Technical Article – Energy Systems Engineering

The Commercial Potential Of Industrial Excess Heat

Dr Romain Lambert
Centre for Process Systems Engineering (CPSE)
Department of Chemical Engineering
Imperial College London
United Kingdom

Abstract: This article is inspired by knowledge acquired during the CELSIUS project. CELSIUS (Combined Efficient Large Scale Integrated Urban Systems) is an EU FP7 framework project involving 5 demonstrator cities: London, Gothenburg, Cologne, Genoa, Rotterdam. The purpose of the project is to document the experience of district heating and cooling technology demonstration pilot projects and share the resulting engineering knowledge at a European level through a network of new CELSIUS member Cities. This project has highlighted the consideration of excess or waste heat as a resource of commercial value.

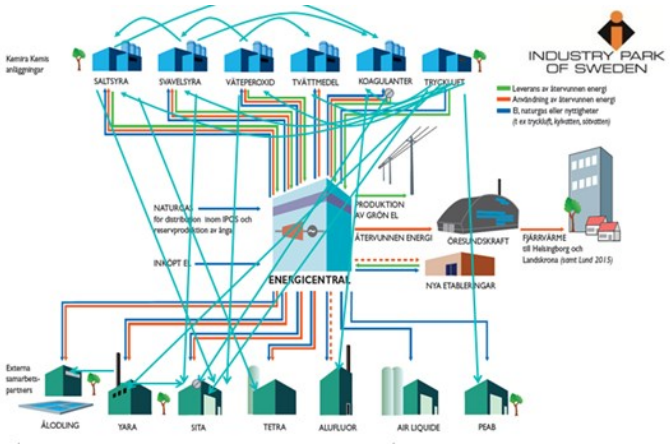
In Gothenburg, a 1400 km heat network is supplied by the cities refineries (Shell and Preem) and, together with a solid waste incinerator, forms the baseload of the annual heat supply profile. The use of waste heat from industry gain momentum following the 1973 oil crisis. It became economically sensible to merge the separate heat networks that were running mainly on oil cogeneration. Nowadays, waste energy from industry is a widespread practice in Sweden. In the Northern city of Luleå, a very large proportion of the district heat is supplied by Swedish steel manufacturer SSAAB. Directly resulting from this synergy with industry ,Luleå has the cheapest heat prices in Sweden. In Gothenburg, the network infrastructure is also used to supply heat and cooling.

The Municipality of Helsingborg is part of the southern Skåne region of Sweden with a close connection to Denmark through Öresunds Bridge which links Malmo and Copenhagen. The District heating system in Helsingborg supplies 170,000 inhabitants through a 560km pipe network and a production capacity of 1.1 TWh. Prompted by the 1973 oil crisis, the system underwent a rapid transition from oil (and fossil) production to reach nowadays rate of 97% of heat produced through recycled energy. In Helsingborg, the district heating system benefits from a close collaboration with the local industrial chemical industry Kemira. Kemira, a Finnish company provides 30% of the 4TW baseload of the heat network. The connection to Kemira was made in 1974 as a consequence from a willingness to increase the security of supply and reduce dependence on fossil fuel imports following the oil shocks of the 1970s. The sales of heat are beneficial to the company and boost its competitiveness by directly contributing to the company revenue, beyond cost savings. It is estimated that the collaboration has contributed to a reduction of 1.6M tons of CO2 since 1974. Kemira has also set-up an industrial park that it continues to own offering energy services to companies that want to settle in the park and benefit from better energy efficiency through connections to waste heat and electricity provided by Kemira's production units.

Technical Article – Energy Systems Engineering

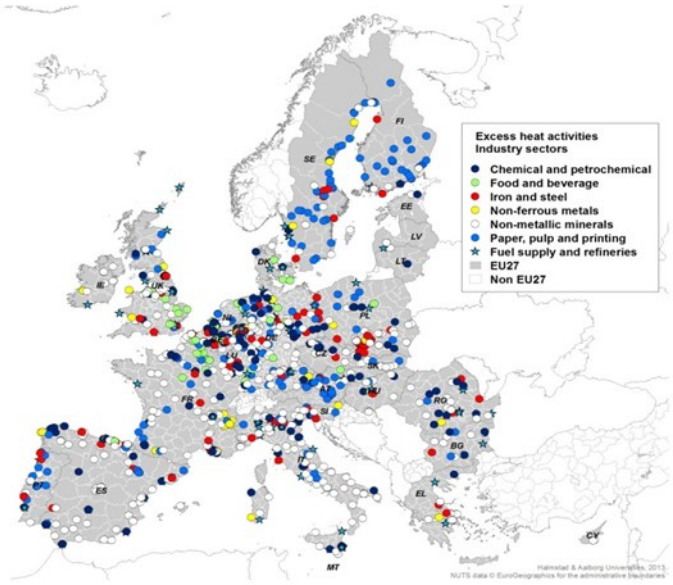
It also features deep logistics support with a deep water port and a local rail network. This industry park business model has the advantage of enhancing the economic competiveness of local industries.

On the industry park of Helsingborg, sulphur dioxide provides an attractive source of waste heat as it is carbon free. Kemira has introduced the concept of "industrial Symbiosis" which goes beyond energetic integration and economic performance with a business models also based on environment and technological innovation. The industrial park hosts various chemical companies such as Yara and Air Liquide. The company SITA offers the only facility in Sweden where rail tankers can be cleaned. Previously rail tankers had to be sent to a facility in Hamburg. Kemira has sufficient heat surpluses to perform both internal, inter-companies and over the fence heat integration meaning there is still enough waste heat to supply ÖresundsKraft after internal heat supply optimization. Although other industrial heat connections exist across Sweden, the industrial symbiosis concept with multi-scale integration is currently the only one of his kind. It has received a lot of attention from the media recently as it has won the smart energy award from EoN in 2014.



Schematic of the industrial Park of Sweden industry symbiosis showing over the fence inter-company energetic integration.

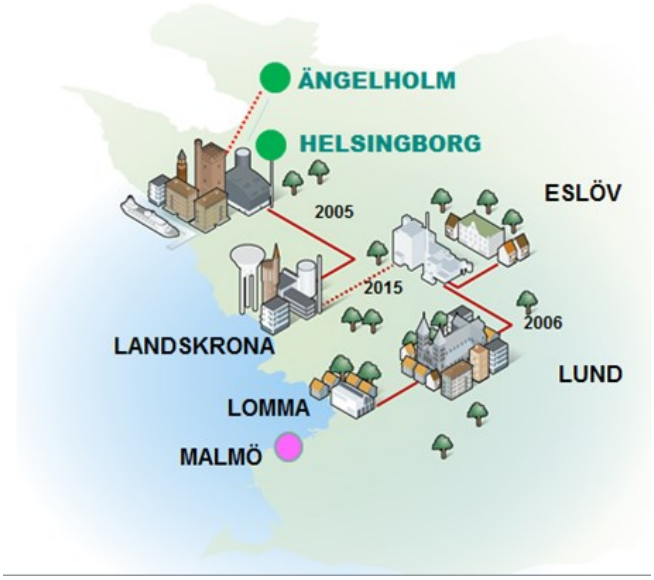
In the UK, the market share of district heating is less than 5% compared to 50% in Sweden. Potential integration between municipal networks and industries and energy intensive industry may exist. For example, the Southampton heat network, one of the largest in the country, run by Engie, is located in the vicinity of ExxonMobil Fawley refinery, which uses 300,000 tons of seawater every day mostly for cooling purposes. The distance between the two infrastructure makes it theoretically feasible to connect them (longest connections exist in several places in Europe). However, there are many difficulties to be overcome to implement this type of projects, including the joint financing of the necessary connection infrastructure, contracts on heat deliveries, seasonal pricing, and operational cooperation and scheduled maintenance downtimes. In Gothenburg, PREEM and Goteborg Energi shared the investment costs of around SEK 180M. The payback period was 3.5 years. Although supplying municipal networks increases the economic competitiveness of industries, the dependence on industry is often seen as precarious by district heating companies who have to put in place the necessary backup should the industry close down. This additional capacity is also necessary for the district heating system to be able to negotiate competitive prices. If the heat network is not large enough, it might not allow for sufficient economies of scale to take place and the fixed investment costs of the required heat recovery system might render the project uneconomical. Local district network operators might not be keen to invest in heat recovery facilities if they have recently investment in other production facilities and that would have to be under-utilised (sunk costs).



Industrial excess heat in Europe – euroheat and power

Technical Article – Energy Systems Engineering

The heat roundabout in Rotterdam, industry supply heat to municipal heat networks and greenhouses.



The interconnection between the municipalities of Landskrona Lund and Helsingborg. The connection from Helsingborg to Landskrona is 29 km long linking Örtofta and Landskrona district heating network. The payback period for this investment was only 7 years. The investment amounted to SEK300M and was funded by the municipalities.

In the UK, the district heating market is growing and has strong backing from the government. It is possible that industry excess heat supply initiatives similar to the Swedish example might become more attractive in the future. This will have to be accompanied by appropriate policy instruments. The renewable heat incentive does not favour the supply of industrial excess heat although this excess heat is secondary 'recycled' energy and therefore 'low carbon'. The development of industry park business models might stand a better chance to happen in the near future. Such initiatives would boost the competiveness of established energy intensive companies by providing them with an additional source of revenue and provide an incentive for companies to remain or relocate to the UK and contribute to its reindustrialisation (and reduce the trade deficit). In this type of over-the-fence arrangement between industrial companies both electricity and heat could be envisaged using appropriate business structures. Electricity could be produced locally by the supplying industries using organic rankine cycle units. This electricity would be cheaper for the customer companies of the park than using grid electricity.

From a national perspective, local industrial smart energy integration could contribute to national objectives for the electricity grid through participation in demand response mechanisms. It might entail a deep analysis to ensure a good coordination between the dynamic behaviour of processes and the dynamic nature of the national grid. Again, appropriate policy instruments would be beneficial to account for the low carbon content of the electricity supplied to the grid. Other possibilities of synergies would be the supply between businesses, for example the use by industries of electricity or heat from local solid waste incinerators.

CPSE is interested in hearing from its consortium members about forming a new subject group on the above topic. Various projects including feasibility or theoretical studies could be envisaged.

https://preem.se/om-preem/om-oss/vad-vi-gor/raff/preemraff-goteborg/

http://www.luleaenergi.se/sv/privatkund/fjarrvarme/fjarrvarme/allmant-om-fjarrvarme/

http://www.industriellekologi.se/symbiosis/index.html

http://www.nudgesustainabilityhub.com/initiatives/2015/5/26/the-heat-roundabout

http://www.landskronaenergi.se/gemensam-fjarrvarmeledning-bra-for-skanes-miljo/