MUNICIPAL HEATING

NEW DEVELOPMENTS IN ENERGY STORAGE

HÄRNÖSAND

THE HEAT VAULT
SECURING ENERGY . NATURALLY

Cover Image - Härnösand, Sweden


Härnösand

EXECUTIVE SUMMARY

Härnösand Energi & Miljö AB (HEMAB) is the municipality district heating supplier for Härnösand. HEMAB is 50th on the list of 276 such large municipal heat networks in Sweden on the basis of capacity, which is 213 GWh heat output plus 26 GWh electricity.

The central assets, located north of Härnösand, house biomass steam and water boilers with supplementary electric and oil boilers averaging 30 years in age. Distributed assets elsewhere in the city are dominated by portable oil boilers, with small capacity electric boilers in specific facilities. Distributed assets have an average age of 27 years.

Throughout Autumn to Spring (5,500 hours) there is significant reliance on the single ÅP1 biomass steam boiler. Total system output is estimated at 64 MW which is dominated by ÅP1 and associated assets at 38 MW and supplemented from supply from the adjoining biomass processing plant of up to 8 MW. In other periods, biomass pellet hot water, electric and oil boilers dominate (up to 2,000 hours).

The economics for full capacity use of ÅP1 constrain CHP operations during summer periods of lowered heat demand. The switch to other assets in these periods increases overall costs of operation at higher carbon footprint. In aggregate in the four summer months, heat supply is 10% of annual supply and no power is supplied. This indicates stranded assets for a quarter of the year which limits overall financial performance.

The current project sponsored by Energimyndigheten has focused on the ways in which large scale energy storage can deliver better overall performance for HEMAB. The proposed build of the first phase of such storage addresses seasonality by transferring thermal energy to store in summer months and making such energy available for use as baseload in the period of higher heat demand in winter. Analysis indicates an immediate opportunity for 20 GWh to be time-shifted to address seasonality.

However, in addressing seasonality, the proposed build of an energy store also addresses other issues beyond recycling thermal energy.

Summer thermal demand which is presently addressed with electrical boilers, more expensive pellet boiler biomass or emergency use of hydrocarbons, could be swapped out in greater use of the energy store.

Summer CHP could operate through the energy store even in periods of lowered electricity prices to enhance total asset use and improve revenue generation for this quarter.

In addition to baseload, the energy store is able to act as a thermal peaker plant. This provides further security for periods of extreme winter weather, which avoids more costly backup systems.

The physical and security risks associated with a clustering of biomass assets in a single plant could be minimised through development of a subsurface energy store capable of operating to mitigate such risks or better manage circumstances of sustained or irretrievable breakdown of key biomass assets.

Consequently, development of an appropriately sized energy store coupled to a district heating plant such as HEMAB would create new opportunity to: shift thermal energy from periods of low demand and low cost to ones of higher demand and higher price; offer summer CHP; avoid dependency on external thermal energy from suppliers; reduce or eliminate use of hydrocarbon assets; minimise use of more expensive pellet feedstocks and related assets; provide greater security of district heating facilities; provide emergency backup; avoid discontinuities in thermal energy supply for periods of breakdown or unexpected disruption.

The decarbonisation of municipal heating in Sweden away from hydrocarbons to biomass use has been a significant success. In looking forwards, three challenges now arise. First, biomass boiler assets are the backbone of heat supply. Many such assets are approaching end of life. Capital reserves for direct replacement of such portfolios of assets are relatively high and annual operational performance is insufficient to allow extended periods of down time for major replacement while maintaining the same level of critical thermal supply. Second, waste biomass availability could decrease while feedstock prices continue the recent trend to much higher prices, which will place considerable pressure on the already thin margins of biomass reliant heat suppliers. Third, population growth within the Härnösand area is forecast to rise by around 17% in the coming years coupled with a move towards progressively more renewables industries. On the one hand community growth will exert more supply pressures on HEMAB. On the other hand green industry will provide a new opportunity to benefit from renewables enabled municipal heating.

With all of the above in mind, the current project has considered the potential evolutionary path which could be taken by HEMAB as an example of how municipal heat systems could transform.

Four phases of evolution have been identified which are: Optimisation; Fuel replacement and diversification; Long term district heating security; and development of a Net Zero Energy System.

With the advent of large scale energy storage, there is opportunity progressively to reduce cost, improve efficiency, increase revenue, mitigate risk, avoid unreasonable capital spend and minimise feedstock use and costs.

But the biggest achievement would be the ability to transition to a municipal heating system which is differently conceived. With the regional and national moves to greater availability of renewable wind and solar assets and the favourable economics these offer, there is prospect for a coupling of national or dedicated local renewable assets with energy storage. This would allow use of the increasingly frequent periods of low prices or negative prices from excess and otherwise wasted, curtailed or constrained renewables electricity to be utilised through conversion to thermal energy then stored. In this manner, renewables-enabled thermal storage at scale can provide both baseload and peaker municipal energy without either biomass or the assets these require. And biomass can be put to better use than burning it for thermal energy.

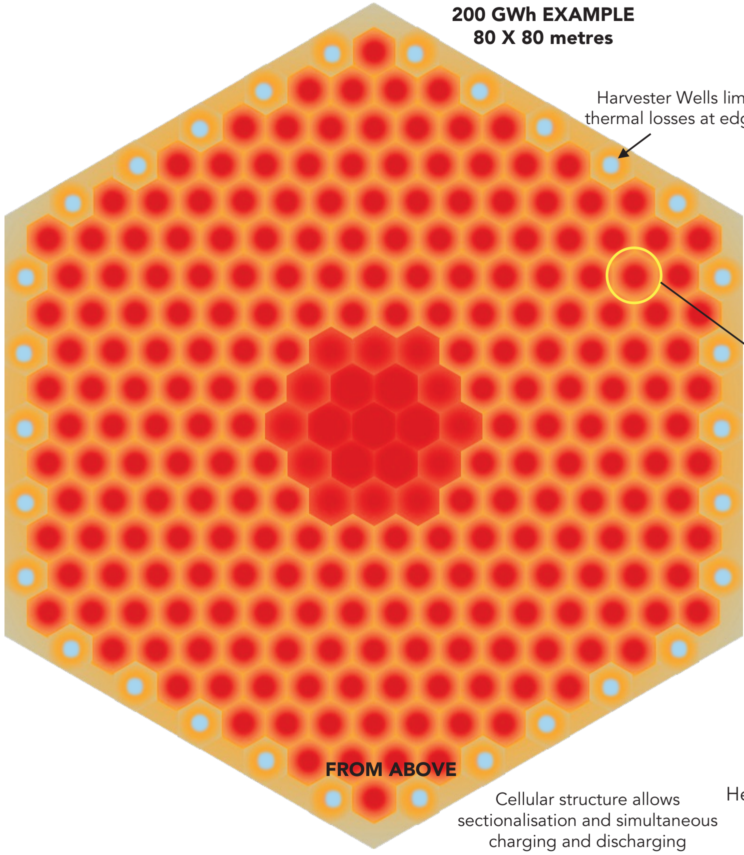
To create the opportunity for a coupled renewables power and energy storage system to be a viable alternative to biomass municipal heating systems it would be essential for the Swedish Government to remove the current electricity tax provision in a similar manner to the removal of such a tax in Finland and Norway.

Request Complete Report

For a copy of the complete report please message The Heat Vault Company via Contact on its website www.theheatvaultcompany.com

THE HEAT VAULT subterranean architecture of boreholes to input or output heat energy stored in solid rocks

200 GWh EXAMPLE
80 X 80 metres



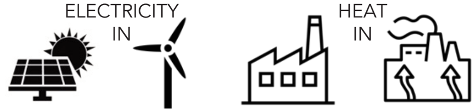
Harvester Wells limit thermal losses at edges

Cellular structure allows sectionalisation and simultaneous charging and discharging

INPUTS

ELECTRICITY IN

HEAT IN



Excess Solar PV

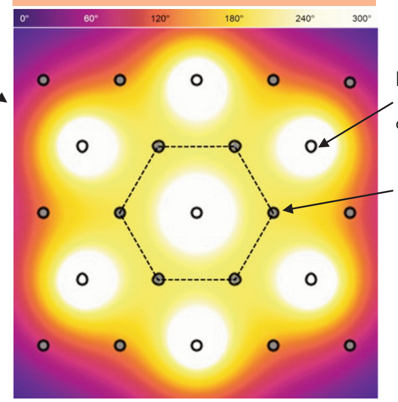
Excess Wind Power

Waste or Seasonal Industrial Heat

Geothermal Heat

EFFICIENCY

INPUT 100%	STORE 92%	OUTPUT 98% HEAT



Central borehole has mineralised cable to heat rocks.

Boreholes at vertices of hexagonal cell have circulating heat carrier fluids to charge or discharge heat

Heat to Cooling

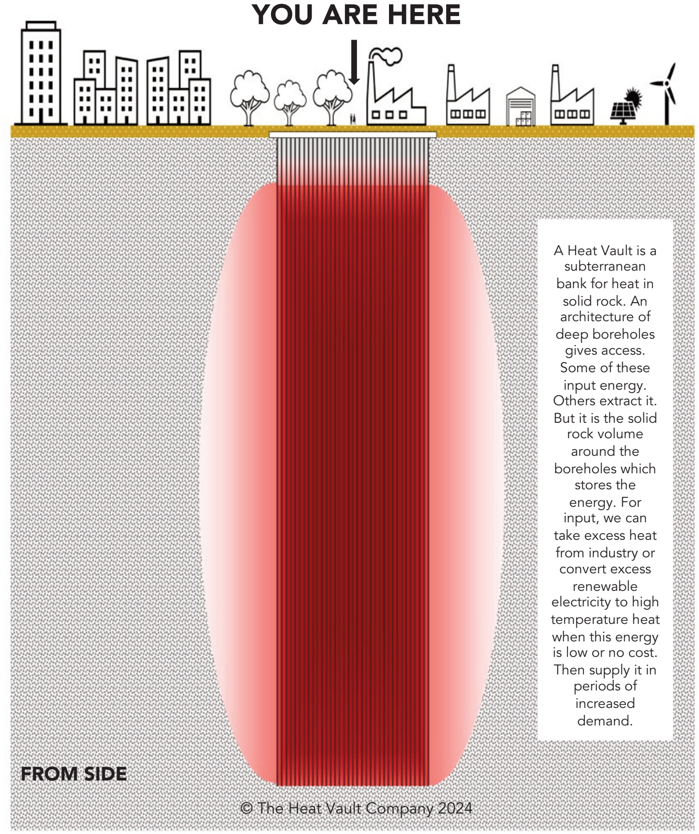
Heat to Power

Heat

Industrial Heat

OUTPUTS

YOU ARE HERE



HEAT VAULT VARIANTS
Illustrative

	Starter	Small	Medium	Large	XL
Storage capacity (GWh)	20	60	200	400	600
Surface Size (m²)	640	2,133	6,400	12,800	19,200
Build cost (SEK M)[1]	29.8	89.3	297.8	594.3	892.0
Payback period[2]	4.7 years	4.7 years	4.3 years	4.2 years	3.6 years
Asset lifespan	30 years +				
Build duration	6 months	7 months	9 months	12 months	16 months

1. Subject to variation plus integration costs
2. This is the payback period assuming a single annual energy output cycle based on the initial project build cost
3. Illustrative figures, subject to contract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