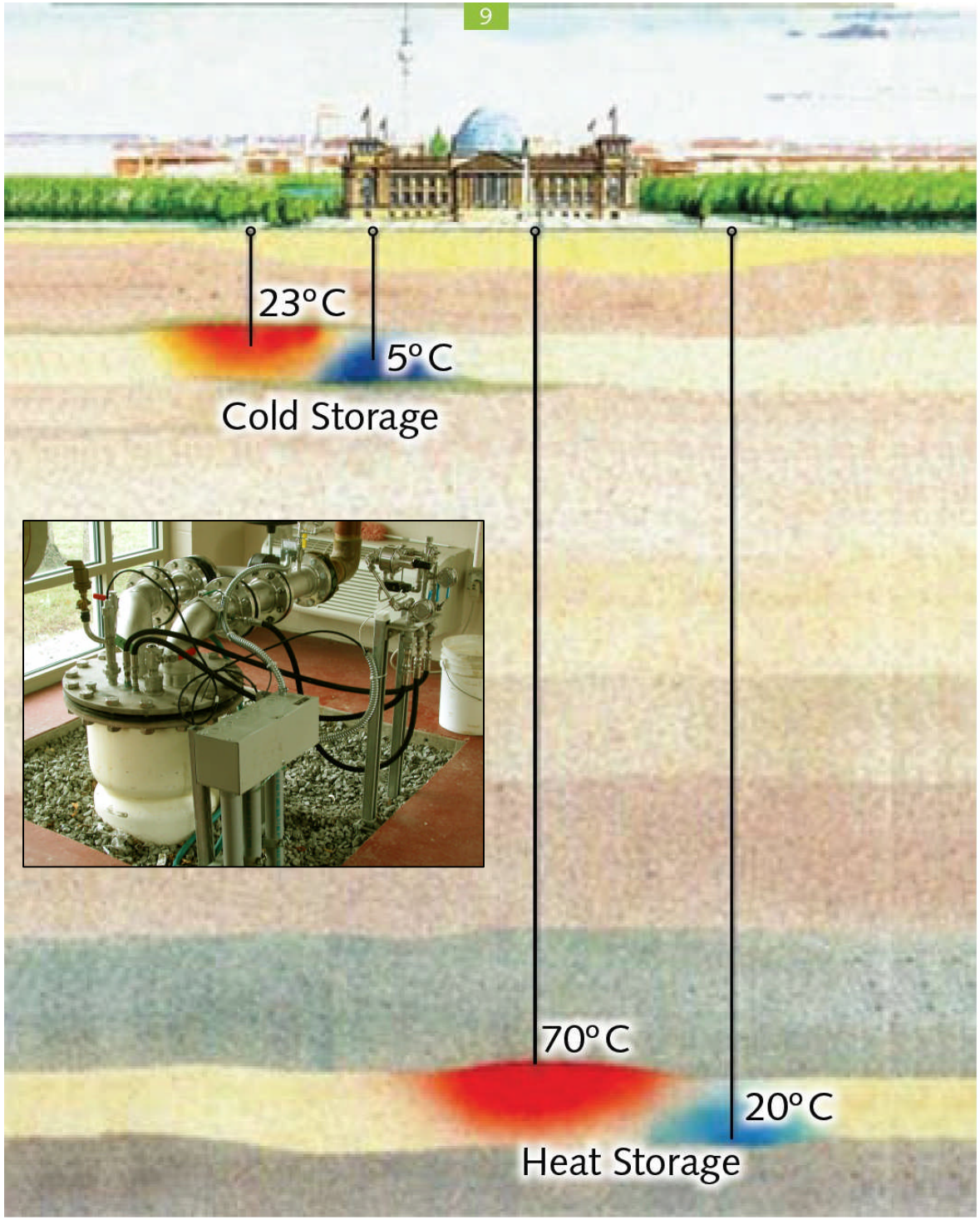
Seasonal Thermal Energy Storage:

Heat or Cold — Saved for Days or Many Months

- *… Underground — **UTES***
  - *In Aquifers — **ATES***
  - *In Boreholes (any strata) — **BTES***

Larry Edwards



ATES

The Reichstag, Berlin

Cold & Heat Storage

In operation since 1999

Provides:

summer cooling & winter heating

The Netherlands —

> 1600 ATES Systems.

A standard design option.

ATES will replace

15 PJ energy by 2020

BTES Borehole Field — 144 boreholes, 155 feet deep

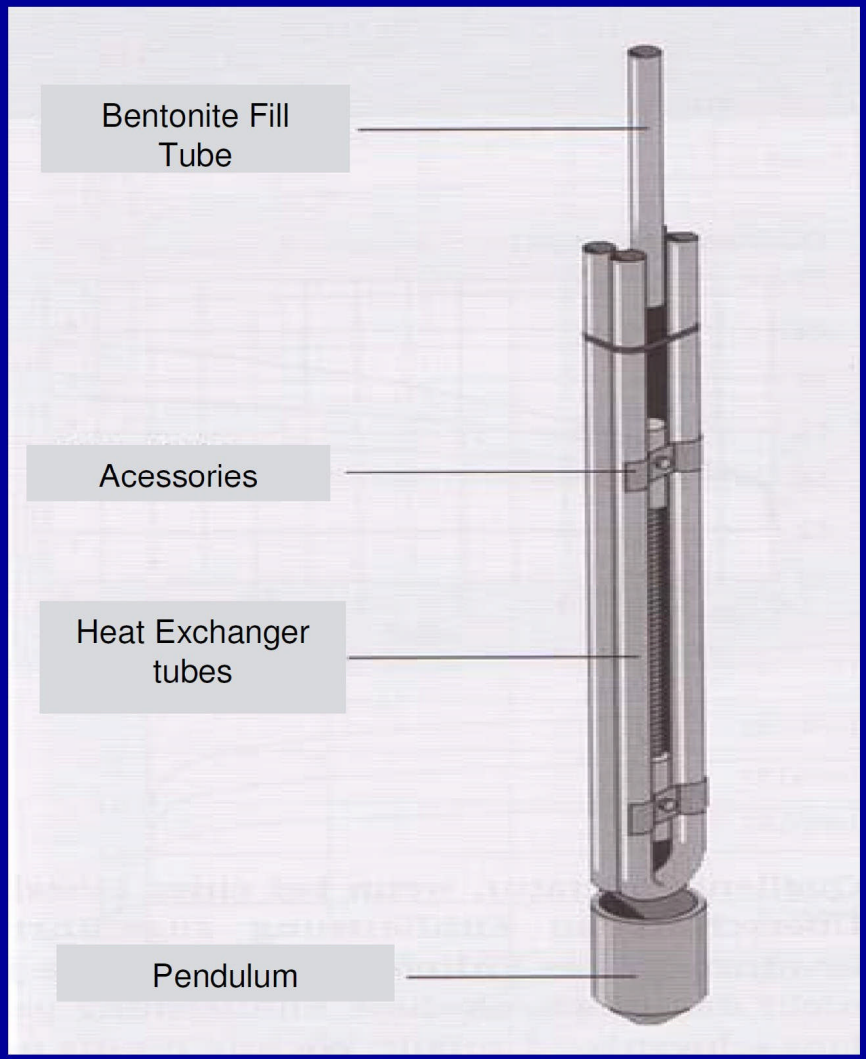
Okotoks, Alberta

Drake Landing Solar Community

90% solar heat fraction for the homes. In operation since 2007.

GROUNDHIT PROJECT

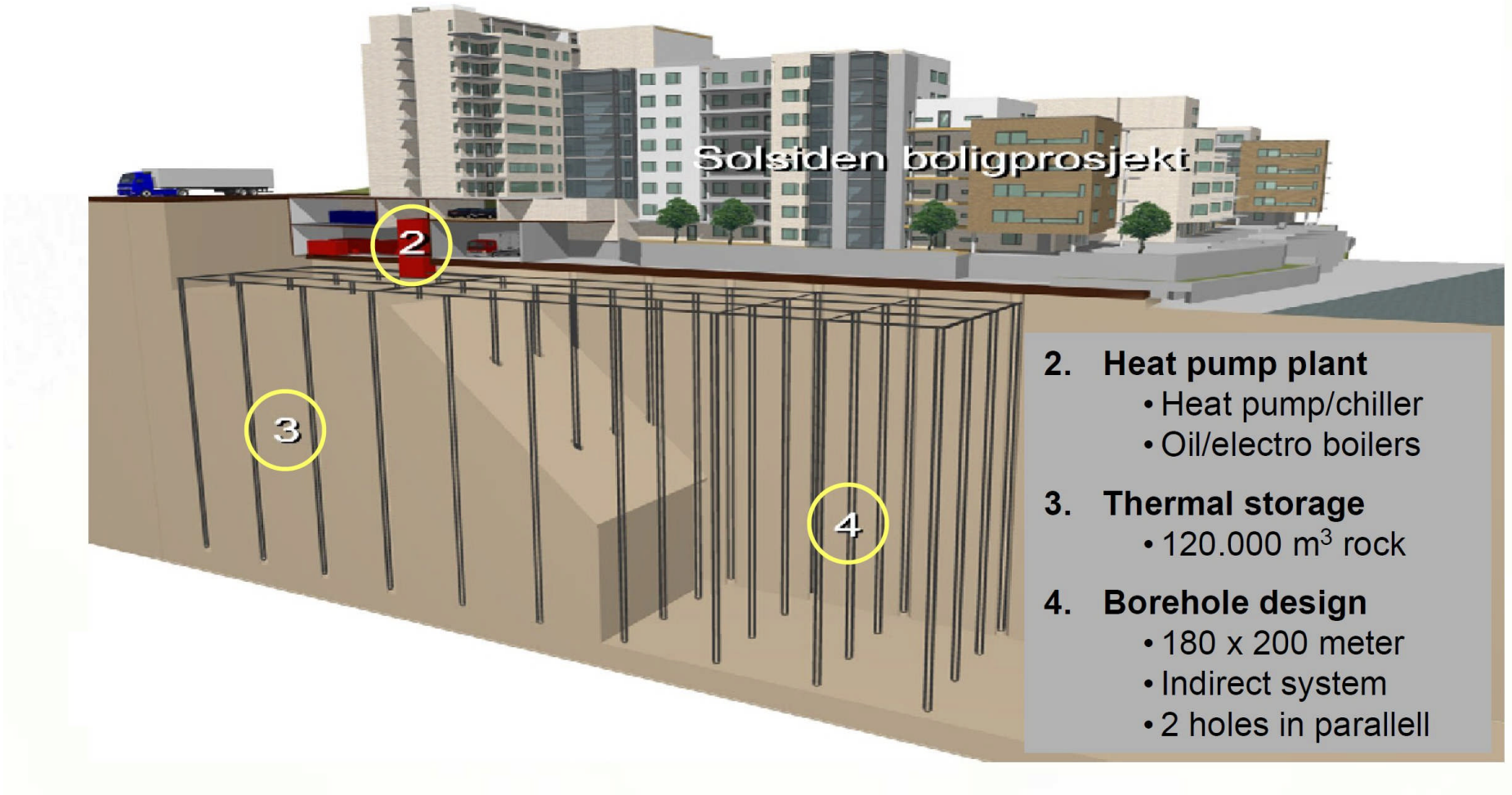
Borehole Heat Exchanger: Double U



GROUNDHIT PROJECT

Double-U pipes

Simple coaxial pipes



180 Boreholes, 656 to 850 feet deep

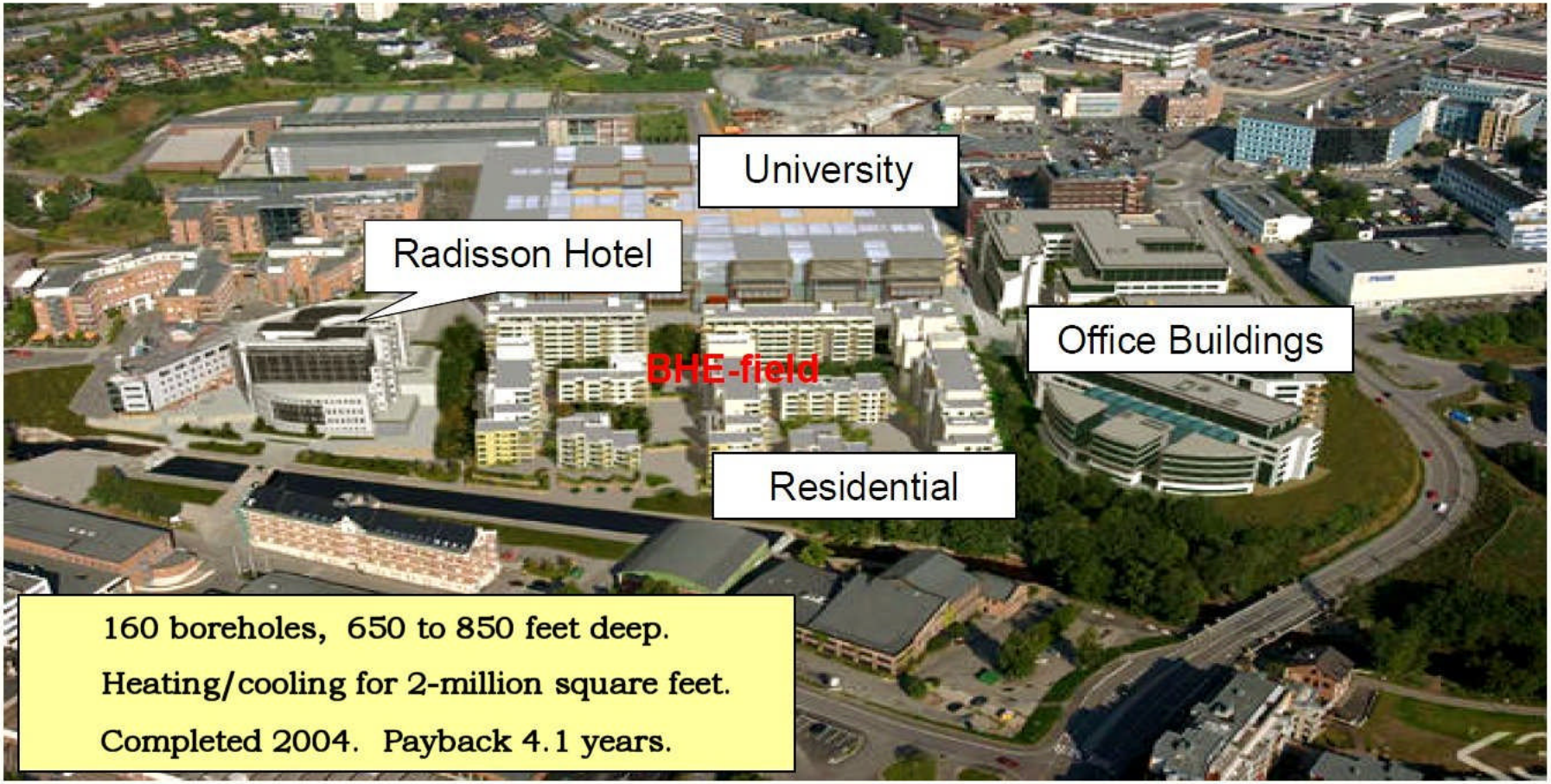
Avantor – Nydalen, Oslo Norway

6 MW heating, 9 MW cooling

Floor Area: 2,000,000 sq. feet

Completed 2004 — 4.1 year pay-back

Avantor development area in Nydalen, Oslo



(Photo: Avantor)

Power requirement 60-70% less than other alternatives

400 boreholes, 425 feet deep, 3.5 acres

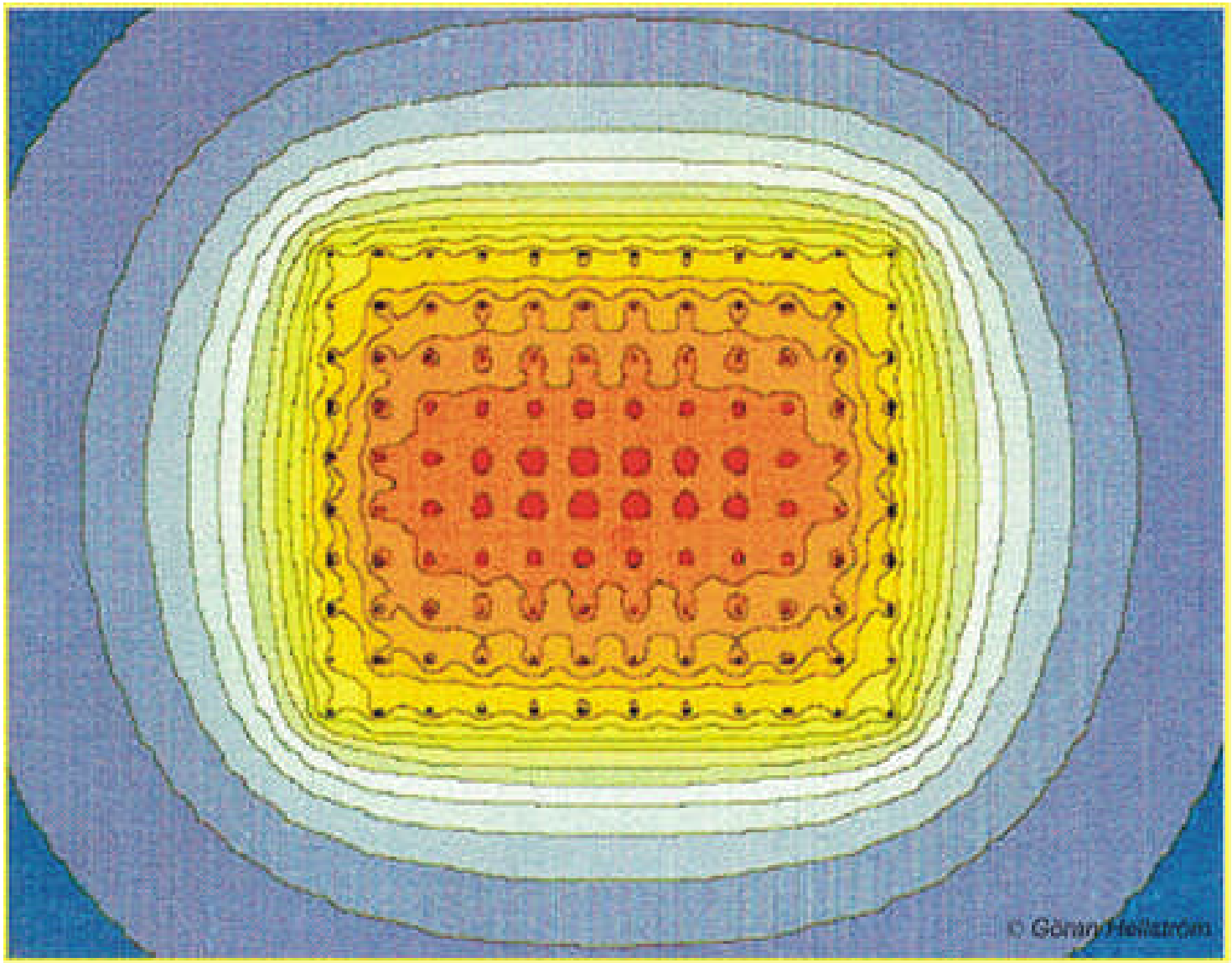
Heat loss: 2% over 6 months

Richard Stockton College, Pomona, N.J.

Buildings: 400,000 square feet

CO2 reduction = 2300 tons/year

Completed 1990 — 4.6 year pay-back



Hellstrom (2005)

Heat gradient in a BTES field

Red: at most 195° F for heating,
at minimum 23° F for cooling.

Nasby Slott (Castle), Sweden

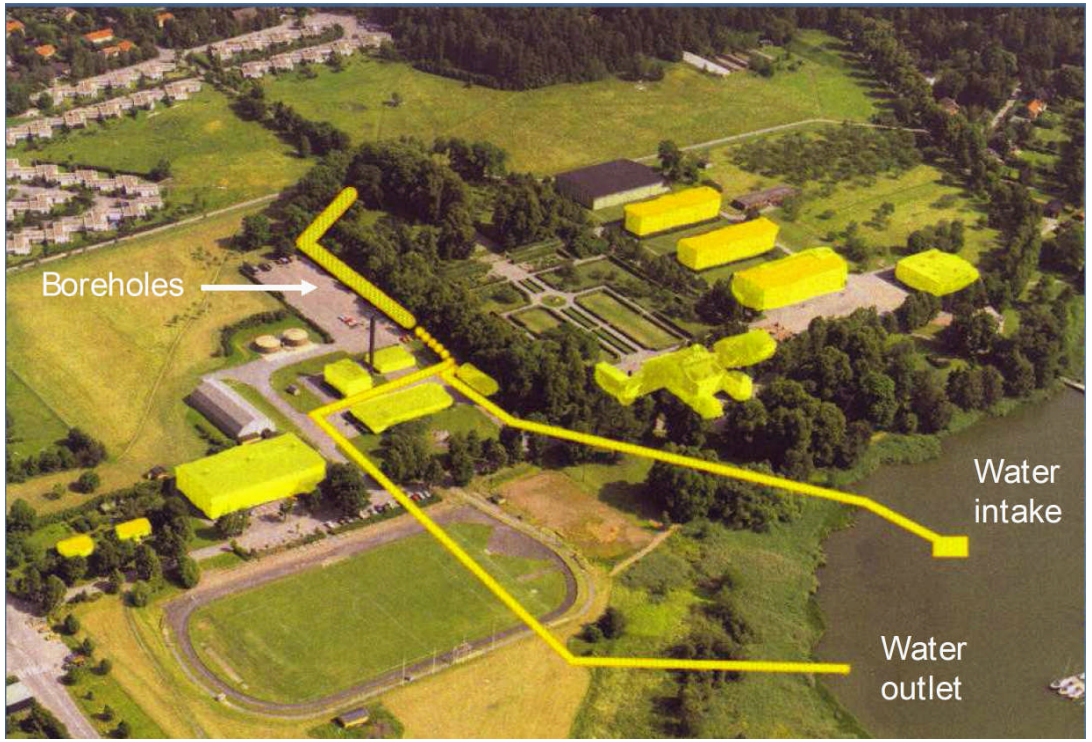
Seawater source heat pumps (Baltic Sea)

48 boreholes, 590 feet deep.

Heating 200,000 square feet.

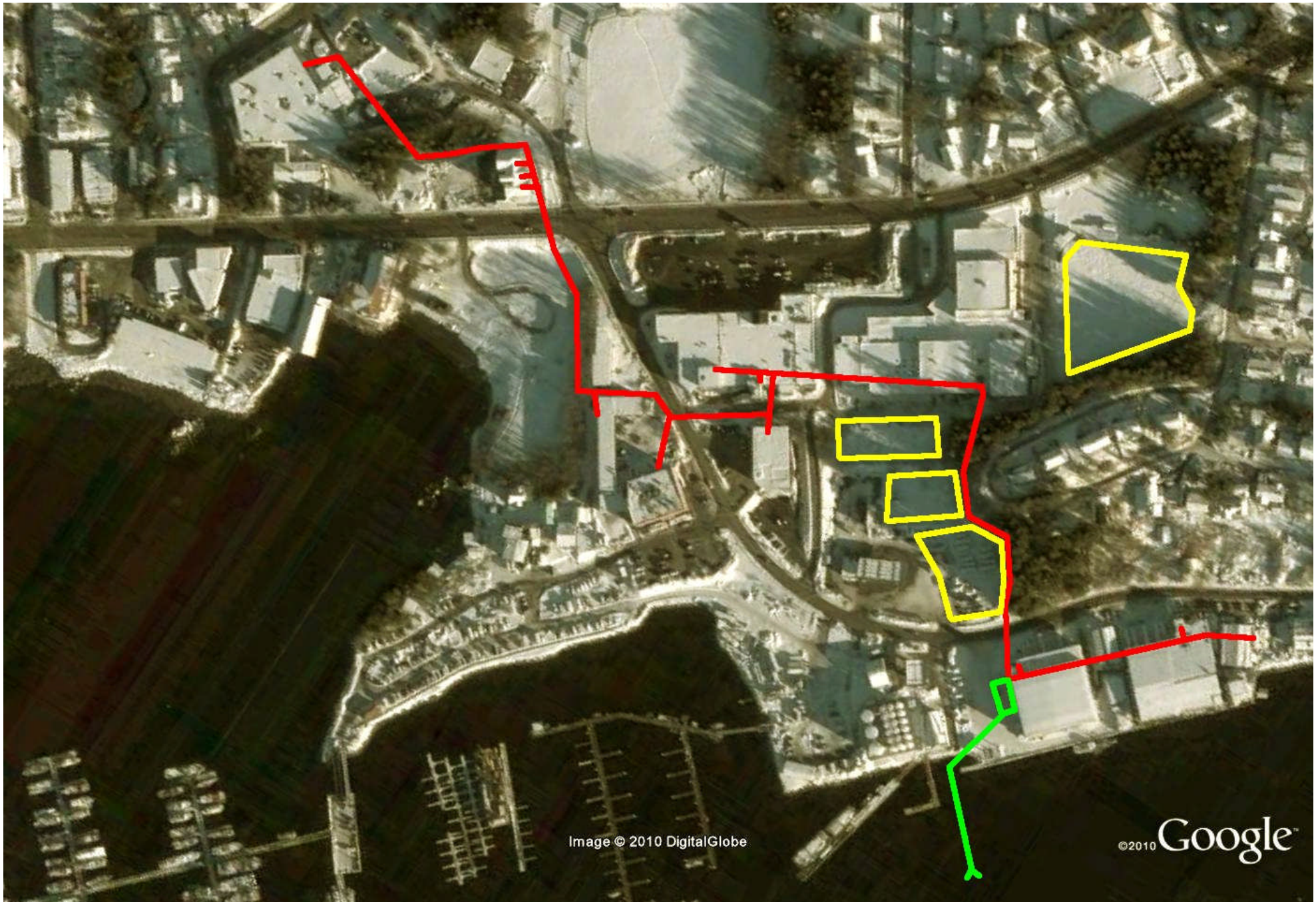
Bought energy reduced 57% (oil reduced by 79%)

Payback: 4.3 years.



GREENPEACE -- April 2011

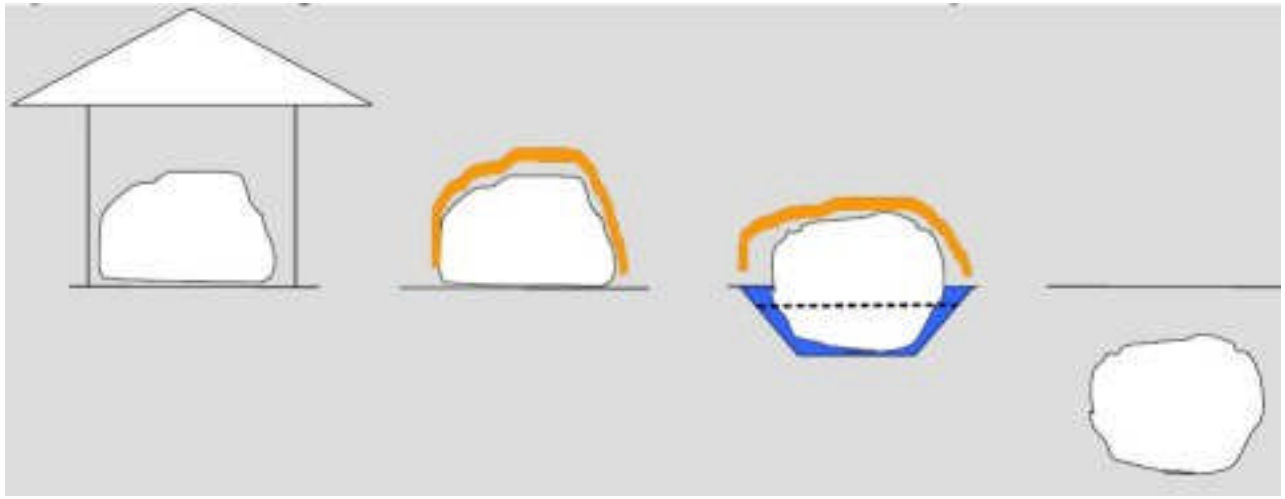
Thought: 1st increment for an STES / seawater-HP district heating system.

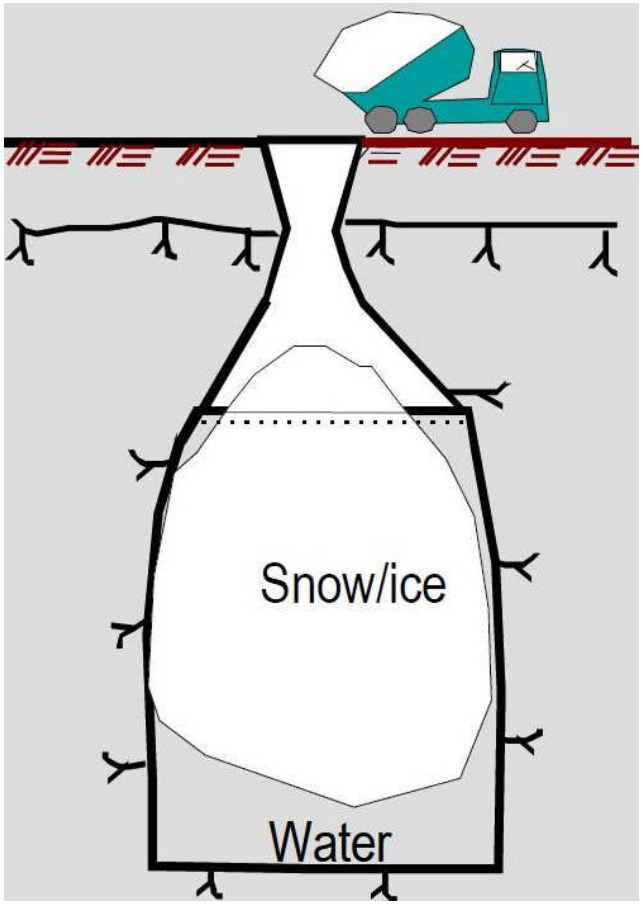


Sitka Numbers — Back of the napkin:

In 2020, dry year hydro capacity:	85	GWh electric
In 2020, medium demand forecast:	-136	GWh electric
Shortfall:	**- 41**	**GWh electric**

Freezer power recovery (3 fish plants)	6	GWh heat
plus heat extracted from fish	3	GWh heat
Interruptible power (8 GWh electric)		
Converted to heat w/ seawater HP	32	GWh heat
Shortfall (reduced by STES & heat pump):	**0**	





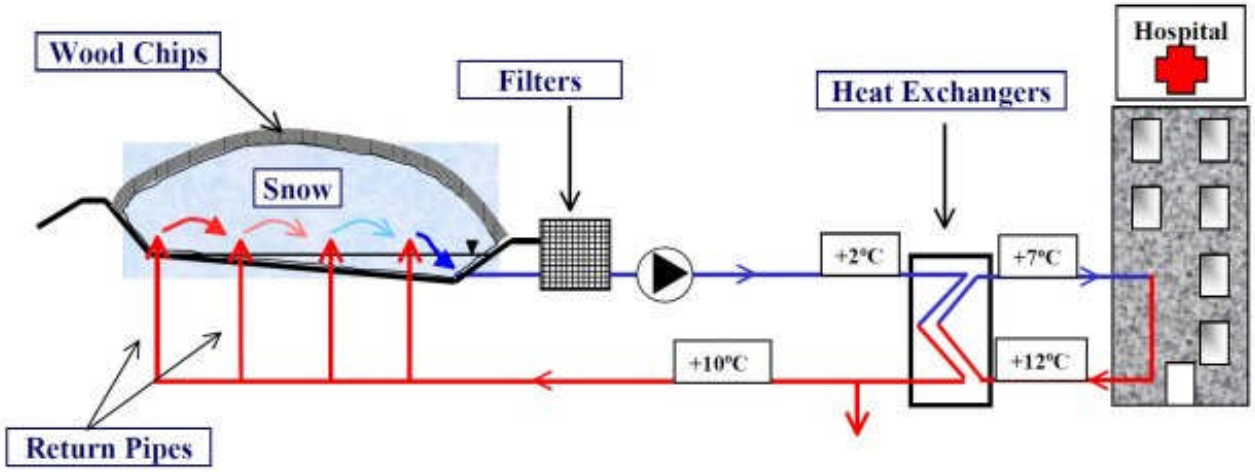
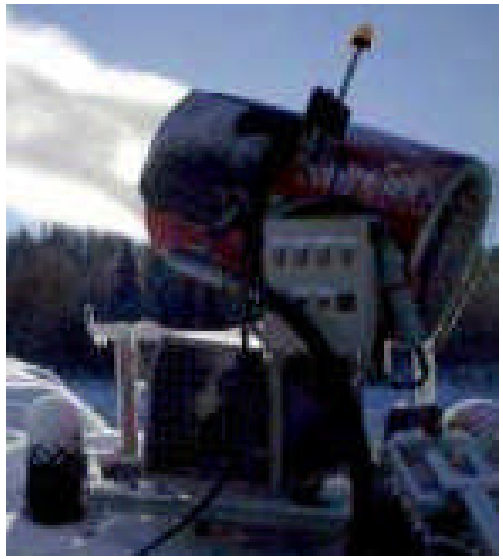


Fig 2.4. The principal configuration of the Sundsvall snow storage



Solar-thermal district heating system

Heat storage in a gravel pit & a water pit

Marstal, Denmark

Jobs!