Irish District Energy Association

CRU National Energy Demand Strategy

Public Consultation Submission

Irish District Energy Association | 16 February 2024

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Introduction

The district energy sector is set to deliver on its Climate Action Plan 2023 targets of,

- 2025 – 0.8 TWh (heat demand equivalent of approx. 80,000 homes) (2022, p. 161).
- 2030 – 2.7 TWh (heat demand equivalent of approx. 200,000 homes) (2022, p. 161).
- 2050 – All buildings to either be connected to heat pumps or district energy networks (2022, p. 163).

These targets are an important consideration with respect the National Energy Demand Strategy as they set out a clear intention to decarbonise Ireland's heat system not only through electrification but also by adopting this proven and established solution to heat demand management. This is not currently reflected in the Strategy as presented, a shortcoming that must be rectified if it is to achieve the aim of falling into line with and supporting the suite of complementary policy levers and instruments aimed at achieving Ireland's climate goals.

The benefits of district energy with respect to the National Energy Demand Strategy can roughly be grouped under three headings, system flexibility, demand reduction, and direct decarbonised heat delivery. The comments below are provided with the broad aim of sketching out these advantages in the hope that the vital role of district energy in delivering Ireland's decarbonisation goals can be better reflected in the Strategy.

About IrDEA

Founded in 2017 to promote the development of low-carbon district energy in Ireland, IrDEA currently represents over 30 member organisations boasting a range of specialisms across the value chain of the district heating and cooling sector both in Ireland and abroad.

We are the only association in Ireland dedicated to supporting and representing the interests of the district energy sector. It is our role to identify and propose solutions to the barriers faced by the sector in meeting the Climate Action Plan 2023 target of supplying enough heat and hot water to serve the needs of up approx. 200,000 homes and 2500 public/commercial buildings by 2030 (i.e., 2.7 TWh of district energy).

Acting on behalf of our members, we support and promote the growth of the district energy sector in Ireland to aid the creation of a new heat market that offers greater opportunities to use indigenous low-carbon and renewable sources of heat.

Our activities include,

- Developing and promoting policy on district heating & cooling.
- Supporting the growth of the sector in Ireland.
- Building and sharing knowledge on district energy in Ireland.
- Stakeholder engagement.
- Commissioning and supporting research on district energy.
- Collaborating with organisations with similar missions to our own in Ireland and abroad, this includes Renewable Energy Ireland and Euroheat & Power.

About District Energy

As of mid-2023, there were just over 17,000 district heating networks across Europe supplying heat to 70 million people (Piel et al., 2023). It is no coincidence that some of the countries with the highest shares of renewable heat across Europe are also heavy users of district energy – they include Sweden, which boasts a renewable heat share of 68.6%, Estonia (61.3%), Latvia (57.4%), Finland (52.6%), and Denmark (51%). By contrast, Ireland has the lowest renewable heat share in Europe at 5.2% (Eurostat, 2023), with less than 1% of heat demand being met by district energy (SEAI, 2022).

SEAI's National Heat Study (SEAI, 2022) provides a comprehensive assessment of the options available to decarbonise Ireland's energy used for heating and cooling homes, businesses, and industry. Published in February 2022, the study indicates that up to 54% of Irish buildings could be suitable for connection to district heating networks.

The estimated total investment required to achieve this is between €2.7 and 4 billion for the deployment of the heat networks and associated heat production plants (approx. 40% public piping, 20% homes & buildings, and 40% new low-carbon production plants) (Government of Ireland, 2023). With over 30 million homes currently connected to district energy across Europe, we estimate that for Ireland to achieve its 2030 district energy targets, less than 1% of what the industry has already delivered in Europe (Piel et al., 2023).

Beyond the decarbonised heat benefit promised by the sector, the rollout of district energy networks will likely lead to the creation of over 2,000 full-time jobs over the next decade. The skills and training for which already exist at the interface between energy, engineering, and construction. Significant cross-over is likely between the district energy sector and these three broad areas of skills and training, which presents a key avenue for workers seeking to transition from fossil intensive industries to renewables (Vogeley et al., 2020).

Benefits.

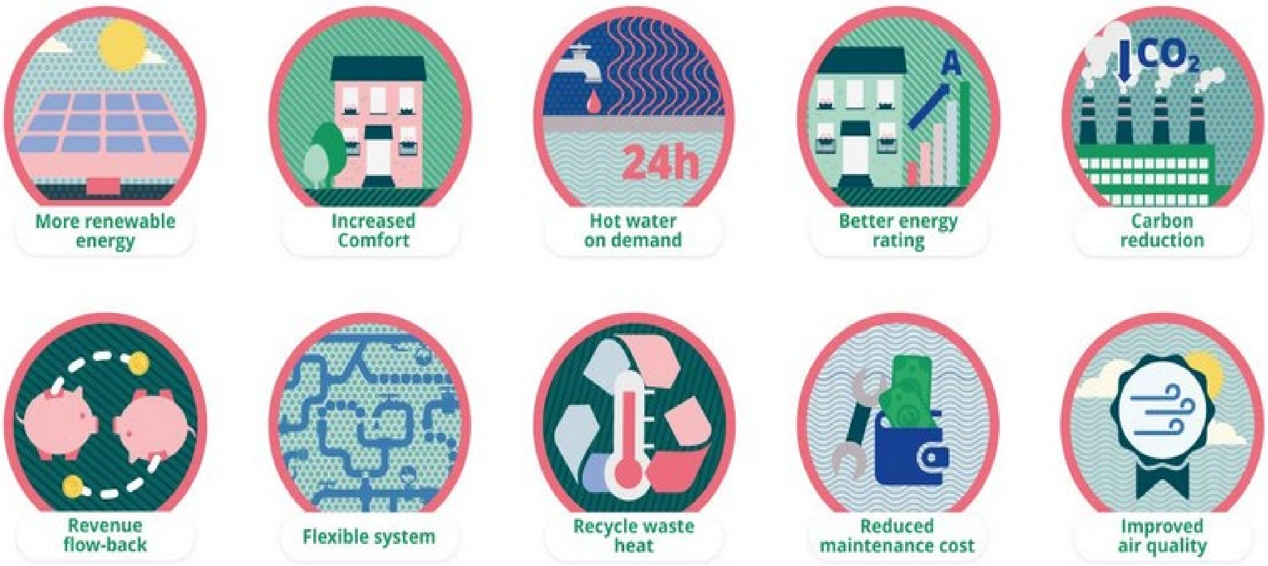

Figure 1. Benefits of District Energy (HeatNet NWE, 2021)

District heating has many economic, environmental, and social benefits, such as carbon reduction, reduced maintenance costs, increased comfort, and reduced fuel poverty. Local authorities, building developers, building managers and customers can all benefit from the development of a district heating network in their area, this includes:

1. Easier integration of renewable and low-carbon heat sources without disruption to customers/homeowners as access to each individual dwelling is not needed.

2. Lower local air pollution as buildings fossil fuel boilers would no longer be needed.

3. Facilitates utilisation of indigenous low-carbon resources which would not make sense at a smaller (individual building) scale such as deep geothermal and industrial waste heat resources – leading to more efficient operation of both industrial plants and heat production and supporting a more circular economy.

4. Provides storage and demand side response for the electricity grid at a fraction of the cost of battery storage when supplied by large-scale heat pumps, electric boilers etc. This also facilitates greater production of renewable electricity (e.g., wind turbine curtailment can be reduced) due to the flexibility provided by this thermal storage capacity.

5. Increased customer safety as there is no risk of gas leaks or carbon monoxide due to on-site combustion of fuels.

6. Benefits local economy by providing low-cost heating to customers (reduced overheads) and residents (reduced fuel poverty), potential revenue from waste heat for local industries and providing new local employment in the construction, operation, and maintenance of the network.

7. Efficient operation of heat production plants is ensured by constant monitoring, operation and maintenance being carried out by trained professionals – this is not possible with solutions located in individual homes where equipment is often not maintained to regularly achieve high operating efficiencies.

1. System Flexibility

There is a natural saturation point for any form of storage. It is, therefore, vital to promote the adoption of a variety of options to ensure the most appropriate and efficient use is made of each one across the system. This is particularly the case when it comes to ambitions to move the electricity system to 80% RES-E, as the efficiency profile of storage solutions changes as the RES-E saturation increases. *Per* Figure 2 below, the greater the saturation of intermittent renewables within the system the greater the need for long-duration storage options.

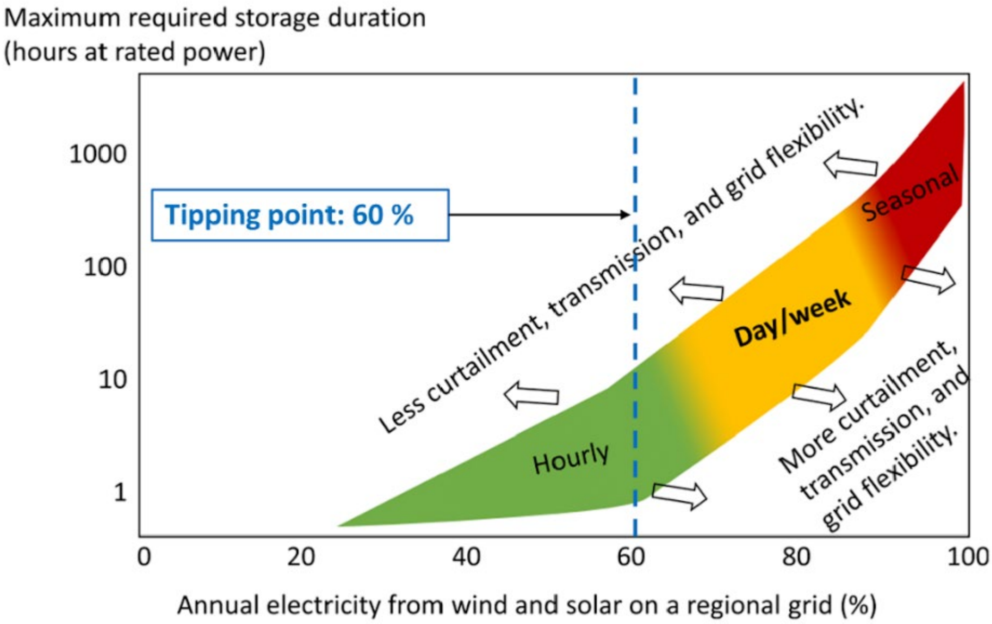

Figure 2. Storage durations for intermittent renewables led electricity generation systems.

The need for storage across various durations (up to 8 hours) is estimated at 2,475MW or 10.8GWh for a ‘Central’ scenario (Eirgrid, 2022). However, as it currently stands, most battery storage today is limited to durations of 2 to 4 hours as durations beyond this have proven expensive to deliver. While this works for an energy mix of under 40% RES-E, once we move beyond that point longer duration storage is needed to support the system, which requires storage durations of multiple hours to days. Having reached a share of 38.9% in renewable electricity generation in 2023 (SEAI, 2023), never has there been a more pressing need to identify, procure, develop, and deliver long duration storage capacity to support Ireland’s energy system.

While battery technology is evolving and advancing at pace with new batteries beginning to offer longer durations than the more established 2–4-hour range, this technology is neither freely available nor well established. This presents a short to medium term problem for the Irish energy system as it gradually ramps upward to a sustained 80% RES-E saturation in time for the 2030 deadline. Alternative forms of long-duration storage are, therefore, needed to meet the storage needs of a system with an increasingly renewables-led energy mix. TES is an established and tested mix of technology; vitally, it is ready for deployment across the Irish energy system alongside the soon to be scaled up district energy system.

Thermal energy storage can address this gap as larger scale, longer-duration TES systems prove to be more cost effective than shorter term and smaller scale alternatives. If, for example, the Climate Action Plan 2024 targets for District Heating & Cooling are achieved, it could provide 1300MW or 9.1GWh of low-cost large-scale thermal storage to support the electricity grid (between 53% and 84% of the storage capacity required based on the MW and GWh estimates from Eirgrid respectively) by 2030 (Codema, 2023). This is a particularly important function considering the duration limitations on battery storage solutions, which tend to decrease in cost-effectiveness as storage duration increases. Conversely, TES systems become more cost effective the larger their scale and the longer their duration.

Indeed, largescale TES systems typically cost a fraction of best-case large-scale battery storage, this is in the order of 0.65% - 4.4% or 50 to 100 times less (Hennessy et al., 2019; Lund et al., 2016a). Broadly speaking, these systems add significant value to the energy system. For example, using largescale installations in Irish district energy networks, as commonly seen in countries like Denmark (Ramboll Sverige, 2015; Zourellis, 2022) would cost approx. 0.065% when compared with equivalent battery storage. Further savings can then follow, for example, from making use of lower night-time electricity rates to generate heat for storage. In this case, the capital cost of the storage would only relate to the cost of the controls required to link its operation to signals from the electricity grid operator or market with the necessary response times. Large-scale TES also benefits from reduced levels of degradation through the charge and discharge cycles over its lifespan when compared with battery storage.

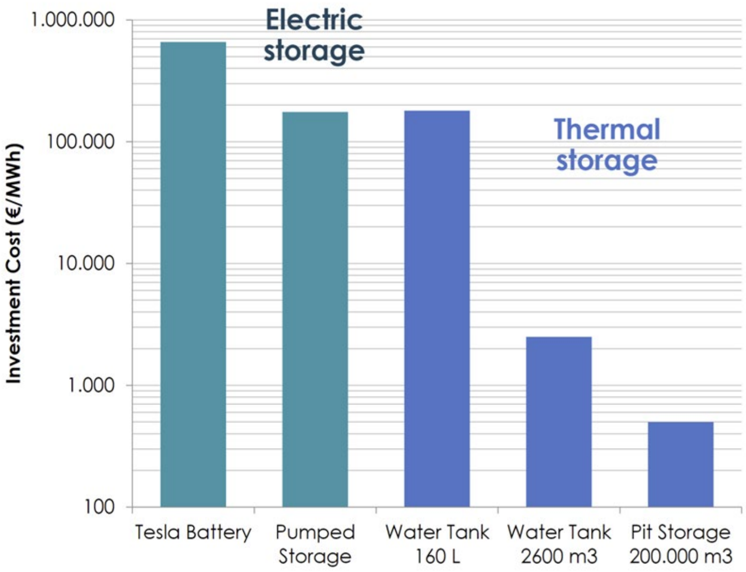

Figure 3. Energy Storage Technology Cost Comparison (replicated with the permission of Codema) (Lund et al., 2016b)

Reduced Curtailment

A further benefit of TES systems is their ability to reduce curtailment of renewable electricity generators by capturing dispatchable demand during low demand periods. These systems provide frequency response to keep the grid stable as the proportion of renewable generation increases. They further help to reduce congestion on the network by introducing flexibility to meet demand (particularly in peak winter when peak heat and electricity demand coincides).

This reduces electricity network constraints by delivering more efficient heat production and by-passing large sections of the lower voltage electricity grid when compared with other forms of electricity integrated heating such as individual building heat pumps. Codema, the Dublin Energy Agency, has estimated a 71% reduction in low and medium voltage grid reinforcement costs when using DHC networks compared with individual building heating solutions based on the Dublin Region Energy Masterplan (O'Shea, 2021).

Supporting Flexible Power Generation

Beyond helping to make fuller use of renewable generation capacity, TES also has a role to play in supporting the need for flexible thermal generation that is so integral to underpinning a renewable led system. By capturing waste heat, thermal storage offers a unique chance for thermal generation operators to improve the efficiency of their power outputs by making use of heat that would otherwise be lost. By offering a potential additional revenue stream, this could help to offset a portion of the considerable operational and capital expenditure costs associated with thermal facilities, thereby adding security to the electricity system, and helping to curb wholesale energy price rises.

As most thermal generation plants currently release heat equivalent to approx. 40% of their fuel input, it is estimated that waste heat could be equivalent to 8.7 TWh per year in 2030. Even though this is a decrease from today as more wind and solar comes online, it is still enough to supply almost 1 million homes. If captured and sent directly to heat networks or stored in TES for later use within district energy systems, this waste heat could be used to boost the energy output of these plants. Such efficiencies have the potential to aid the viability and affordability of flexible thermal generation as the energy system evolves to increase the proportion of intermittent renewable generation in the energy mix.

Energy Price Stability

Despite an ever-increasing move toward renewables, Ireland's energy needs are still largely provided for through fossil imports. The Russian war in Ukraine and the resulting gas and oil shortages in recent years have shown the difficulty this can present both for security of supply and affordability. The greater the amount of local renewable heat and electricity in the energy system, the greater the level of local control and insultation from price and supply volatility.

Thermal energy storage as part of a district energy system allows for greater use of sustainable and renewable energy sources, which can help to reduce pressure on the grid and lessen demand for fossil generated energy. TES has the potential to reduce energy costs by flattening peak demand, which can reduce capital costs as it reduces the headline generation capacity needed to satisfy peak demands. This is of relevance to the current consultation, as it could have a direct effect on the extent of demand flexibility procurement needed to deliver stability in the Irish energy system. It also for cheaper rates of energy production to be capitalised on where surplus energy can be captured in the form of heat and stored while prices are low and then released into the network when demand or costs are higher.

To incentivise investment and ensure energy is affordable for consumers, we need to balance placing sufficient storage on the system and keeping capital costs to a minimum. As one of the most cost-effective storage solutions currently available, TES has the potential to help achieve this. For example, when incorporated into a district heating system, TES is approximately 100 times cheaper than electricity grid storage (Lund et al., 2016a).

2. Demand Reduction

TES and Demand Reduction

Thermal energy storage (TES) reduces heat load variation in district heating systems by flattening demand peaks. This can, in turn, lessen capital expenditure as the level of generation required to satisfy peak demand is lower than in the absence of a stored energy reservoir. TES also facilitates system flexibility that allows for cost savings through smart energy use, typically achieved by capturing energy when demand and costs are low and deploying when demand and costs are high (District Heating and Cooling, 2022).

By helping to flatten demand curves, particularly when applied at a larger scale (Romanchenko et al. 2018), TES reduces the amount of generation capacity needed to meet demand on district energy systems, which positively impacts consumer energy costs and wider system demand. Incentivising and facilitating thermal storage as part of district energy systems will be crucial to delivering 0.8 TWh of district heating installed capacity by 2025, and up to 2.5 TWh by 2030 set out in the Climate Action Plan 2023.

Evidence from countries where these systems are well-established shows the efficacy of using this form of sector coupling to reduce curtailment in renewable energy generation (IRENA, 2020). Significant gains have been demonstrated at scale in energy systems with high concentrations of district energy systems. For example, with approx. 50 GWh of thermal storage as compared with less than 2 GWh in Ireland, Denmark is well placed to harness a greater proportion of its significant renewable generation potential. When there is excess wind or solar power in Denmark, large-scale electric boilers and heat pumps are activated to produce heat on district heating systems. If there is no demand for the heat at that specific time, it is stored as thermal energy until a heat demand occurs. Wind or solar power that would otherwise be curtailed is instead used to generate heat before it is needed.

The proportion of energy that can be saved in this way is variable contingent on a range of factors. However, solid evidence exists across a range of jurisdictions and project types. For example, a collaborative demonstrator project led by the Birmingham Centre for Energy Storage, funded by the UK Engineering and Physical Sciences Research Council and the Natural Science Foundation of China, was able to pull 80% of its electricity demand, over 5 000 MWh per year, from wind energy sources that would otherwise have been curtailed.

From an Irish perspective, Renewable Energy Ireland (2021) estimated that by 2030 the annual electricity surplus will be approx. 2.8 TWh due to dispatch-down of intermittent renewable generation. However, we need not look to the future to make the case for the need to reduce curtailment. Enough renewable electricity was lost in the first six months of 2020 to power Galway for a year (Wind Energy Ireland, 2020). Yet, if harnessed by large scale heat pumps, with a current efficiency of 300%, 8.5 TWh of renewable heat could be produced cost-effectively as part of a demand-response strategy. Capturing this heat through thermal storage would allow for it to be used within district energy networks, thereby contributing to the decarbonisation of the heat network while simultaneously using a greater level of the potential generation capacity of the renewables fleet.

CHP, Surplus Heat, and Energy Efficiency Measures

In addition to the effective use of TES, optimized district energy systems play a significant role in reducing energy demand through a range of heat production, recovery, and energy efficiency mechanisms. For example, heat networks can incorporate combined heat and power (CHP) or cogeneration technology, which simultaneously produces electricity and captures waste heat for heating or cooling purpose. This is significantly more efficient than separate generation of electricity and heat, resulting in lower overall energy demand. The ability to recover surplus heat from various sources such as industrial processes, power plants, and data centres also allows for a similar form of efficiency gain. By using surplus or waste heat of this sort for space heating, domestic hot water, or industrial processes, the need for additional energy consumption is reduced, which benefits the wider energy system.

Modern district energy systems embed energy efficiency measures within their infrastructure, such as optimizing distribution networks, improving insulation, and upgrading equipment. This reduces energy losses during transmission and distribution, resulting in overall energy demand reduction. In addition, these systems can form part of demand response programs involving adjustment to energy consumption patterns in response to grid conditions or price signals. By temporarily reducing energy consumption during peak periods, district energy systems have the capacity to alleviate strain on the grid and contribute to overall energy demand reduction.

Coordinated urban planning, building, and heat network design allows for gains to be made by adjusting to factors such as building orientation, energy-efficient building envelopes, and passive solar design principles, leading to reduced energy demand in buildings connected to the system. The bespoke and localised nature of heat networks allows for this to be done in the most effective way possible as they take account of a broad range of local factors to improve efficiency, which benefits developers, operators, consumers, and the environment alike.

3. Decarbonised Heat Delivery

At approx. 60 TWh per annum, heat makes up 42% of final energy demand in a typical year for Ireland (SEAI 2019). Decarbonisation in the sector has, however, lagged electricity, with total fossil fuel-based CO_2 emissions from building and industrial process heating remaining around 14.1 $MtCO_2$. This equates to approx. 38% of total energy-related CO_2 and 24% of total national greenhouse gas emissions – natural gas (39%), oil (36%), and coal and peat (25%) (SEAI, 2019). Significant action must be taken to address this if Ireland's net zero emissions ambitions are to be realised.

Though relatively new and underdeveloped in Ireland, district heating is well-established as means of providing sustainable heating solutions to industrial, commercial, and residential energy consumers. With between 54% (District Heating and Cooling, 2022) and 58% (Europa-Universitat Flensburg, 2019) of heat demand in Irish buildings identified as being suitable for district energy, this form of heating is primed to lead the decarbonisation of the sector.

This is a significant amount of energy to divert away from current dependency on fossil fuel sources without adding to the growing demand for grid capacity in the same way that electrified solutions to heat decarbonisation do. In addition to the system flexibility and demand reduction benefits boasted by district energy, one of the core strengths is that it offers a heating solution that is not solely based around electrification. Certainly, modern district energy systems tend to rely on largescale heat pumps or electric boilers to raise the temperature of the water pumped through their systems. However, the electricity demand from this is increasingly being reduced using recovered or stored heat derived from a wide array of sources.

Solutions of like district energy are essential to managing the national energy demand, both now and into the future, as they offer a much-needed alternative to wholesale heat system electrification, which would be highly challenging to achieve and perhaps less desirable from a cost and efficiency standpoint.

4. Conclusion

As set out in the consultation document, a national approach to energy demand management requires all actors to be aligned on the matter. It is vital that as one of the key emerging energy strategies, the National Energy Demand Strategy better reflect the ambition that Ireland transition to widescale use of district energy systems.

As a technology with the proven ability to play a substantial role in linking the heating and electricity sectors as a means of increasing efficiency and bringing about more effective demand management, its omission would be a significant oversight that would prematurely date and weaken the Strategy unnecessarily.

IrDEA urges that those working to finalise the Strategy review its contents and identify the areas that could be strengthened through reference to district energy and thermal energy storage systems.

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