Technical Validation Pack

A source-linked summary of the research behind Sympheny's optimisation engine. Prepared for technical reviewers, engineering teams, procurement teams, and internal champions who need a concise evidence trail.

Bottom line: Sympheny is not a reporting layer on top of spreadsheets. It is an optimisation workflow for multi-carrier energy systems, built around published methods for modelling networks, technologies, storage, and hourly operation in one decision process.

What the engine is built on

Multi-energy modelling	Energy-hub formulations for electricity, heat, cooling, gas, hydrogen, conversion technologies, and storage.
Optimisation	Mixed-integer linear programming (MILP) for technology sizing, operational scheduling, and multi-objective trade-offs.
Networks	Methods that account for district heating layout, thermal networks, and electrical grid constraints.
Scaling	Clustering, temporal decomposition, and rolling-horizon approaches that make large scenario sets practical.
Decision workflow	Structured design methods that connect modelling outputs to project decisions before capital is committed.

Validated claims and source links

10-100x reported solve-time reduction

What it supports	Multi-scale and rolling-horizon methods make larger urban and district optimisation problems practical in planning time.
Source	Marquant et al., Applied Energy 2017; Marquant et al., Procedia Computer Science 2015
Link	Applied Energy DOI Procedia DOI

40% more renewables without grid upgrades in a published case

What it supports	Grid-aware optimisation can coordinate distributed energy design and operation with electrical constraints.
Source	Morvaj et al., Applied Energy 2016
Link	Applied Energy DOI

23% lower emissions at the same cost in a district-heating case

What it supports	A simultaneous model for technology sizing, operation, and district-heating layout can reveal cost-neutral emissions improvements.
Source	Morvaj et al., Energy 2016
Link	Energy DOI

Public Modelica/Sympheny district dataset

What it supports	Technical reviewers can inspect a public district-scale reference dataset connected to the structured design research.
Source	LBNL Simulation Research Group
Link	GitHub dataset

Key references

Platform-based design for energy systems

Authors	Sulzer, Wetter, Mutschler, Sangiovanni-Vincentelli
Venue	Applied Energy, 2023
Why it matters	Explains why complex, sector-coupled energy systems need reusable digital design workflows. Useful for understanding the bridge between research methods and a productized planning workflow.
Link	DOI

Optimization-based planning of local energy systems - bridging the research-practice gap

Authors	Bollinger, Marquant, Sulzer
Venue	IOP Conference Series, 2019
Why it matters	Identifies the practical ingredients needed to move mature optimisation methods into real planning: stakeholder iteration, temporal decomposition, automation, and KPI visualisation.
Link	DOI

A holarchic approach for multi-scale distributed energy system optimisation

Authors	Marquant, Bollinger, Evins, Carmeliet
Venue	Applied Energy, 2017
Why it matters	Core multi-scale optimisation paper behind city and district modelling. It connects building-level detail with larger district models and reports major solve-time reductions.
Link	DOI

Optimization framework for distributed energy systems with integrated electrical grid constraints

Authors	Morvaj, Evins, Carmeliet
Venue	Applied Energy, 2016
Why it matters	Adds electrical grid constraints to distributed energy optimisation, supporting designs that account for voltage, current, and grid-upgrade implications.
Link	DOI

The Ehub Modeling Tool

Authors	Bollinger, Dorer
Venue	Energy Procedia, 2017
Why it matters	Open-source precursor showing how raw district data can be translated into executable optimisation models and interpretable outputs.
Link	DOI

Open-access and product evidence

Open dataset	Modelica/Sympheny district dataset
Research page	sympheny.com/research
Case studies	sympheny.com/case-studies

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