Lessons learnt from the Italian cases (Reggio Emilia, Lodi, Cremona)

The Italian frontrunner cases (Reggio Emilia, Lodi, and Cremona) provide practical and transferable insights for district heating (DH) systems characterised by high operating temperatures, fossil-based supply, and increasing integration of renewable energy sources (RES) and waste heat (WH).
The following sections summarise the key lessons learnt and common pitfalls observed across the cases, with a focus on actionable aspects for replication in the Italian DH context. The insights are particularly relevant for replication in DH systems with similar characteristics and constraints.

Key messages

- High-quality data and modelling are prerequisites for reliable decarbonisation planning
- Early stakeholder engagement is essential to access data and enable realistic analyses
- Heat pumps and thermal storage are key technologies for integrating RES and waste heat
- Regulatory uncertainty remains a major barrier for investment decisions in the Italian context.

Learnt From the Frontrunner Case

A first key lesson concerns **the central role of data and modelling**. Reliable decarbonisation planning requires high-resolution operational data and a well-calibrated baseline model. In practice, this means collecting detailed hourly data (e.g. heat production, temperatures, load profiles) and validating them directly with the operator. Modelling tools such as EnergyPRO are essential not only for technical analysis but also to support discussions with operators and evaluate alternative scenarios.

Another important lesson relates to **stakeholder engagement**. Early and continuous involvement of key actors—such as municipalities, system operators, and external stakeholders (e.g. wastewater treatment plant operators)—facilitates access to data, enables site visits, and improves the understanding of system behaviour, including seasonal variability of heat sources. At the same time, defining a structured work plan and clear data requests from the beginning is essential to ensure efficient collaboration.

From a system planning perspective, the integration of RES and WH requires a solid territorial approach. **Mapping both heat demand and available sources** (industrial heat, wastewater, ambient sources) is a fundamental step to identify viable options.

In particular, wastewater treatment plants emerge as strategic sources in the Italian context: despite relatively low temperatures, they provide stable, continuous, and predictable heat flows, which can be effectively integrated through large-scale heat pumps.

The analysed cases also highlight **the importance of considering system operation when introducing new technologies**. Decarbonisation is not simply about adding new heat sources, but about integrating them into an existing system. Detailed hourly techno-economic simulations are necessary to assess the impact of additional or alternative sources. In this context, large-scale heat pumps and thermal storage play a key role. Heat pumps enable the use of low-grade heat, while thermal storage is essential to avoid competition between sources, ensure flexibility, and optimise system operation, including peak load management. The economic viability and large-scale deployment of heat pumps are strongly influenced by **electricity prices** and market conditions, which can significantly affect their competitiveness compared to conventional solutions.

Finally, decarbonisation pathways must be framed within **realistic planning and regulatory conditions**. The implementation of RES and WH solutions requires long lead times (feasibility studies, permitting, financing, construction) and must be aligned with the operator's investment cycles. Economic feasibility remains a key challenge and is strongly dependent on national support schemes, energy prices, and investment conditions. At the same time, regulatory uncertainty—particularly related to the incomplete transposition of the Energy Efficiency Directive (EED) and the coexistence of EED, RED III, and EPBD—represents a significant barrier. In this context, adopting a flexible approach and testing different regulatory scenarios is essential to support robust decision-making.

Worst Practices:

Several recurring pitfalls emerged across the analysed cases.

A first critical issue is the underestimation of **data-related efforts**. The collection and validation of operational data for modelling the initial system configuration proved to be significantly more complex and time-consuming than expected. Without sufficient time and structured data requests, this phase can delay the entire analysis.

Another common weakness concerns **stakeholder coordination**. The absence of a clear and structured collaboration plan with operators and relevant stakeholders can lead to inefficient interactions, repeated data requests, and limited usefulness of the results. Without early engagement, access to key information (e.g. from external heat source operators) can also be constrained.

Unrealistic planning assumptions represent an additional risk. Decarbonisation scenarios are often developed without fully considering internal constraints, particularly the operator's industrial plan, which is not always accessible or directly influenceable. As a result, technically sound solutions may not be implementable in practice, especially in the short term.

From a technical perspective, an important pitfall is the evaluation of theoretical RES and WH potentials without applying **practical feasibility criteria**. Ignoring aspects such as distance from the network, temperature levels, continuity of supply, and integration constraints may lead to unrealistic scenarios.

Another frequent issue is underestimating **system integration challenges**. Introducing new heat sources without considering their interaction with existing base-load production can result in operational inefficiencies or conflicts between technologies. In particular, neglecting system integration aspects (e.g. interaction between sources and the role of thermal storage) can compromise system performance.

Finally, **regulatory aspects** are often oversimplified. Evaluating compliance based on a single interpretation of current regulations, or ignoring ongoing regulatory uncertainty, may lead to misleading conclusions. In the Italian context, the lack of a clear and harmonised framework - especially regarding waste heat classification - adds further complexity. More broadly, **focusing only on short-term actions without a long-term perspective can limit the effectiveness of decarbonisation strategies,** which require a phased and flexible approach aligned with 2035–2050 targets.