The ATES project – a sustainable solution for Stockholm-Arlanda airport

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Abstract

LFV, owner and operator of Stockholm-Arlanda Airport, has set up a goal to have zero CO2-emissions 2012 from LFV's own business. As the airport has large needs for heating and cooling, an important part to lower emissions is to find sustainable solutions for energy supply. One such project is an Aquifer Thermal Energy Storage (ATES) system. This system will supply the airport with renewable heat and cold, thus replacing conventional chillers and reduce the dependence of district heating.

The ATES plant is expected to reduce the electricity use by 4-5 GWh/year, the district heating use by 10-15 GWh/year, and CO2-emissions by 7 000 tonnes/year. A comprehensive environmental assessment study suggests that there will be no considerable impact on the surroundings. The system is designed to cover a cooling and heating load capacity of 8 MW at a maximum ground water flow of 720 m3/h.

1. Background

Stockholm-Arlanda Airport, Sweden's largest airport, is situated about 40 km north of central Stockholm and is an important hub for both the Stockholm region and Scandinavia.
Each year 18 million people travel to or from Stockholm-Arlanda airport and it is the largest place of work in Sweden, about 15 000 people in total has their work at the airport.

The airport is owned and operated by LFV, previously called Luftfartsverket (the Swedish Civil Aviation Administration), which is a Swedish State enterprise that is responsible for operating and developing 16 Swedish airports.

For LFV and Stockholm- Arlanda airport environmental issues has been a high priority for many years. There are about 40 environmental conditions that Stockholm-Arlanda must continuously meet in order to be granted a permit to operate as an airport. But the environmental work is not only a matter of meeting these conditions. It is also all about taking serious steps to minimize the environmental impact and be a good neighbour. Examples are measures to reduce carbon dioxide emissions, lower noise levels, protect waterways and soil around the airport and lower energy consumption.
Significant for Stockholm-Arlanda is that, as the only airport in the world, the airport has a cap for carbon dioxide emissions included in its environmental permit. This environmental condition, the emission cap, includes emissions from starting and landing of aircraft, ground transports to, from and at the airport and heating and cooling of airport buildings. The permit

states that the net CO2 emissions from these activities shall not be higher in year 2016 than they were in 1990, regardless of any possible expansion.

2. Towards zero carbon dioxide emissions

LFV has set up a goal to have zero fossil carbon dioxide emissions 2012 from our own businesses at Stockholm-Arlanda Airport. Main activities are related to energy supply and LFV's fleet of vehicles, where we strive to only have renewable fuels in 2012.

Over the last four years the net carbon dioxide emissions from LFV's own business have decreased by more than 50%. Still, in 2007 the net carbon dioxide emissions from business included in the emission cap were one (1) percent higher than the amount stated in the permit. The main reasons to the high emissions are aircraft and ground transports that together represent 97% of the emissions.

Therefore in order to successfully fulfill the permit we are depending on other operators and companies and LFV co-operates with many of them.
Examples of activities are green approaches for the airplanes, letter of intent with operators in purpose to strengthen and expand the public transport to the airport in order to decrease emission from the car traffic, only allow taxi cars with fuel that does not cause any net carbon dioxide emissions.

For supply and consumption of energy LFV has set up the following goals for our own business at Stockholm-Arlanda Airport.

- 100% renewable energy supply 2010
- 30% less electricity in 2010
- 35 % less energy in 2010

The electricity consumption per year is 77 GWh (LFV's own business) and the consumption of district heating is 40 GWh per year.

Both district heating and electricity are generated from renewable sources, but we strive to reach the goal of lower total energy consumption. To do this, LFV has a designated organization, Arlanda Energi, with the mission to reduce the total energy consumption and to guarantee that all energy supply comes from renewable sources.

So far the concept has been successful and since 2006, when Arlanda Energi was formed, the energy consumption has been reduced with 18%. This has been done by expanding the district heating system and thereby replacing oil heating, both to LFV's own buildings and to building owned by other companies located at the airport area. We have also adjusted the systems for lighting and ventilation to work when needed and not all round the clock.

2008-2010 a project is carried out with the purpose to further reduce the energy consumption. The project involves all parts of LFVs organization as we need all personal to contribute to be able to reach the goals. Activities in the project are technical development and more efficient processes, as well as everyday behavior such as turn off the light and computer in the end of the day.

3. The aquifer thermal energy storage (ATES) plant

The largest project at the moment is the construction of an Aquifer Thermal Energy Storage (ATES) plant. This plant will supply the airport with natural, renewable heat and cold, thus replacing conventional chillers and reduce the dependence of electricity and district heating. A schematic illustration of the system is shown in figure 1.

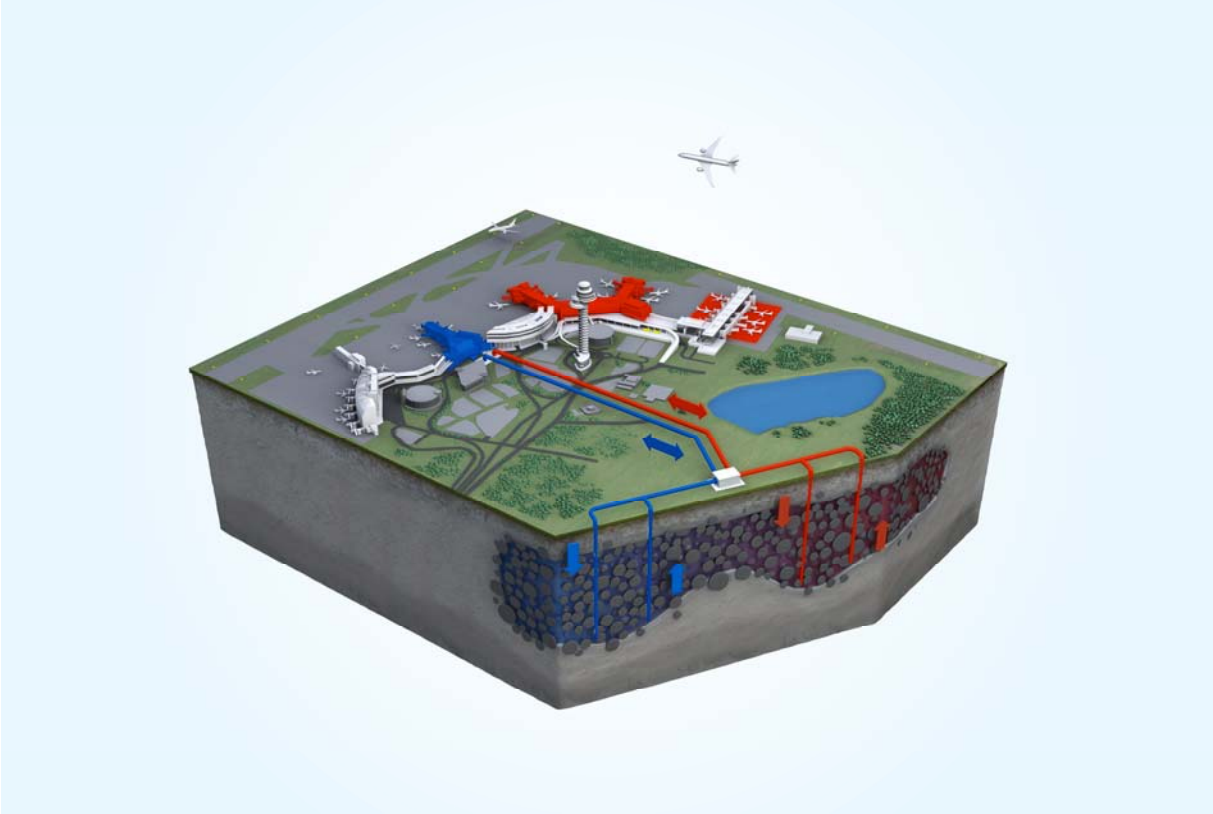

Figure 1. *Heat and cold is seasonally stored in an aquifer close to the airport. In winter the heat is used for heating ventilation air and for snow melting at gates. In summer the cold is used for comfort cooling.*

The aquifer is situated in the local esker Långåsen, a couple of kilometers away from the terminals. The idea to use the esker for seasonal storage of natural heat and cold took form in 2005. Feasibility studies began the year after, followed by hydro-geological site investigations, and a permit application including an environmental assessment was sent to the Environmental court in 2007.
The court gave the permit in august 2008 and the construction of the plant could begin almost immediately. The construction of the plant is expected to be finished at late spring and start of operation is scheduled to the end of May 2009.

The system is designed to cover a cooling and heating load of approximately 8 MW at a maximum ground water flow of 720 m^3/h.

The flow is obtained from five cold wells in the northern part of the aquifer and six warm wells in the southern part. The system will be a closed circuit where the groundwater in the esker is used for the transmission of energy through a large heat exchanger. The water is pumped up from one side of the esker, delivering heat or cold passing the heat exchanger, and then continuously injected back at the other side to the aquifer. The heat or cold is distributed by a local district pipe system to connected buildings.

During winter season the heat from the plant will be used to preheat ventilation air to the terminals and to the system of ground heating coils at the gates. The waste cold from heating is distributed back and stored at the cold side of the aquifer. The cold storage temperature is estimated to vary between +3 and +5°C under normal conditions. Today the heating is all district heating and the plant will reduce the dependence of district heating with 10-15 GWh per year.

In summertime the flow of aquifer system is reversed. The ATES plant then delivers cooling to the terminals where the need of cooling is large. The warm water in return holds a temperature of about +15 °C. However, this temperature can be increased to approximately +25 °C by using the ground heating coils at the gates as solar collectors during sunny days. Today conventional chillers are the main cooling production, consuming 4-5 GWh electricity per year.

4. Environmental aspects

A comprehensive environmental assessment study has been performed regarding effects on the groundwater, salt and microbes in the system, effects on vegetation and on outdoor life.

The assessment suggests that there will be no considerable impact on the surroundings. Instead, a positive effect on the lake Halmsjön is expected since much less heat will be dumped in the lake (currently used for condenser cooling of chillers).

Together with the permit from the Environmental court, a number of conditions are stated. These conditions are mainly covering monitoring of system flow (momentary and annually), changes of ground water levels and temperatures at different places in and outside the aquifer, ground water chemistry analyses and a special survey of forest areas that may be affected.

A special program has been worked out in order to fulfill these conditions. This has been in close cooperation with the local inspection authority (Länsstyrelsen), to whom the results of the program are reported once a year. This program will continue until it has been shown that the plant can be operated safely from an environmental point of view. However, if unforeseen impacts turn up, the authority has the power to change the program

5. Conclusions

LFV has so far reduced the energy consumption with 18 %. The goal is to reduce 22 GWh, 30%, to 2010 and the ATES plant is an important contribution to reach the goals for lower energy consumption, with reduced electricity use for cooling production by 4-5 GWh/year and the district heating use by 10-15 GWh/year.

As mentioned earlier, all electricity and district heating used at the airport comes from renewable sources and cause no net carbon dioxide emission. Therefore we can not claim any decrease of carbon dioxide obtained by the ATES system. However, the reduced consumption of electricity and district heating will enable other businesses to use the same amount renewable energy. In the case the released resources are used to replace fossil fuels (oil burners for heat and the European electricity mix for electricity) the savings of ATES represents some 7 000 tons of carbon dioxide emission .

From an economic point of view, LFV will cut the cost for energy with at least 1 million Euro annually (at current energy prices). With an investment of approximately 5 million Euro, a straight pay back time in the range of 5 years is expected. However, of greater interest is that the system has a very high seasonal performance factor (around 60), indicating that the system is practically independent of future energy prices.