, institutional factors and political context. These aspects are sometimes overlooked.
  - ➢ Transition requires **partnership and cooperation**

Find out more on our activities:

JASPERS support for the clean energy transition

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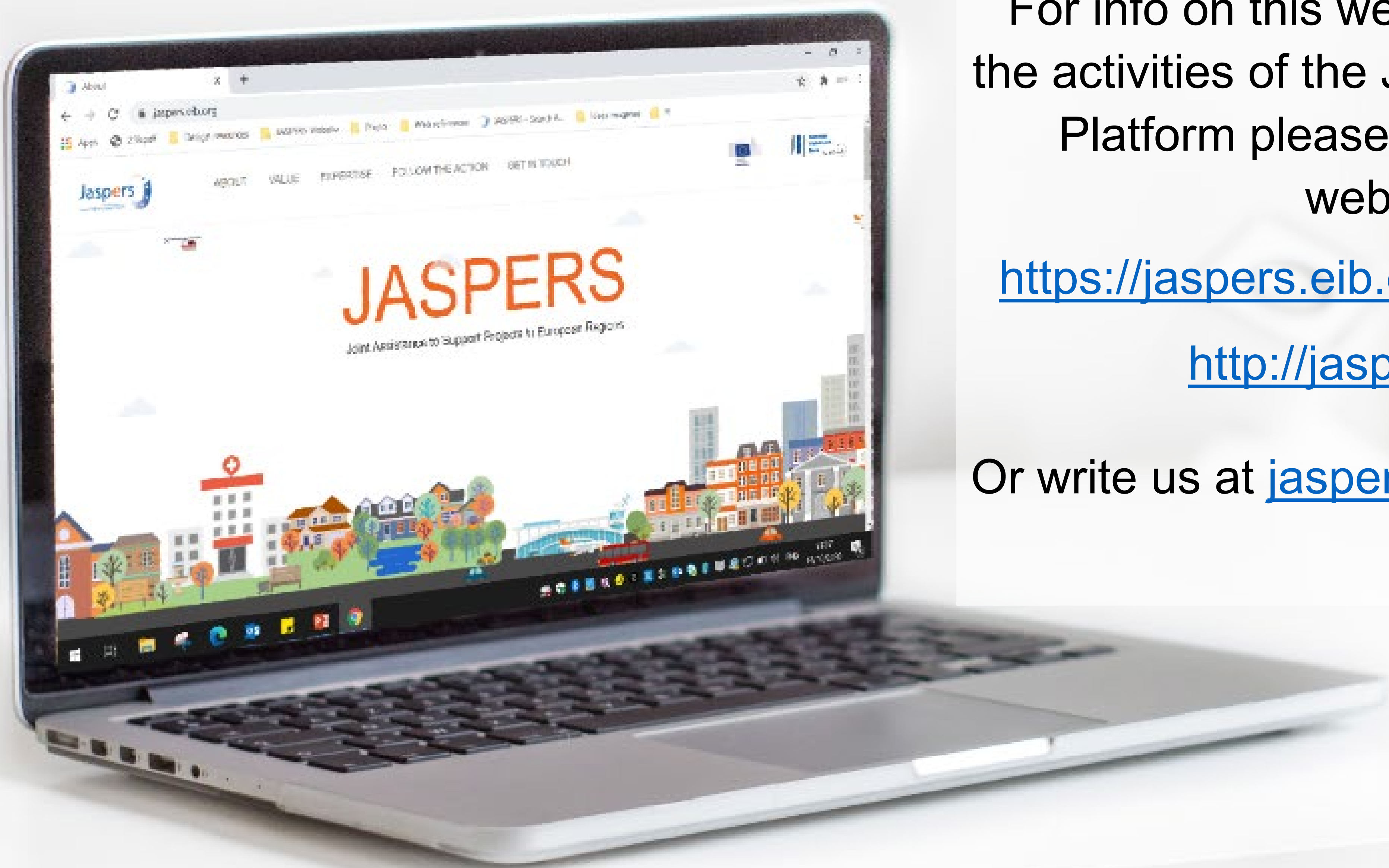
Energy Advisory and Energy Efficiency
European Investment Bank

jaspers@eib.org



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