INTERNATIONAL ENERGY AGENCY
TECHNOLOGY COLLABORATION PROGRAMME ON
DISTRICT HEATING AND COOLING

SUMMARY FOR NON-TECHNICAL AUDIENCES

HY2HEAT – USING ELECTROLYSIS WASTE HEAT IN DISTRICT HEATING NETWORKS

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CONTENT

1 INTRODUCTION

The HY2HEAT project explores the potential of integrating electrolysis waste heat into district heating networks (DHNs) to enhance energy efficiency and support decarbonization. Electrolysis, a key hydrogen production process, generates substantial waste heat, which is often dissipated instead of being harnessed. This study assesses the technical feasibility, economic benefits, and policy considerations of utilizing electrolysis waste heat in DHNs.

Hydrogen is widely recognized as a crucial component of the future energy system, particularly as economies transition towards carbon neutrality. The production of green hydrogen via electrolysis plays a key role in decarbonizing various sectors, including industry, transport, and heating. However, electrolysis is an energy-intensive process that generates large amounts of heat, much of which remains unexploited. Capturing and utilizing this waste heat could provide an additional renewable energy source for district heating (DH).

DHNs offer a particularly promising opportunity for integrating electrolysis waste heat. DHNs are a well-established solution for urban heating, efficiently supplying heat to residential, commercial, and industrial consumers. By integrating electrolysis waste heat into these systems, excess thermal energy can be repurposed, thereby reducing the reliance on fossil fuel-based heating sources and improving the efficiency of the hydrogen production process. This integration would also support the development of a more sustainable and cost-effective energy system. An overview of the concept is shown in Figure 1.

The HY2HEAT project investigates the feasibility of such an approach by analysing the technical configurations required for effective waste heat recovery, the economic benefits of heat integration, and the regulatory and policy frameworks that could support implementation. A central aim of the project is to identify how electrolysis waste heat can complement existing DH sources while minimizing the need for additional infrastructure investments. Through a combination of modelling, case studies, and stakeholder engagement, the study evaluates practical solutions for waste heat utilization. By addressing these aspects, the study aims to contribute to the broader goal of energy system decarbonization and increased energy efficiency. Understanding the role of electrolysis waste heat in DH will optimize hydrogen production while supporting the transition to a more sustainable energy landscape.

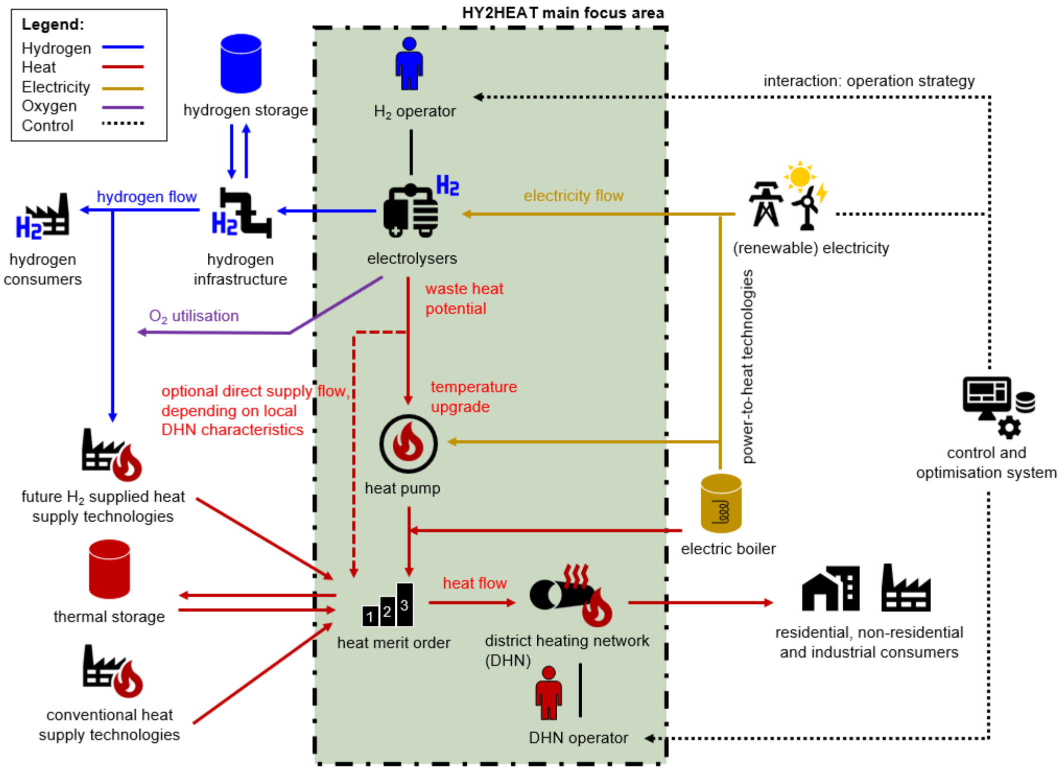

Figure 1: Graphical overview of HY2HEAT concept, its system boundaries, involved stakeholders, and potential components

2 FUTURE ELECTROLYSIS CAPACITIES AND WASTE HEAT UTILISATION IN DISTRICT HEATING

Electrolysis capacity is projected to expand substantially in the coming decades, driven by increasing hydrogen demand and decarbonization targets. European countries have outlined ambitious plans and roadmaps for hydrogen production, with the European Green Deal envisioning over 500 GW of electrolysis capacity by 2050. Aligning this expansion with DHNs requires strategic planning to ensure efficient waste heat utilization.

The potential for integrating electrolysis waste heat into DHNs depends on several factors, including waste heat temperature, operational stability, and spatial proximity to DH infrastructure. Alkaline Electrolysis (AEL) and Proton Exchange Membrane Electrolysis (PEM-EL) generate waste heat at temperatures of 50–80°C, making them suitable for modern low-temperature DHNs but requiring additional heat pumps for conventional DHNs with supply temperatures of up to 130°C. Fluctuations in electricity prices and the intermittent nature of renewable energy sources impact the stability of electrolysis operations, affecting the consistency of waste heat supply. Implementing thermal storage solutions and optimizing hydrogen production schedules can improve integration with DH demand. Infrastructure investments and policy support are crucial in ensuring that waste heat recovery aligns with future electrolysis capacity growth.

Electrolysis capacity expansion and waste heat integration into DHNs vary based on national priorities, regulatory frameworks, and infrastructure. Some regions with well-developed DH and supportive policies can integrate waste heat more easily, while others prioritize hydrogen exports or industrial applications, making integration more complex. Factors such as grid stability, energy market regulations, and investment incentives further influence feasibility. Aligning expansion strategies with local conditions is essential for efficient implementation.

Strategic coordination between hydrogen production and DH sectors will maximize the benefits of electrolysis waste heat utilization. Infrastructure planning, financial mechanisms, and regulatory adjustments are essential to ensure that the growing electrolysis capacity contributes to a more sustainable and efficient energy system.

3 TECHNICAL INTEGRATION CONCEPTS

Integrating electrolysis waste heat into DHNs requires efficient technical solutions that ensure compatibility with existing infrastructure. Heat exchangers facilitate the direct transfer of heat from electrolysers to DHNs, minimizing energy losses. However, because waste heat temperatures are typically too low for direct use, heat upgrading is essential. Heat pumps play a crucial role by raising the waste heat temperature to a usable level, enabling its effective integration into DH.

Preheating strategies further enhance system performance. By using waste heat to elevate DHN return temperatures before final upgrading in the heat pump’s condenser, the system's coefficient of performance (COP) improves by up to 110%, and the required heat pump capacity decreases by up to 50%. However, this method is only viable when waste heat is at least 10°C above the DHN return temperature. By reducing additional energy input, preheating makes electrolysis waste heat integration more cost-effective.

Thermal energy storage solutions help balance fluctuations between waste heat availability and DH demand. Hydrogen production varies based on electricity market conditions and renewable energy availability, leading to inconsistent heat supply. Thermal energy storages mitigate these fluctuations, optimizing heat delivery. The feasibility of storage depends on hydrogen production schedules and the type of electrolyser used.

Strategic co-location of electrolysers near DHNs is crucial to minimize heat transport losses. Infrastructure investments in heat recovery technologies should be carefully planned to align with DH expansion. By optimizing system configurations, electrolysis waste heat can serve as a stable and sustainable component of DH, reducing reliance on fossil fuels.

4 TECHNO-ECONOMIC ASSESSMENT

The economic feasibility of integrating electrolysis waste heat into DHNs depends on multiple factors, including operational efficiency, infrastructure costs, and market conditions. A techno-economic assessment evaluates the financial viability of heat recovery from electrolysis and its potential impact on the levelized cost of heat (LCOH).

Reducing the LCOH is a major benefit of waste heat recovery. By utilizing waste heat from electrolysis, DH operators can reduce primary energy consumption, lowering heating costs by up to 23% based on the evaluated case studies. This reduction makes DH systems more competitive and supports the transition to low-carbon energy sources. Hydrogen producers also benefit from waste heat integration, as reduced cooling costs and potential sales of waste heat leads to operational cost savings.

Despite these benefits, integrating electrolysis waste heat may require significant infrastructure investment. The installation of heat exchangers, heat pumps, and, if necessary, thermal storage solutions involve upfront capital expenditures that must be balanced against long-term savings. The economic feasibility depends on the scale of integration, the efficiency of heat recovery technologies, and the stability of waste heat supply.

Market mechanisms and policy incentives play a critical role in ensuring financial viability. Regulatory support, in the form of subsidies, tax incentives, or heat purchase agreements, can encourage investment in waste heat recovery. Transparent pricing structures for waste heat transactions between hydrogen producers and DH operators are necessary to establish a fair and predictable economic framework.

Long-term cost reductions and operational savings can justify initial investments, making waste heat recovery an attractive option for both the hydrogen and DH sectors. Strategic planning, technological advancements, and regulatory support will be essential in maximizing the economic benefits of electrolysis waste heat utilization.

5 STAKEHOLDER PERSPECTIVE AND RECOMMENDATIONS

The perspectives of key stakeholders, including DH operators, hydrogen producers, and policymakers, highlight various factors that either drive or hinder the integration of electrolyser waste heat into DHNs. The results from a survey with 70 responses underscore the recognition of potential benefits and motivations for this integration, such as sustainability improvements, decarbonization goals, contributions to a circular economy and in some cases economic advantages. However, several challenges have been identified. These include the need for additional infrastructure and high investment costs, proximity constraints between electrolysers and DHNs, limited awareness of the concept, and regulatory barriers. Existing policies usually do not sufficiently incentivize waste heat utilization, creating uncertainty for investors and slowing the adoption of integration technologies. There is a need for clearer regulatory frameworks that formally recognize electrolysis waste heat as both a valuable energy source and a coproduct of hydrogen production.

Market structures and pricing mechanisms must be established to facilitate fair and transparent transactions between hydrogen producers and DH operators. Without structured pricing, the economic benefits of waste heat recovery remain unclear, limiting participation from both sectors. Infrastructure investment remains another significant challenge, as modifying existing DHNs and hydrogen production facilities to accommodate waste heat recovery requires substantial financial resources. Public-private partnerships and financial incentives are critical to overcoming these barriers.

Enhanced collaboration between stakeholders is necessary to align technological capabilities, operational strategies, and policy frameworks. Coordinated efforts will help optimize waste heat integration and maximize the benefits for both the hydrogen and DH sectors. Highlighting successful good practice examples can also serve as a motivational driver. Stronger regulatory support and targeted funding mechanisms will ensure that waste heat recovery becomes a core component of the energy transition.

6 CONCLUSION

Integrating electrolysis waste heat into DHNs presents an opportunity to enhance energy efficiency, reduce carbon emissions, and improve the economic viability of both hydrogen production and DH systems. The growing deployment of electrolysers will provide an increasing source of waste heat that, if effectively captured and utilized, can support the decarbonization of heating sectors.

Optimized heat recovery strategies, such as preheating DH return and using heat pumps for temperature upgrading, will maximize system performance. Thermal energy storage solutions can help balance fluctuations in heat supply and demand, improving reliability. Infrastructure investments, regulatory alignment, and financial incentives will be essential to facilitating the large-scale adoption of electrolysis waste heat recovery.

Coordinated planning between hydrogen producers, DH operators, and policymakers is necessary to unlock the full potential of this integration. By implementing supportive policies, establishing transparent market mechanisms, and encouraging technological innovation, electrolysis waste heat can become a key contributor to a more sustainable and efficient energy system.