

## West Swedish collaboration of surplus industrial heat

The project is collaboration between industry, academia and the public sector with the aim of increasing understanding of consequences, opportunities and barriers to increased regional interaction for utilization of industrial waste heat. The project was completed in February 2015

In several previous studies, large amounts of surplus heat are detected in the industry complexes in the western part of Sweden. There are opportunities to use them internally so that, for example, the fossil fuel use in these industrial complexes can be significantly reduced, or externally, for example by linking a future regional district heating systems with the industry clusters in west Sweden.

This could allow a large change in the western Swedish energy system, which would entail substantial reductions in carbon emissions in the region and the potential for significant economic gains.

The "West Swedish collaboration on industrial surplus heat" was formed to support the understanding of the large amounts of surplus heat available at the West Swedish process industry and how it best should be utilized.

The project implemented three subprojects and an analysis of the large district heating customer needs and demands of sustainable district heating. In addition, an analysis and processing of company supplying technology linked to the district heating system. Analysis of the business concepts and models can build up a strong domestic market, which could ultimately generate export opportunities for Western Swedish technology companies.

### *The three sub-projects:*

1. Sustainable use of industrial excess heat –internal heat recovery or export to a district heating network (*Chalmers University of Technology and SP Technical Research Institute of Sweden*)
2. Sustainability aspects of using excess heat in district heating systems
  - Economic viability and sustainability
  - Other sustainability aspects
  - Influence of policy instruments on the use of excess heat(*IVL Swedish Environmental Research Institute and Chalmers University of Technology*)
3. Market design models for cooperation of excess heat usage (*SP Technical Research Institute of Sweden*)

## From the report

### *The main aspects studied in the projects are:*

- Consequences for the excess heat potential of internal industrial heat recovery
- Influence of future conditions on the sustainability in a broad sense (including economic performance and climate consequences) of export of industrial excess heat to a district heating system, taken alternative/competing technologies into account
- How shall market design models be developed in order to have reasonable distribution of profits/reduced costs between stakeholders and at the same time a more sustainable West Swedish energy system?

A fourth project, financed separately by Chalmers Energy Area of Advance has been:

- Scientific coordination of the three projects. The coordination project has been carried out by Thore Berntsson, Chalmers Industrial Technology, Industriell Energi, who also has edited the project report.

### *Main Aims*

The overall main objectives of the projects were:

- to analyze a possible future pipeline connecting the chemical cluster in Stenungsund to the district heating system in Gothenburg and Kungälv, in terms of economic performance, climate consequences, general sustainability aspects and market design model consequences
- to make an assessment of a corresponding pipeline from Värö to the Gothenburg area
- to assess different opportunities for using excess heat available at PREEM's refinery in Lysekil (this part has been studied in Project 1 and the results will be presented at the end of that project, December 2015, i. e. are not included in this report).
- to investigate the importance of different types of policy instruments on excess heat usage

### *Main Results and Conclusions*

The system cost reduction with a pipeline from Stenungsund varies considerably with the different scenarios and assumptions. In some cases, there is no cost reduction. However, with very favorable assumptions of main parameters, especially regarding biomass prices, pipeline cost and investment interest rate levels, this cost reduction can reach 130 MEuros over the studied time period, 2020-2050. In the Värö case, a smaller number of conditions have been studied, but the general levels of system profits seem to be on the same order as in the Stenungsund case. However, the cost reductions calculated are valid only for the following two main conditions:

- A substantial part of the present excess heat sources in Gothenburg, will disappear in 2025
- The industries connected to the new excess heat deliveries will all be active until 2050 with the same delivery capacity as of today

Moreover, the higher levels of cost reductions are valid only with combinations of:

- pipeline cost on the lower side of the assumed span
- biomass price development on the higher side of the assumed span
- interest rates on the lower side of the assumed span and/or economic service life on the higher side of the assumed span.

Also in some cases with specific conditions, such as no natural gas allowed in the area, interesting cost reductions could be calculated. The calculated profit is very small compared with the total cost for heating the district heating systems during the time period considered. In the Stenungsund case, see total cost levels in the Project 2, economic consequence report.

The system cost reduction has been calculated as the decrease in total cost compared with the case when a pipeline is not installed, with an operational price for the new excess heat of 0. As all annualized investment costs are included, all total profits above 0 means, in principle, an investment opportunity. However, considering the low levels of annuity factors used, the small resulting total profit, the uncertainties in the input data and future other opportunities for the supplying industries to use the excess heat, it is reasonable to believe that the business opportunity will maybe not be big enough for several stakeholders to invest in a pipeline.

The influence on greenhouse gas emissions by using a pipeline depends to a high degree on the corresponding emissions from the North European (and in the future maybe a bigger part of Europe) power grid system. With present levels of these emissions, with coal condensing plants as marginal technology, a pipeline would in most cases not reduce the global emissions. However, the marginal grid emissions are likely to decrease in the future by using e. g. natural gas combined cycles, coal condensing plants with CCS and/or wind or solar power production. In most of these cases (except a few cases with natural gas combined cycle), global emissions will decrease with a pipeline. As a pipeline, at favorable conditions, could be in place by 2025, the conclusion is that it is likely that a future new pipeline can contribute considerably to greenhouse gas emissions in West Sweden. This means that there could be a regional or national interest for a pipeline.

Regarding other sustainability consequences, it was concluded that the social impacts of a pipeline are mixed. The effect in employment is likely to be small. There is a risk for adverse impacts on land owners affected by the pipeline, but these impacts can be reduced by, for example, coordinating the pipeline with a pipeline for freshwater.

In the techno-economic calculations a general CO<sub>2</sub>-charge has been used, representing a total sum of future fiscal policy instruments. However, it was concluded that not only the level of this charge but also how it is applied fiscally will have importance for the future use of industrial excess heat.

Regarding market models for a future cooperation between all stakeholders, the results from the case studies have shown that the types of market designs investigated are not possible to use in an evaluation of possibilities for a regional investment in a pipeline. More parameters and conditions must be included in order to make such decisions. An important conclusion is that market design models based on the ones used for power pricing do not seem to favor or give a fair pricing for industrial excess heat.

It has also been shown that the totally available industrial excess heat on the Swedish West coast, not yet utilized, is substantial. In the projects calculations about investing in a pipeline up to 150 MW have been carried out. However, the total available amount is approximately 170 MW from Stenungsund, 150 MW from Södra Cell Värö and up to 200 MW from PREEM Lysekil. It should therefore be of high strategic interest for the region to also investigate other opportunities for more use of industrial excess heat, internally within the industries or for external use. Examples of interesting opportunities for future use are:

- Internal heat recovery
- Power production (via e. g. ORC)
- Heat pumping (for internal heat recovery or external use)
- Drying of biomass (for use in future biorefineries)
- Production algae (for use in future biorefineries)
- Production of district cooling in addition to district heating
- Coal Capture and Storage (CCS) in industry

Finally, it should be pointed out that a future long-distance pipeline for industrial excess heat use would mean an important infrastructure and flexibility for the Swedish West coast. Industries connected to the pipeline can achieve a better economic performance than otherwise and, if parts of the excess heat usage would disappear, the existence of a pipeline could mean that new industries can be established in the area, taking advantage of the opportunities to sell excess heat.