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Risk of industrial heat recovery in district heating systems

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Abstract

Industrial heat recovery can be used in district heating systems. It is a possibility to make use of heat that is otherwise lost. Increased usage of industrial heat recovery reduces the need for fuel combustion lowering greenhouse gas (GHG) emissions, such as CO₂. Industrial companies can, however, move or close down industrial activities. This is apprehended as a risk and lowers the interest of district heating companies to invest in industrial heat recovery.

In Swedish district heating systems, industrial heat recoveries have been undertaken since 1974. Today, the heat recovery is active in about seventy systems. This leads to the question of how risky it is, for district heating companies, to engage in industrial heat recovery.

Over forty years of operation statistics have been collected and analyzed in order to estimate the risk of industrial heat recovery to district heating companies. Key results show that the risk is not linked to different industrial branches. Recommendations include suggestions to management on how to consider risk and consequence when assessing potential industrial heat recovery investments.

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1. Introduction

There are ongoing initiatives in the European Union (EU) to save energy and to reduce greenhouse gas (GHG) emissions. By 2030 the goal is to save 27% of the primary energy used in the EU and to lower GHG emissions by 40% [1]. There are both environmental and economic gains to be made from industrial heat recovery [2] and there is a large potential for further industrial recovery [3]. In Sweden, residual heat is reused in district heating networks. Approximately 3TWh is reused per year whereas the available amounts of residual heat are in the range of 6,2-7,9 TWh per year [4]. The first EU level study on available residual heat considered three industrial branches; oil refining, chemicals and steel and dates to 1982 [5]. In it 2.4 million toe is identified as available resource. A more current study shows that only 1% of the available residual heat is being reused in the EU [6]. There is potential to use more residual heat. If the EU, Iceland, Norway and Switzerland resorted to residual heat in its district heating networks, to the same extent that Sweden does, it could lead to 300 TWh of heat per year [7].

Residual heat investments lead to lower costs of district heating production by putting energy that would otherwise be lost to alternative use. Also, since less fuel is incinerated the emission of GHG is lowered. There are, however, risks to residual waste investments. In Sweden, current legislation with landfill ban and green certificates makes waste incineration and biofuelled combined heat and power plants (CHP) more competitive than utilization of industrial residual heat [8]. Other, known risks to residual heat investments are geography (where distance can hinder investments), different mindsets in industries compared to municipally owned district heating companies, a desire of industries to have own and independent heating solutions, volatile residual heat deliveries into district heating systems, the risk that industries go out of business, the notion that residual heat losses must be covered for by back-up facilities and an inability between parties to reach agreements that are mutually beneficial [ibid,2,4,9,10,11,12].

Swedish district heating companies and industries seem to have a greater ability to enter residual heat investments than corresponding parties in the EU. Why is that? Are Swedish district heating companies and industries better at managing investment risk than others or are residual heat investments in Sweden less risky than in other countries? Or are residual heat investments not as risky as they seem to be? In Swedish district heating systems, industrial heat recovery has been undertaken since 1974 and heat recovery is currently active in more than seventy systems. Analysis of Swedish data makes it possible to make a first estimation of the risk of residual heat investments. *The question of research in this study is if it is possible to asses risks of residual heat investments based on the Swedish experience.*

2. Data collected

The first assessment of risk related to residual heat investments is performed in this pre-study by focusing on how long co-operations have existed in both current and terminated projects. Also, heat recoveries from various industrial branches have been analyzed. Later, complementary analysis will be performed focusing on why residual heat investments are undertaken and on how the risk of residual heat investments can be minimized.

Over forty years of operation statistics have been collected and analyzed in order to estimate the risk of industrial heat recovery to district heating companies. Main data resources have been the annual statistical surveys from the Swedish District Heating Association, the Swedish Energy Market Inspectorate, and Statistics Sweden.

Until 2014, 1570 years of residual heat deliveries have been identified in verified co-operations, as indicated in Table 1.

	Total number of localities	Total number of operation years	Average of operation years
Still in operation during 2014	69	1221	17.7
Terminated before 2014	28	349	12.5
Total	97	1570	16.2

Table 1. Overview of data collected in verified co-operations

Co-operations that are based on non-industrial processes (such as biomass boilers in sawmills for example) have been excluded from the report. Low temperature industrial sources as input to heat pumps have been included.

3. Results

The data indicate that co-operations for recovering industrial heat to Swedish district heating systems are initiated with similar frequency across the time span of 1974 to 2014. In seven years no co-operations are initiated at all, seen from Figure 1.

As a result of the second, global oil crisis, a trend of including heat pumps in the heat recovery investments is discernable in the time span on 1983 to 1985. The trend ends in 1986 as a result of increasing electricity prices in Sweden in that year.

Considering the number of operation years the data shows that more than 85% of the co-operations have an operation lifetime of five years or more. This indicates that industrial heat recovery co-operations tend to be long-rather than short-term.

On average, a co-operation that has been terminated lasted for 12.5 years. Co-operations that were still active in 2014 experienced an average 17.7 year life span. In Figure 2, the number of co-operations terminated before 2014 and the number of co-operations still in operation during 2014 are shown.

Analyses show that investments in industrial heat recoveries are undertaken in different industrial branches. The most long lived co-operations are found in the production of basic metals and in the extraction of metal ores, seen in Figure 3.

A peak of heat pump co-operations was identified for the time span of 1983-1985. Separate analysis of heat pump co-operations shows that this kind of co-operation is rare (one heat recovery investment out of five). Of the established co-operations approximately seven out of ten have gone out of business.

In Table 2, the number of heat pump investments that have been undertaken and that have gone out of business are compared to the total number of heat recovery investments undertaken (1974-2014).

	With heat pump	Without heat pump	Total
Still in operation during 2014	6	63	69
Terminated before 2014	13	15	28
Total	19	78	97

Table 2. Co-operations with/ without heat pump Table 2. Co-operations with/ without heat pump

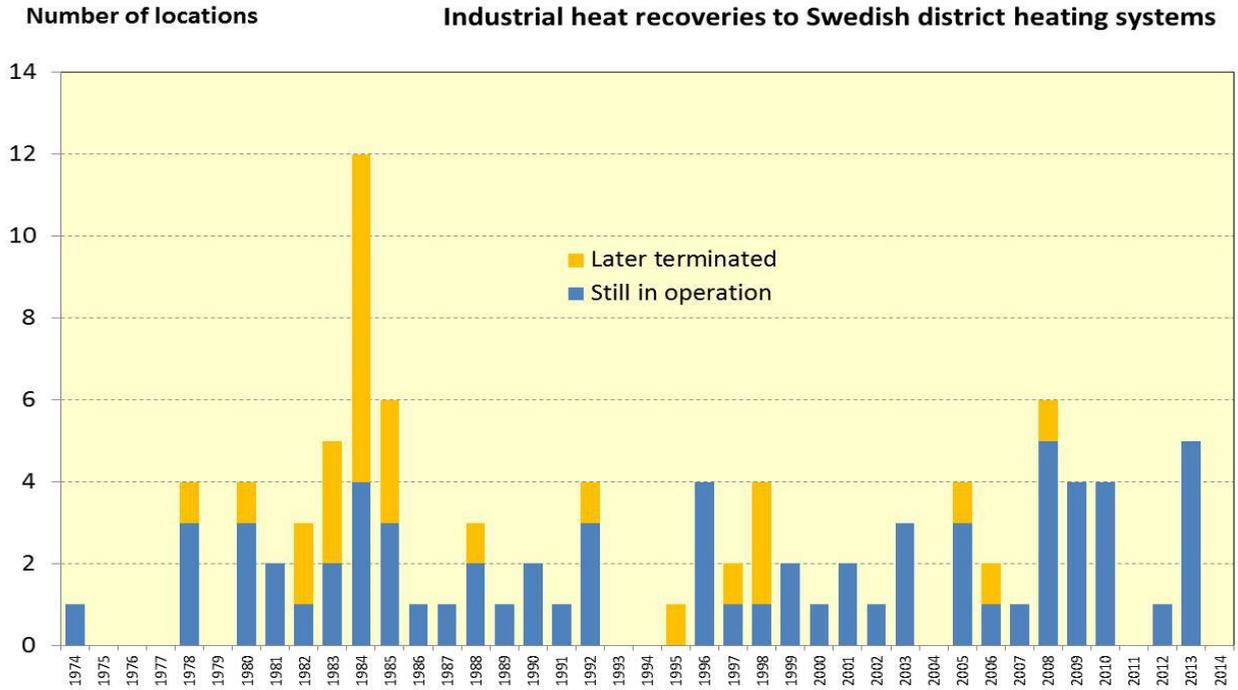


Figure 1. Initiated co-operations concerning industrial heat recoveries by commissioning year

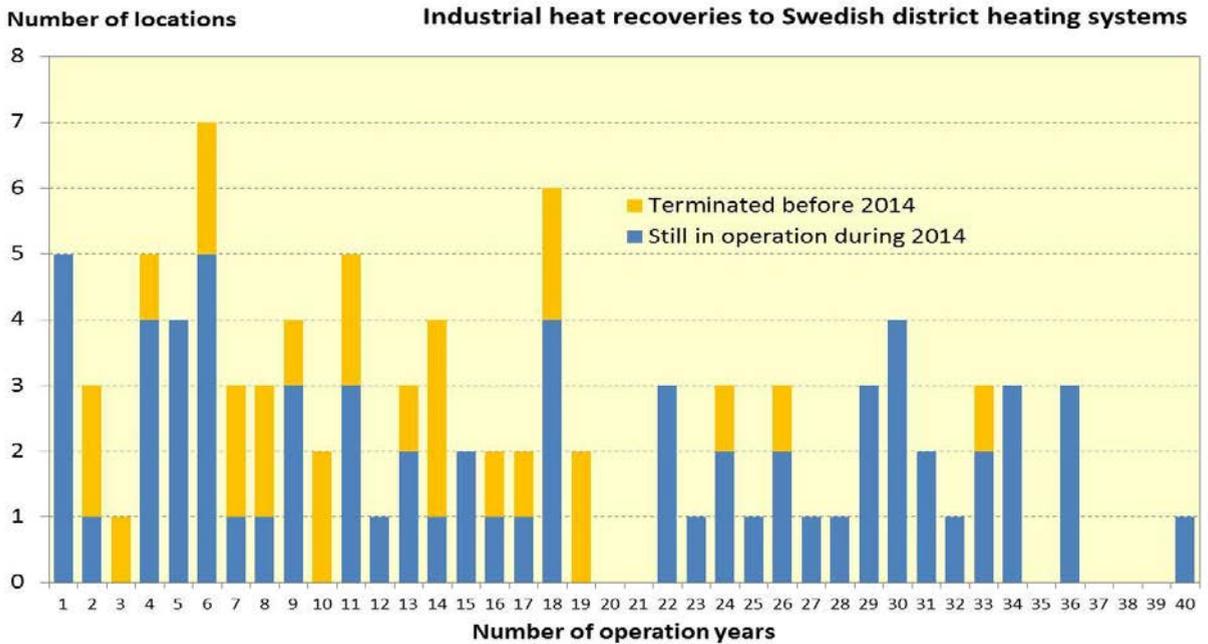


Figure 2. Number of operation years by terminated and ongoing co-operations concerning industrial heat recoveries

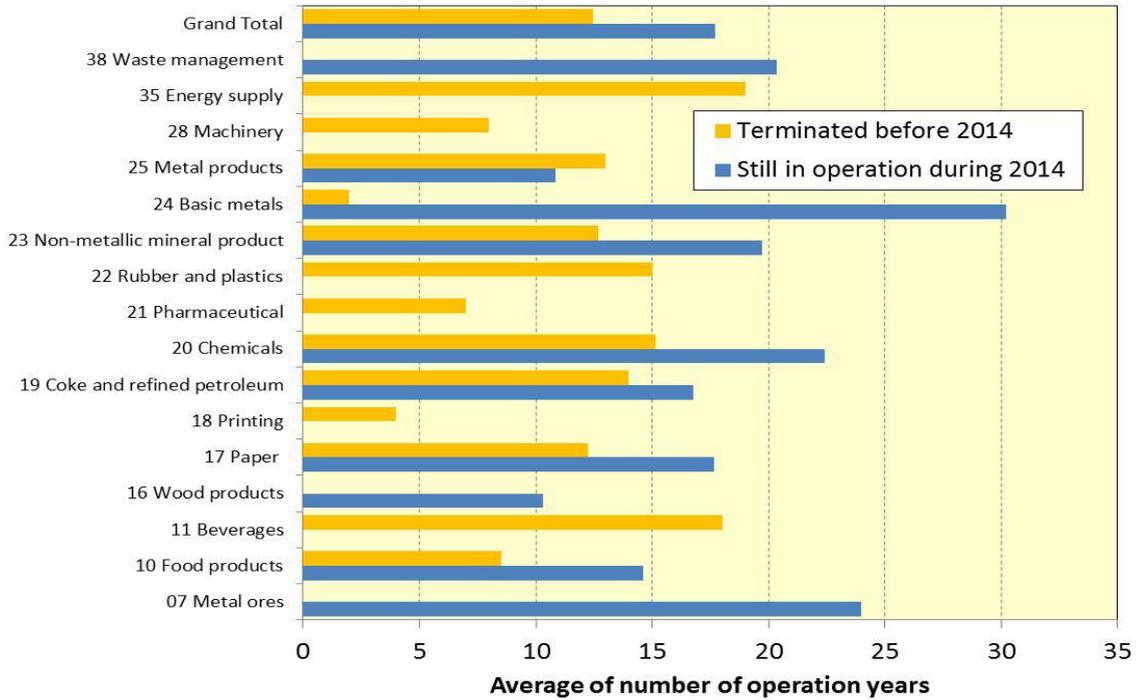


Figure 3. Average number of operation years for co-operations per industrial branch

4. Conclusions

Industrial heat recovery investments are not a new phenomenon. Investments have been undertaken almost every year in different industrial branches.

A large majority of the identified co-operations have an operation life of 5 years or more. Such a time frame should be enough for most industrial heat recovery investments to pay themselves back and to generate a return. It seems as if the investment risk of industrial heat recovery co-operations is rather limited. Industrial heat recovery investments are undertaken in a variety of industrial branches. This diversity indicates that the idea to put the excess heat generated to use is spread and appeals to different kinds of industries. It appears as if risks related to industrial heat recovery co-operations is not correlated to particular branches.

Heat pump investments are undertaken in one case out of five and seven investments undertaken go out of business. It appears as if heat recovery investments including heat pumps are more risky than investments excluding heat pumps. One probable reason is that heat pump residual heat investors rely on both cost for heat and electricity. Electricity has historically had a volatile price.

Returning to the question of research the conclusions drawn from this pre-study imply that it is possible to assess risks of residual heat investments based on the Swedish experience. However, more information is needed. Further statistical analyzes are going to be undertaken focusing on delivered residual heat volumes. Additionally, complementary interviews will be performed to discern why residual heat investments have been undertaken. Thereafter an analysis will be made on how the risk of residual heat investments can be minimized.

Decision makers considering if to enter an industrial heat recovery investment or not should note that heat pump co-operations create a dependency towards both heat- and electricity- price development.

The co-operations seem apt for different industrial branches and constitute an opportunity for energy savings that should be investigated when erecting new industries and/ or revisiting the energy system of existing facilities. Industrial heat recovery investments are apt for long term investments. Investors with short investment horizons should opt for other energy solutions.

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