Green Inland Ports

Good Practices

Funded by
the European Union

Public steam network in combination
with a heat recovery network

Public steam network in combination with a heat recovery network

1.1 Description

Steam is a naturally efficient source of thermal energy. In general, steam is generated by using heat to convert water into steam. Steam can be generated using waste heat, extracted by heat recovery units, in power plants (Power Technology, 2023). Steam can then be used as a sustainable heat source. As a good practice, a steam network could be available for recipients within the port area. Waste heat (green heat), which can be a by-product of waste incineration or other industrial processes, can be distributed through a steam network and then be used by other businesses or houses in the vicinity. Waste heat with a temperature below 100 degrees Celsius is difficult to use for industrial processes (Port of Rotterdam, 2022). Warmtebedrijf Rotterdam (Heating Company Rotterdam) supplies excess heat from industrial processes in the port of Rotterdam to operators of district heating networks, reducing the use of fossil fuels (Warmtebedrijf Rotterdam, n.d.).

1.2 Specific aim of the measure

Steam and heat as byproducts can reduce greenhouse gas emissions, because they can provide part of the energy demand (Raptis, C. E. et al., 2020). According to Hawleys, (n.d.), the consumption of fossil fuels and environmental damage can be minimized because steam can be generated from cleaner energy sources (natural gas, biomass, solar thermal energy), and steam-based systems are in general also very energy efficient, so they lose less energy and emit less carbon per unit of output.

1.3 Ports that make use a public steam network or heat recovery network

- Groningen Seaports
- Port of Strasbourg
- Port of Rotterdam
- Port of Mulhouse Rhine (Heating network is being created, should be operational in 2026)
- Port of Switzerland (Basel)
- DeltaPort (Wessel)
- Bayernhafen
- Port of Belgrade
- Port of Hamm
- Port of Stuttgart

1.4 Stakeholders

- The port authority: As they can be the owner or the landlord of the port area. The infrastructure needed to enable a steam- or heat-powered system must fit within the area. It depends a lot on the port ownership structure who plays a role in this.
- Local government: When the local government has ownership of (a share of) the port area, they would also be involved or responsible in the realization of the steam- or heat-powered system.
- The companies that supply/receive the heat/steam: These companies are, often in collaboration with the port authority, responsible for creating the infrastructure.
- Energy company: In many cases, an energy company is responsible for the collection and transportation of residual heat. The port area delivers the heat to the energy company, and they transport it to their customers.

1.5 Voluntary or mandatory

Realizing steam and/or heat networks is, in most cases, not a mandatory measure that companies within port areas must take. However, it is a logical consequence of making port areas circular. One company has a waste product that they cannot fully use and other companies can use it for their own processes.

1.6 Realised/potential impact

According to Warmtelinq, (2021), residual heat from the port of Rotterdam can be supplied up to 120,000 houses in The Hague (The Netherlands). It is currently being investigated if a branch can be made to Leiden (The Netherlands), which allow 50,000 houses in Leiden to be heated sustainably. By using residual heat from the port of Rotterdam to heat buildings and greenhouse horticulture, less natural gas needs to be used. The pipeline proposed by Warmtelinq could lead to a CO2 reduction of around 0.18 megaton per year (Warmtelinq, 2021). Van den Wijngaart et al., (van den Wijngaart, R. et al., 2012) claims that in the case of industrial residual heat, the energy saving will be nearly 100%, with a spread of between 60 to 100%. CE Delft, (2021) has executed an analysis to the possible development of demand of heat for the built environment, demand of heat for greenhouse horticulture, and the cost consideration of consumers. The realization of maximum CO2 reduction potential depends strongly on the transportation costs of the residual heat of WarmtelinQ and possible alternative heat sources, such as geothermal heat. For greenhouse horticulture, there are other techniques, such as a biomass boiler and geothermal, which are more financially beneficial than Warmtelinq residual heat. This explains why the potential impact is very uncertain.

1.7 Possible obstacles when implementing good practice

According to Hawleys, (n.d.):

- To ensure optimal performance and minimal energy loss, a steam-based system requires careful design and maintenance to prevent and address steam leaks.
- Steam-based systems are difficult to scale up, because the systems are complex and require significant investments in infrastructure and equipment.
- Steam turbines have specific operational characteristics, including warm-up and cool-down periods, which can affect their responsiveness to fluctuations in energy demand. Mitigating these limitations requires efficient system controls and mechanisms to optimise power generation and heat utilisation.
- Alternatives, such as geothermal heat, are less expensive at the moment and the effectiveness and attractiveness of residual heat depends largely on their costs compared to alternatives (CE Delft, 2021).
- Inland ports that have developed or consider developing a heat recovery network or public steam network consider it as relatively difficult (Ecorys et al., 2024).

1.8 Key learnings

- Waste heat is an effective way to turn a by-product of industrial processes to a resource that can be utilized by other stakeholders.
- Industrial waste heat can at best yield energy savings of nearly 100%.
- Steam-based systems require large investments in infrastructure and equipment.
- An important precondition for reaching the full potential is that waste heat must be less expensive than alternative heat sources, because the two are perfect substitutes consumers will choose the cheapest option in most cases.

1.9 Sources

CE Delft, 2021.*Onderzoek Warmtevraagontwikkeling WarmtelinQ,* Delft:

Ecorys, CE Delft, Panteia, Pro Danube, Erasmus University Rotterdam, Planco & EICB, 2024.*Second survey Green Inland Ports,* Rotterdam:

Hawleys.n.d.The Role of Steam in Today's Green Energy Movement, https://www.hawleys.com.au/blog/our-blog/the-role-of-steam-in-todays-green-energy-movement/.

Port of Rotterdam.2022.Grote potentie voor de inzet van lage temperatuur restwarmte uit de haven, https://www.portofrotterdam.com/nl/nieuws-en-persberichten/grote-potentie-voor-de-inzet-van-lage-temperatuur-restwarmte-uit-de-haven.

Power Technology.2023.Green steam: heat recovery, and power generation in the clean energy transition, https://www.power-technology.com/features/heat-recovery-steam-capture/.

Raptis, C. E., Oberschelp, C. & Pfister, S., 2020. The greenhouse gas emissions, water consumption, and heat emissions of global steam-electric power production: a generating unit level analysis and database. *Environmental Research Letters*.

van den Wijngaart, R., Folkert, R. & Elzenga, H., 2012.*Heating the built environment more sustainably by 2050,* The Hague:

Warmtebedrijf Rotterdam.n.d.Havenwarmte heeft een duurzaam doel, https://www.warmtebedrijfrotterdam.nl/#:~:text=Warmtebedrijf%20Rotterdam%2C%20

als%20onderdeel%20van,klimaatdoelstellingen%20van%20de%20gemeente%20Rotterdam.

Warmtelinq.2021.Aanleg warmteleiding voor duurzame warmte 120.000 woningen van start, https://www.warmtelinq.nl/nieuws/aanleg-warmteleiding-voor-duurzame-warmte-120000-woningen-van-start.