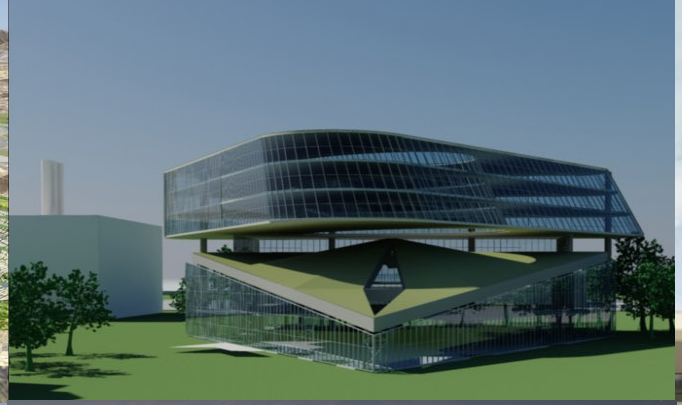
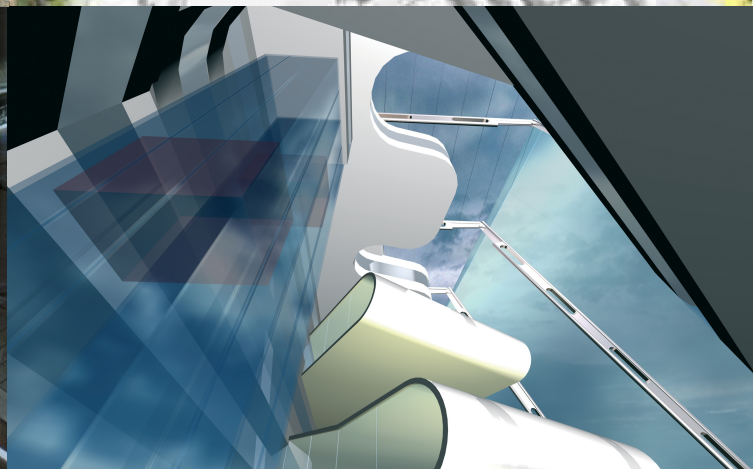
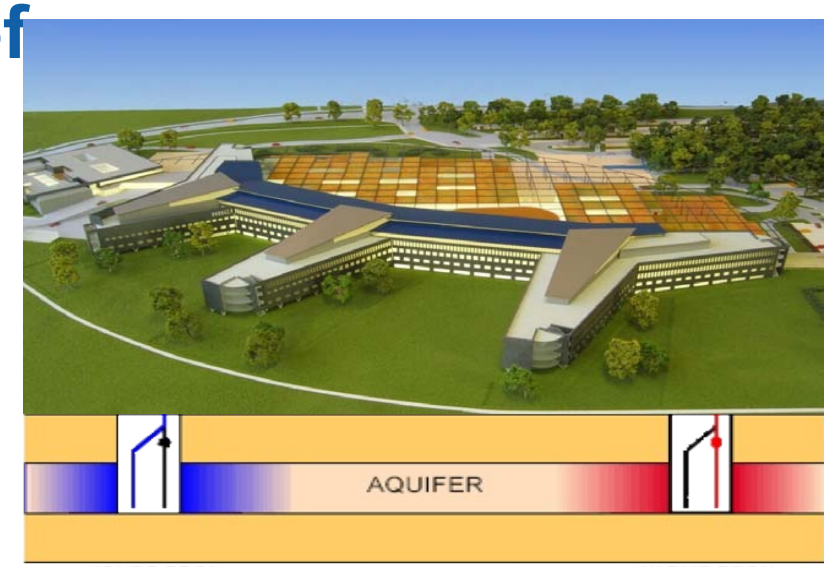









Energy Saving Potential of Aquifer Thermal Energy Storage Systems



Director: ir. A.W. Jansen MBA

Deerns Consulting Engineers

4th European Conference on Healthcare Engineering, Paris

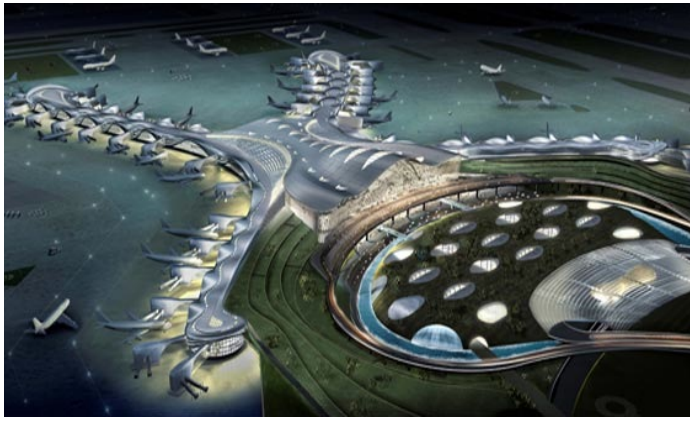
How bright and green is our future?

Earth during night

Agenda

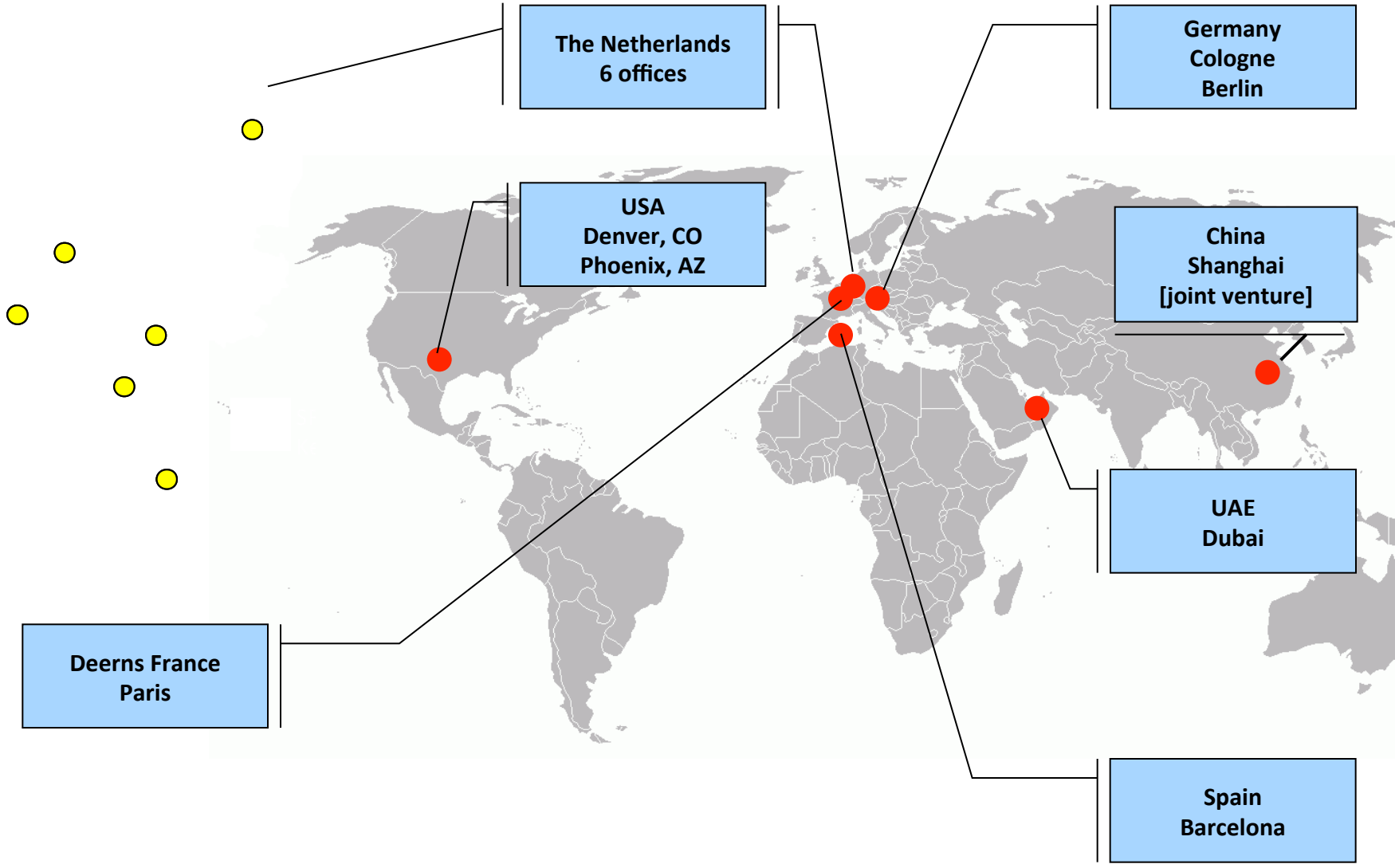
- Introduction Deerns
- Aquifer Thermal Energy Storage
- Sustainable Hospital Design

Introduction



Deerns Consulting Engineers

- International leading firm
- Designing all techniques of buildings
- Markets include:
  - Healthcare
  - Offices
  - Airports
  - Datacenters and laboratories


The Netherlands
6 offices
Germany
Cologne
Berlin
USA
Denver, CO
Phoenix, AZ
China
Shanghai
[joint venture]
UAE
Dubai
Deerns France
Paris
Spain
Barcelona

Sustainable design

People

Create a comfortable and safe indoor environment by applying our extensive expertise on building physics

Planet

Combining our experience and creativity to create practical solutions for green buildings

Profit

Decisions are based on life cycle cost analyses, taking into account the effects on people and planet

The Green Challenge

- Minimize the Demand
- Use Renewable Sources
- Produce and Utilize Energy and Water as Efficiently as Possible

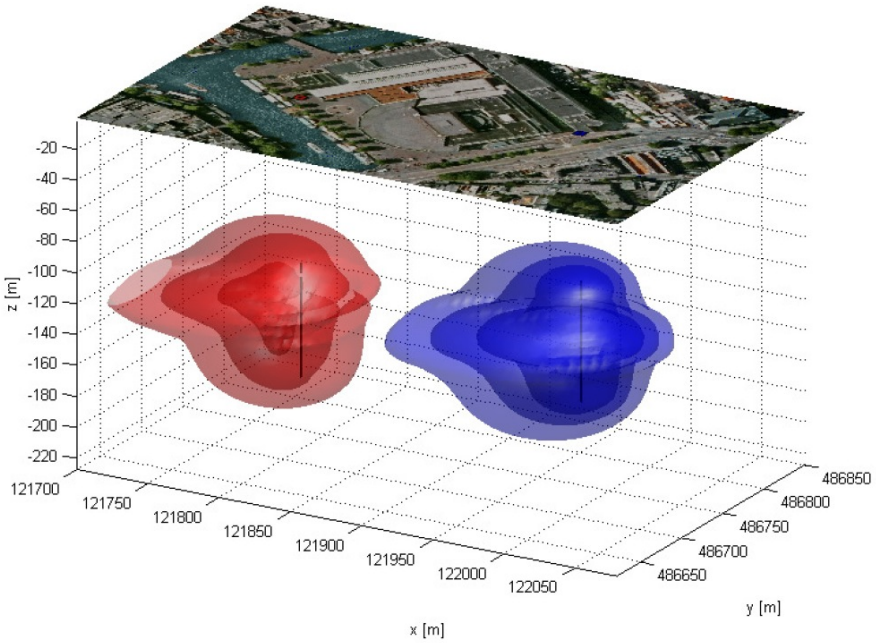
Trias Energetica

The Argument

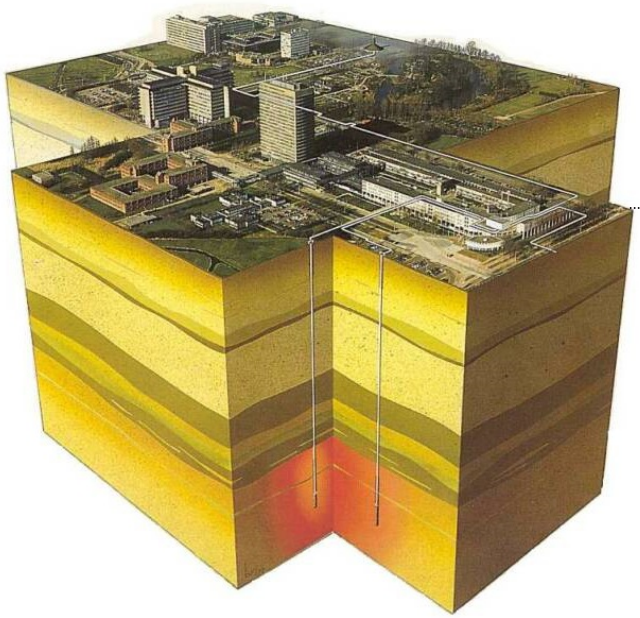
- Highest Profit and Green Rating

Potential of Aquifer Thermal Energy Storage

- Aquifer Thermal Energy Storage (ATES)
- Implementation in the Netherlands
- Feasibility in France



Sustainable Earth Technology

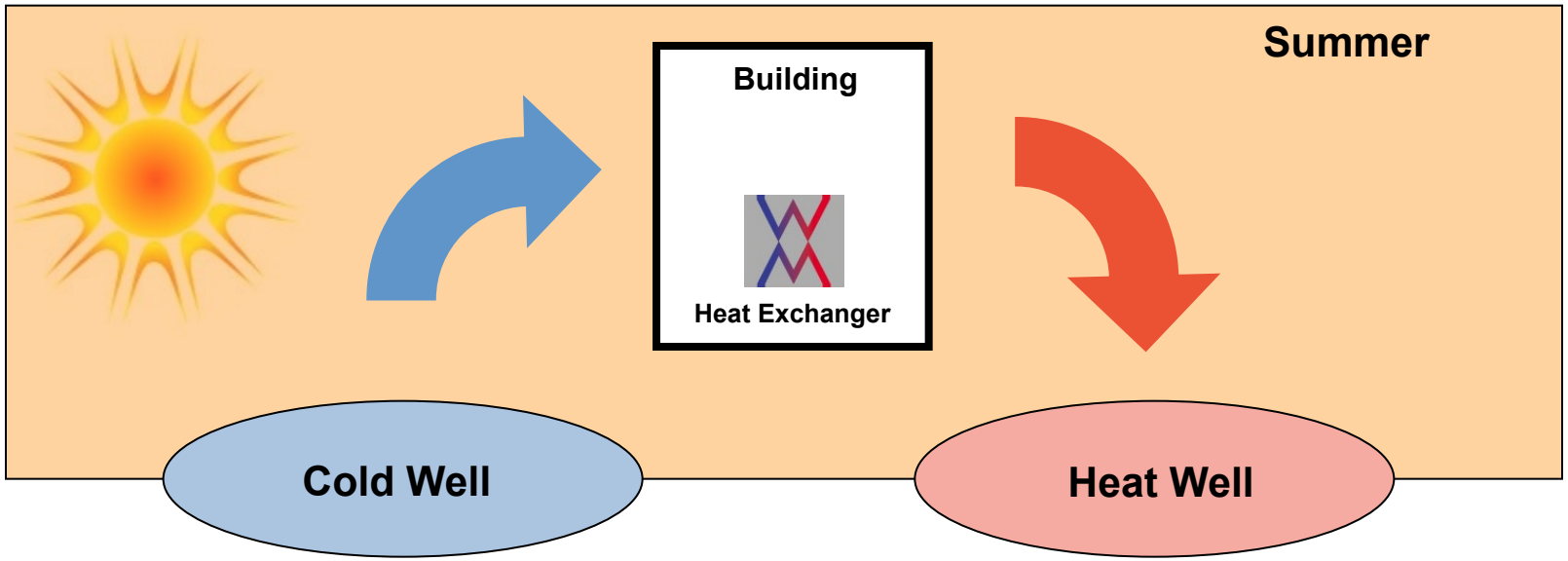


20 m	Closed Ground Heat Exchangers
25 - 250 m	Open Aquifer Systems
2 - 6 km	Deep Geothermal Energy

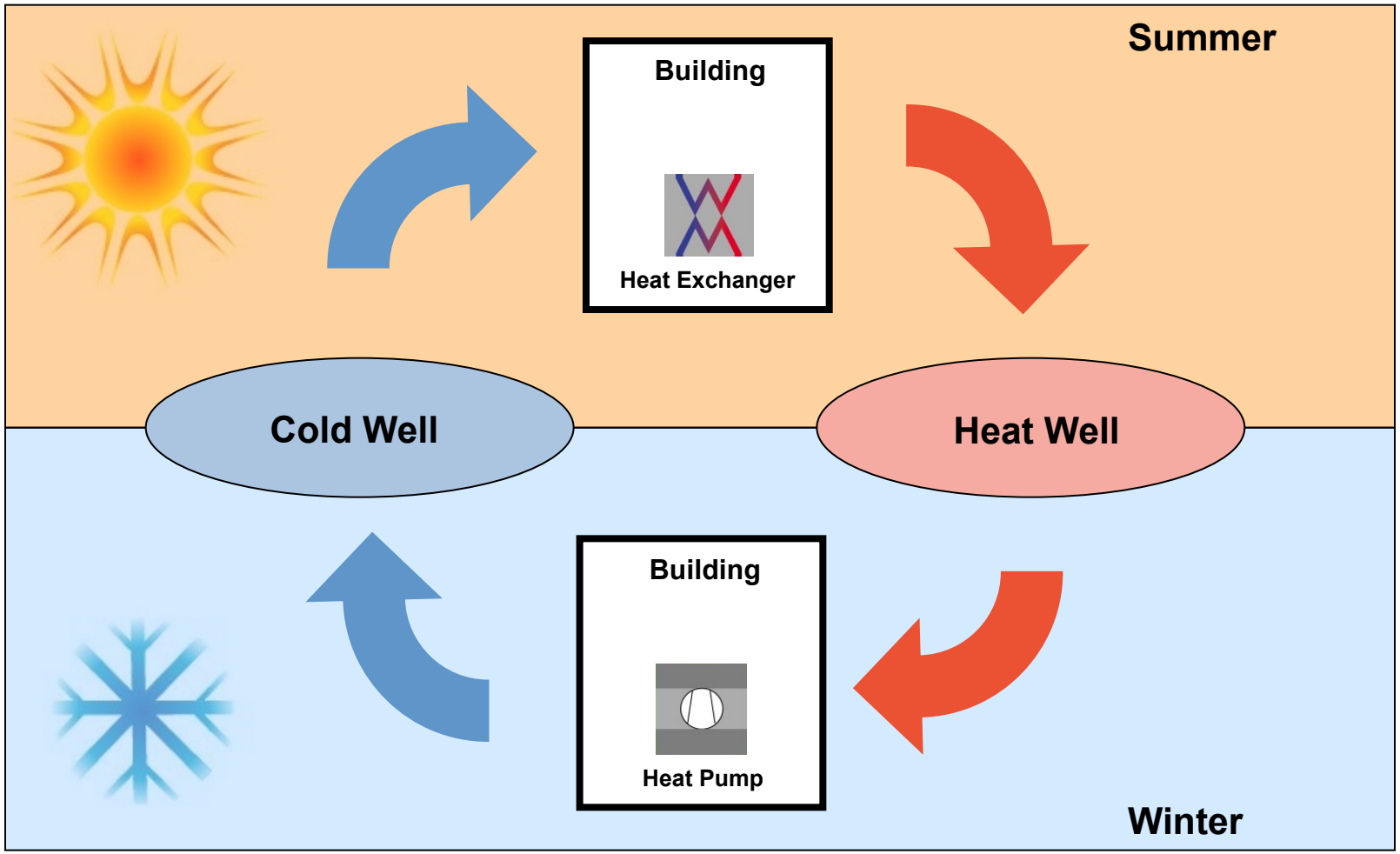
Potential of Aquifer Thermal Energy Storage

- Proven Technology
  - ATES-System with Heat Pump Technology
  - Seasonal Storage of Heat and Cold
  - Suited for Low Temperature Heating (40 ^{o}C) and High Temperature Cooling (16 ^{o}C)
  - Standard solution for new constructions in the Netherlands

Principle ATES

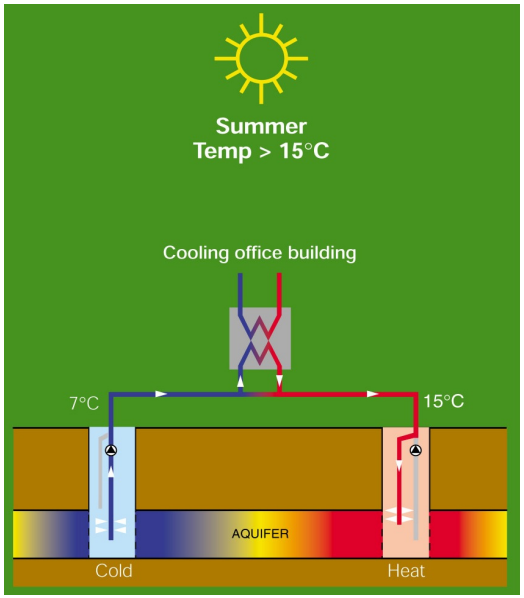


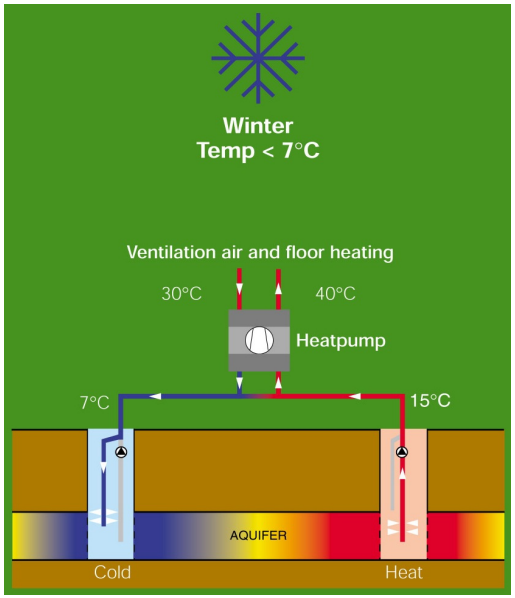
Principle ATES



Typical temperature ranges

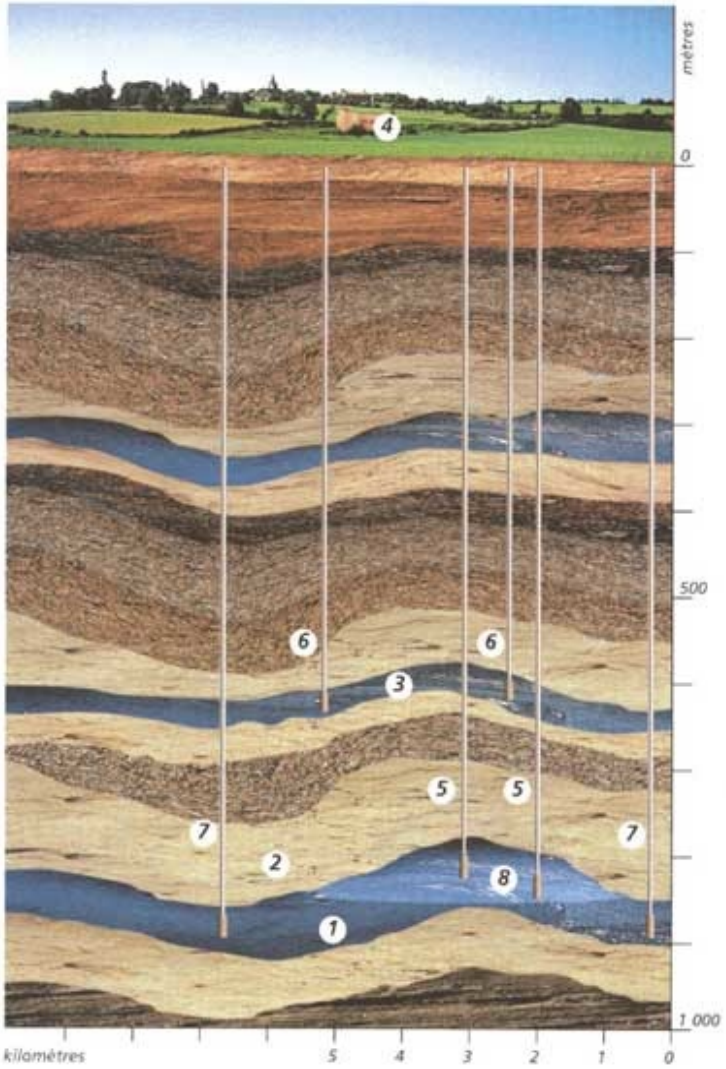
- Cold well 7-10 °C
- Heat well 18-20 °C
- Upgrading with heat pump technology to 40 °C





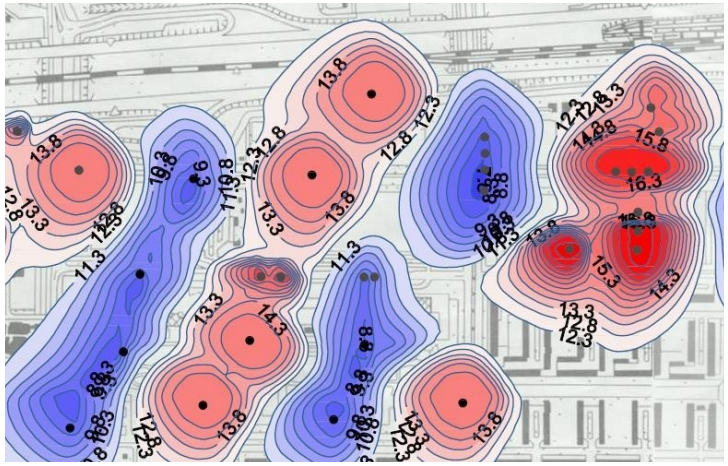
Requirements Aquifer

- Water Bearing Layer of permeable materials
- Typical depths 25 – 250 m
- Max. Groundwater Speed 10 m /yr
- Water Chemistry (Redox, Metals, Degassing, Oxigen, etc.)

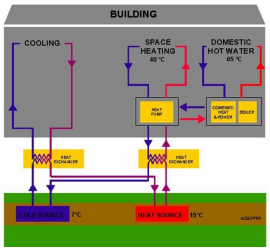


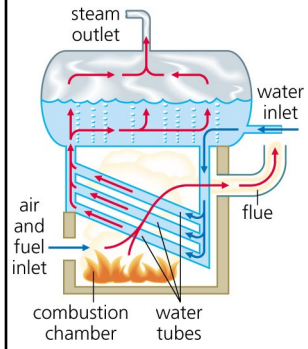
ATES Design

- Ground system
  - Boreholes (doublet, mono)
  - Well head and pumps
  - Distance between cold and heat storage
- Building system
  - Heat exchanger
  - Heat pump
  - Integrated controls



ATES in Numbers



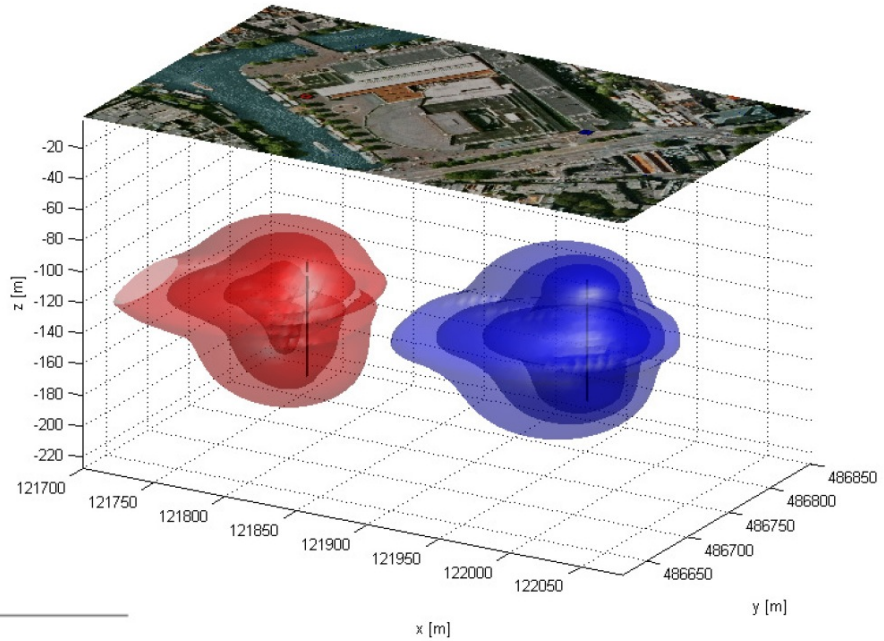


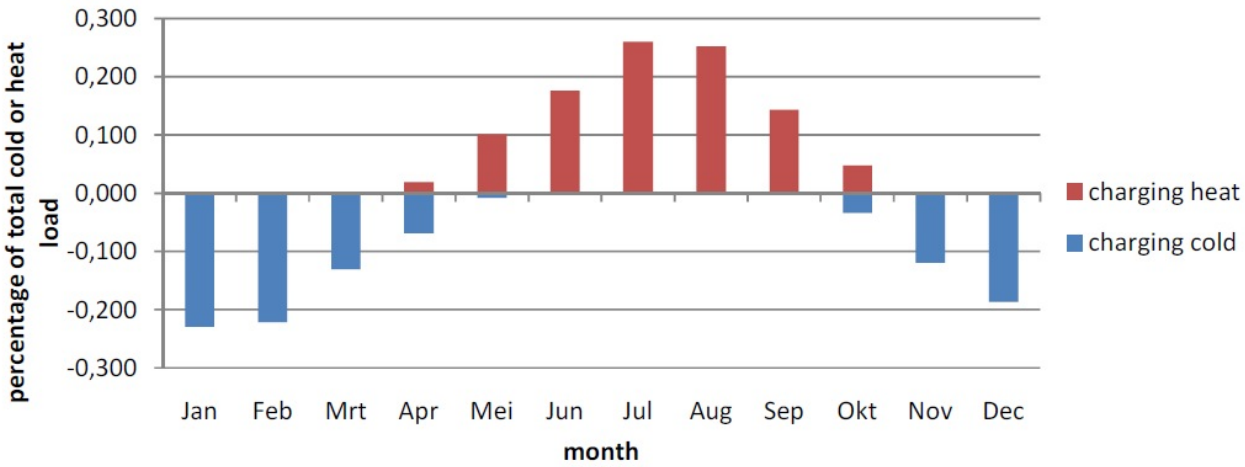
	ATES-Technology with Heat pump	Traditional	Energy Savings
Cooling	8	1.2	**Ca. 85%**
Heating	2	0.9	**Ca. 50%**

PER: Primary Energy Rating

Seasonal Charging

Loading of heat / cold wells during summer / winter





ATES system

- Technology allows for:
  - Sun collectors: gain extra heat in summer
  - Dry coolers: gain extra cooling in winter
  - Sanitation of groundwater
  - Sprinkler system supply
  - 40 °C heat storage instead of 25 °C → higher PER heating
  - Combinations with surface water

ATES system

- Possible difficulties in operation of aquifers
  - Not enough charging of wells
  - Balancing demand over time of the building and aquifer flows
  - Design integration of building - and aquifer control system

Potential of Aquifer Thermal Energy Storage

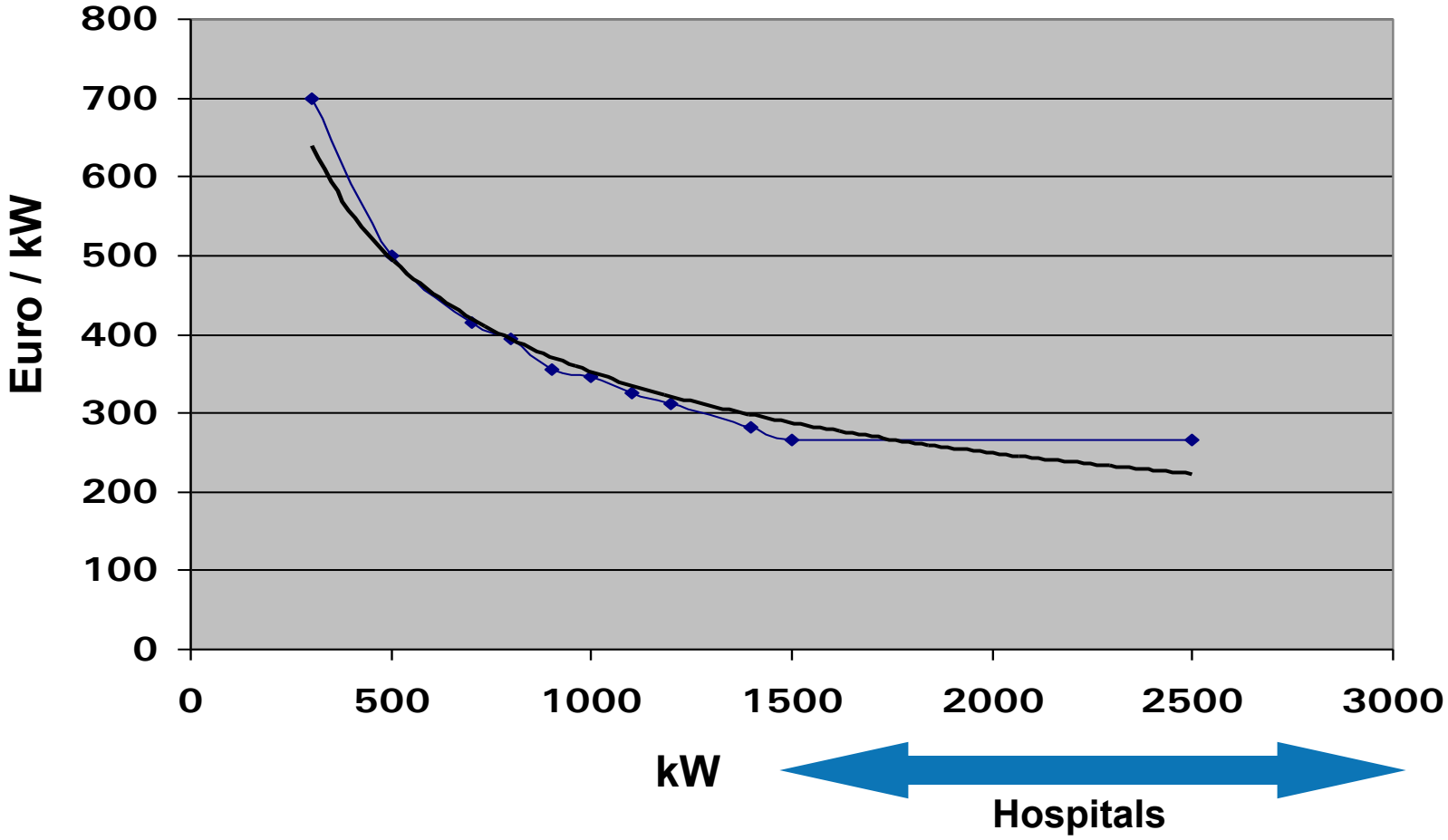
- Aquifer Thermal Energy Storage
- **Implementation in the Netherlands**
- Feasibility in France

Implementation in the Netherlands

ATES systems in the Netherlands

> 1000 systems operational

Decrease of Investment Costs for Large Systems



Implementation in the Netherlands

Deventer Hospital, Deventer

60.000 m^2 gfa

Jeroen Bosch Hospital, ‘s Hertogenbosch

140.000 m^2 gfa

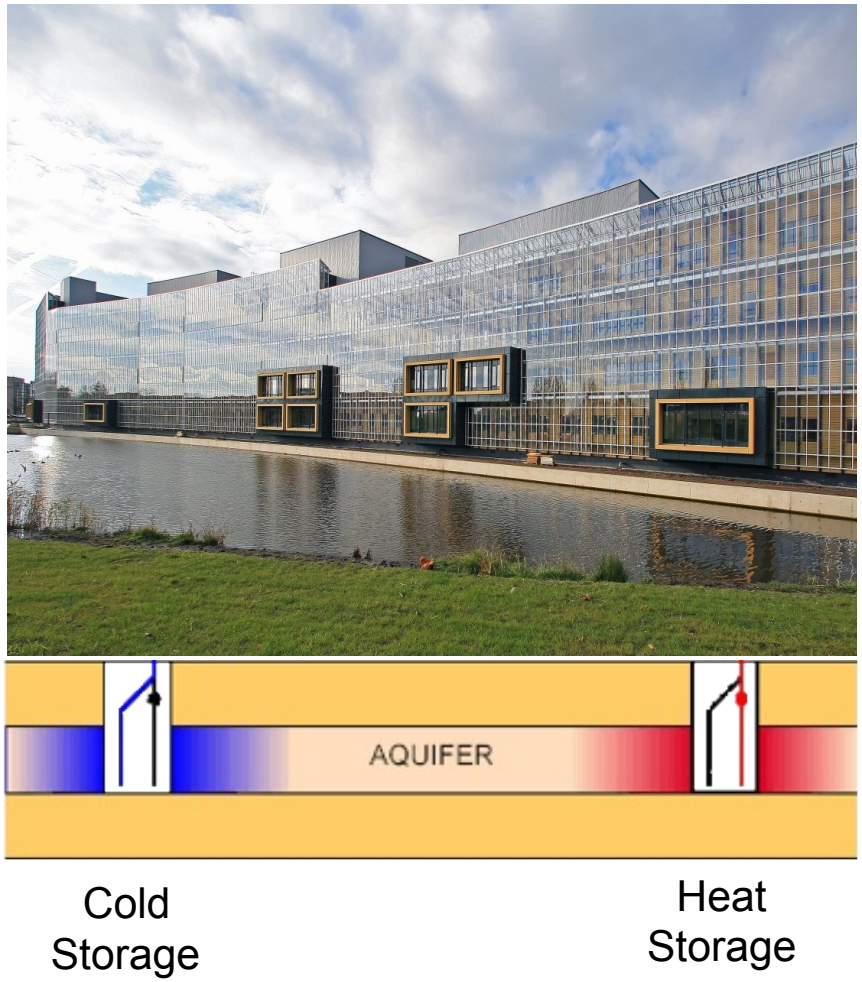
Martini Hospital, Groningen

83.000 m^2 gfa

- 100% of total cooling demand supplied by cold storage
- 80% of total heating demand supplied by heat storage + pump
- Payback time 5 -10 years

Martini Hospital Groningen

- Construction: 2003-2007
- Sustainable design
- Flexible industrial design



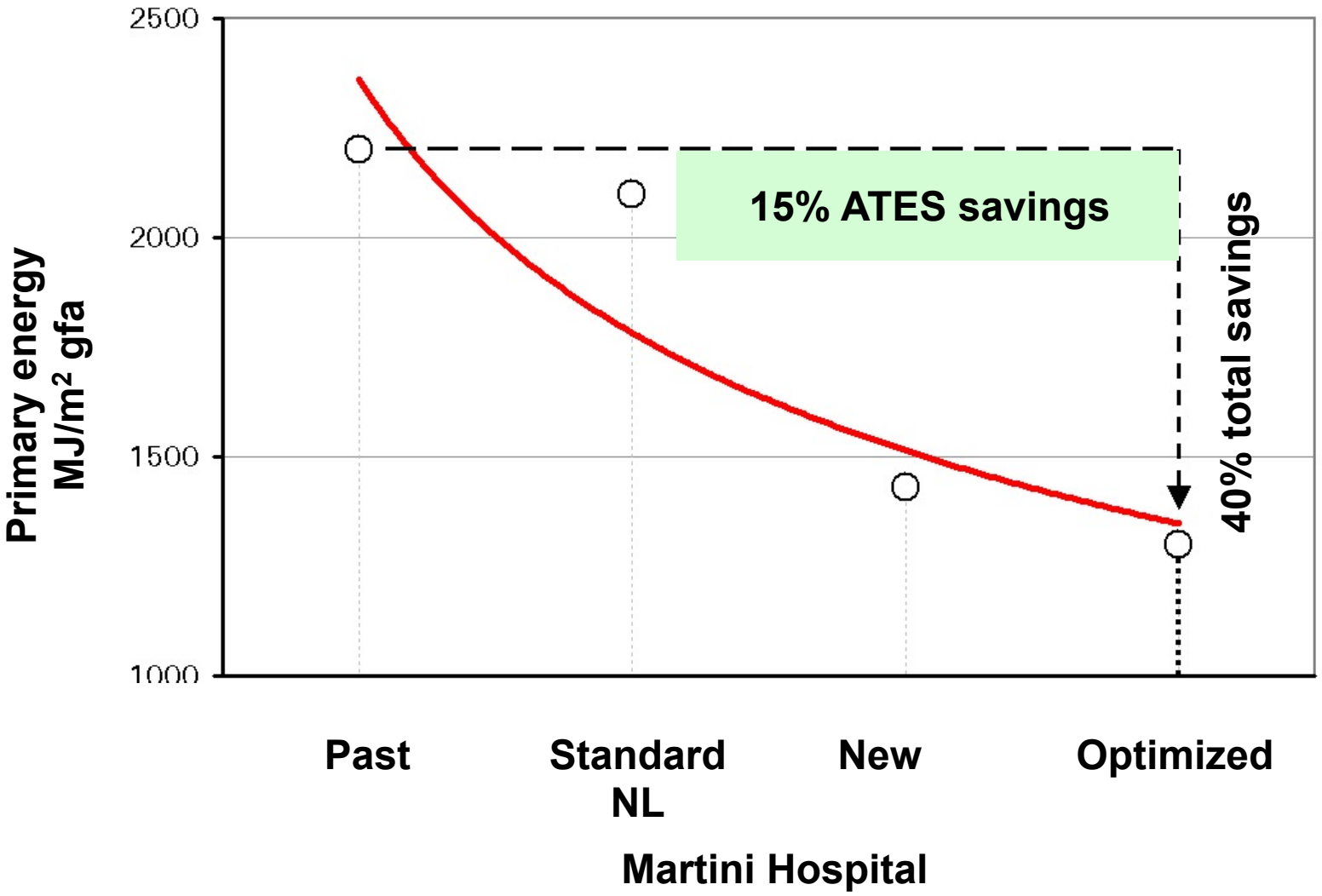
CO_2-savings per year

2 million kg CO_2 =

13,5 million car kilometers

Energy Savings:

- ATES with Heat Pump Technology
- Heat Recovery Ventilation
- Energy Efficient Lighting


2500
2000
1500
1000
Primary energy
MJ/m² gfa
15% ATES savings
40% total savings
Past
Standard NL
New
Optimized
Martini Hospital

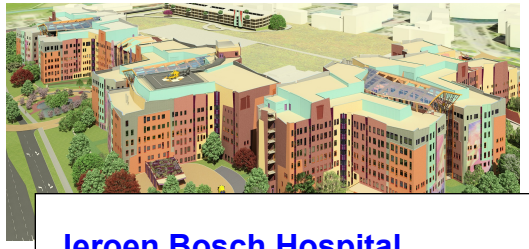
Sustainable Hospital Design

Spaarne Hospital

Gelre Hospital

Reinier de Graaf Group

Isala Hospital

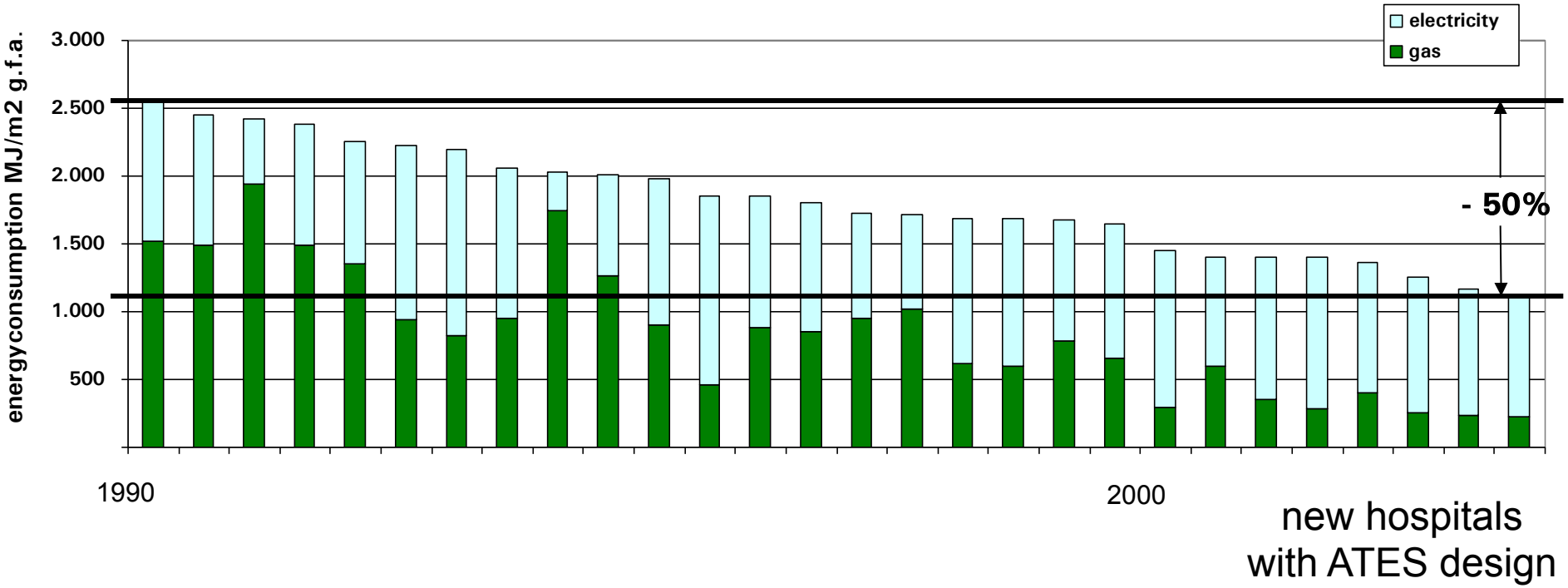


Jeroen Bosch Hospital

Deventer Hospital

Martini Hospital

Performance of hospitals designed by Deerns



Example of combined ATES

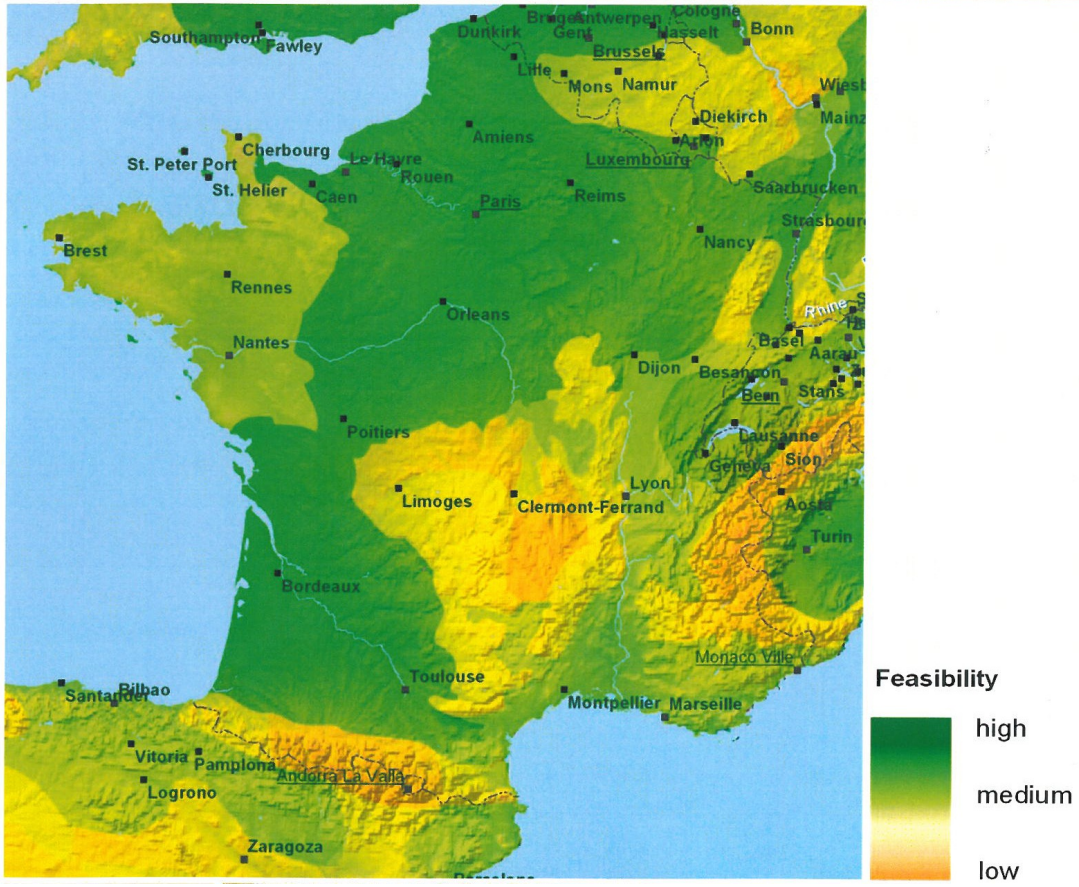
Philips High Tech Campus

- Largest in the world: 15 MW
- 30-50% reduction in gas consumptions
- 170.000 m^2 new and 40.000 m^2 refurbished

Potential of Aquifer Thermal Energy Storage

- Aquifer Thermal Energy Storage
- Implementation in the Netherlands
- **Feasibility in France**

Feasibility of ATES in France



Aquifer Thermal Energy Storage:

High energy savings
with proven technology for
new and existing hospitals