REHAU
Unlimited Polymer Solutions

Underground Thermal Energy Storage

RENEWABLE SOURCE OF HEATING AND COOLING

www.rehau.co.uk

Building Solutions
Automotive
Industry

LEARNING OBJECTIVES

CPD AGENDA

- Introduction to REHAU
- Basics of Ground Source Heat Pumps (GSHP)
- Interseasonal heat transfer
- Underground thermal energy storage (UTES)
- Using infrastructure as renewable energy sources

REHAU COMPANY HISTORY

UK LOCATIONS

Private Company

- 1948 Founded in the Bavarian town of REHAU
- 1962 First UK Sales Office and Warehouse opened in Slough
- 1975 First Manufacturing Plant was opened in Amlwch
- 1995 Opening of the new headquarters in Ross-on-Wye
- 2012 REHAU celebrated its 50th anniversary trading in the UK

REHAU DIVISIONS

UNLIMITED POLYMER SOLUTIONS

Industry

FURNITURE, HOUSEHOLD APPLIANCES, HOSES AND INDUSTRIAL DEVELOPEMENTS

Automotive

EXTERIOR, WATER MANAGEMENT, AIR MANAGEMENT & SEALING

Building Solutions

WINDOW AND CURTAIN WALLING TECHNOLOGY, BUILDING TECHNOLOGY, CIVIL ENGINEERING

INTRODUCTION

WHAT TYPES OF RENEWABLE ENERGY ARE THERE?

Solar (solar thermal / PV)

Wind

Geothermal / Ground-source

Water (tidal / hydro)

Biomass

Biogas / Anaerobic digestion

INTRODUCTION

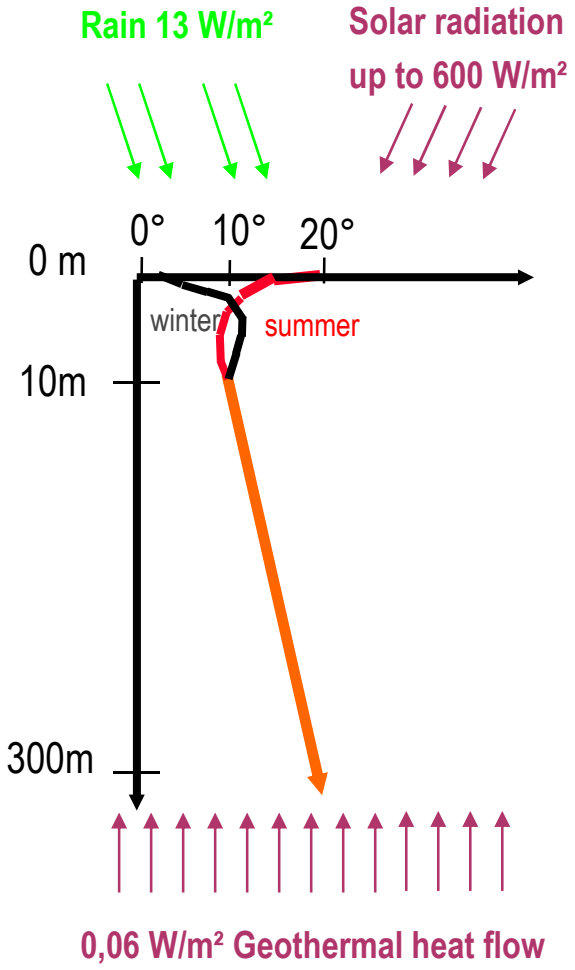
WHAT TYPES OF GEOTHERMAL ENERGY ARE THERE?

Deep geothermal (from within the ground) (> 400m)

- **Hydrothermal systems** *(using water stores)*
- **Petrothermal systems** *(artificially pumping water deep underground)*
- **Deep geothermal probes** *(using a closed loop system)*

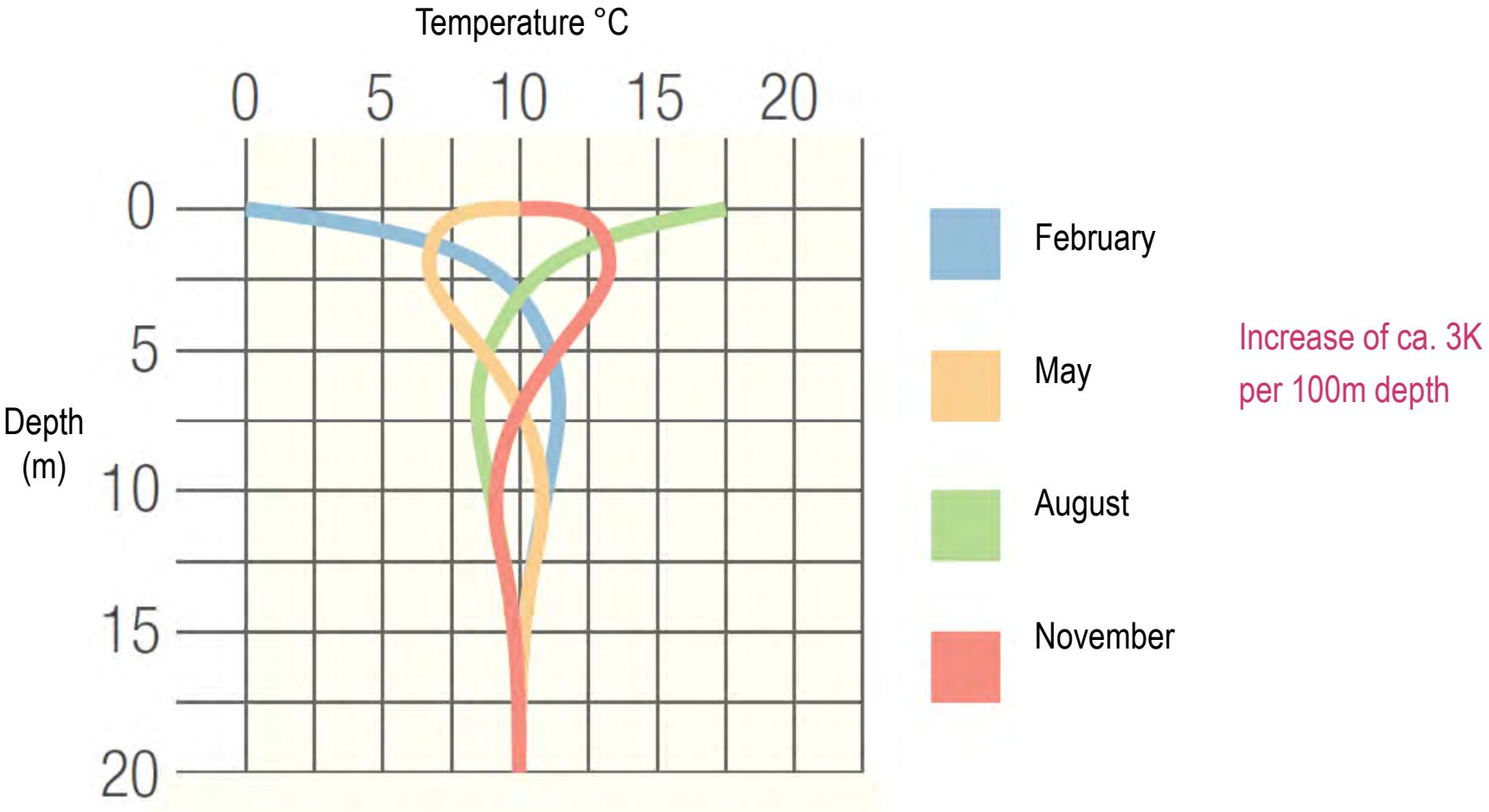
Ground-source (from the sun) (< 400m)

- **Ground-source collectors** *(sub-surface, at a depth of 1.5m)*
- **Ground-source probes** *(using boreholes at depths of ca.100m)*
- **Ground-source spiral probes** *(spiral probes buried up to 5m deep)*
- **Ground-source energy piles** *(using the building foundations)*
- **Ground water bore holes** *(open loop systems using ground water)*
- **Ground-air heat exchanger** *(using mechanical ventilation)*



INTRODUCTION

SEASONAL VARIATIONS OF GROUND TEMPERATURE

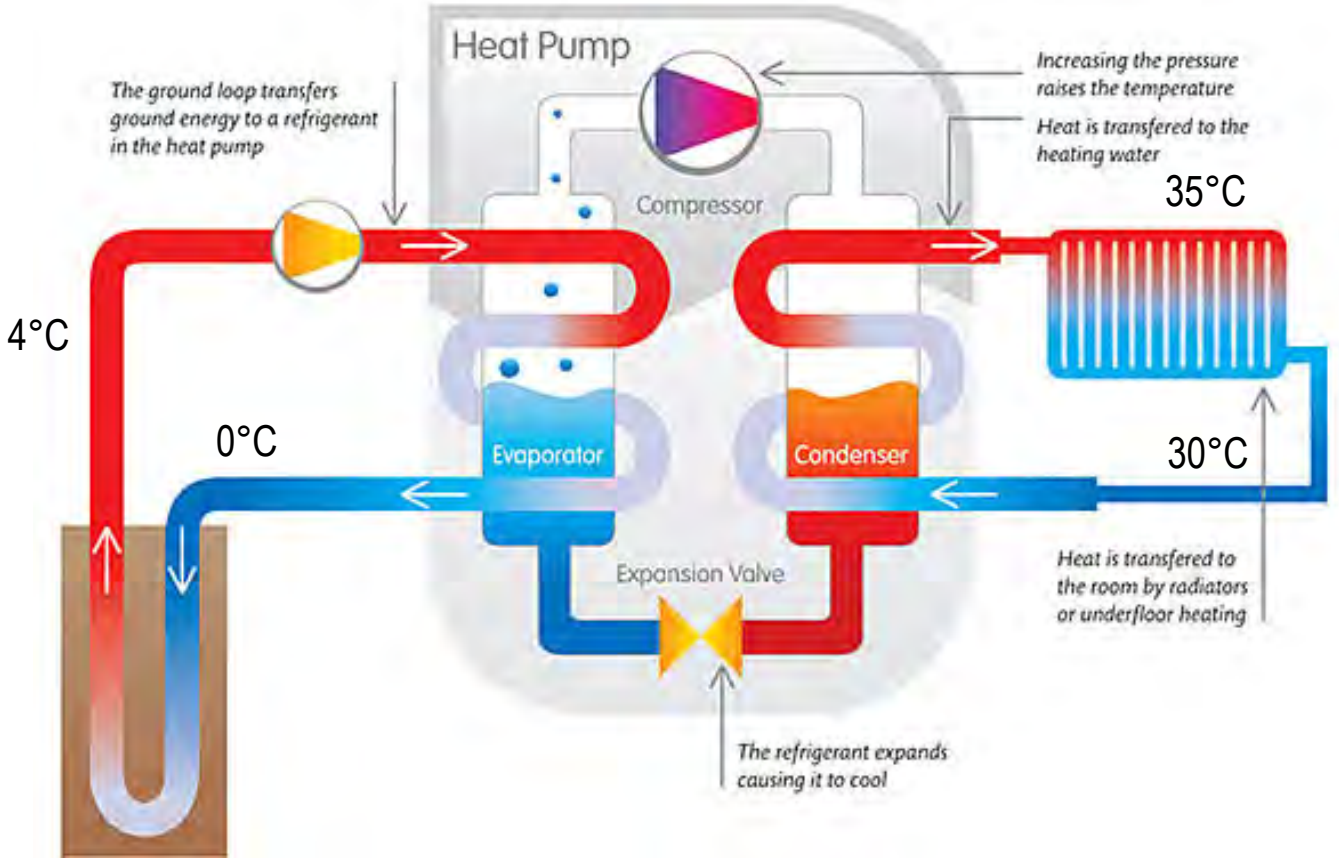


INTRODUCTION

HOW DOES A GROUND SOURCE HEAT PUMP WORK?

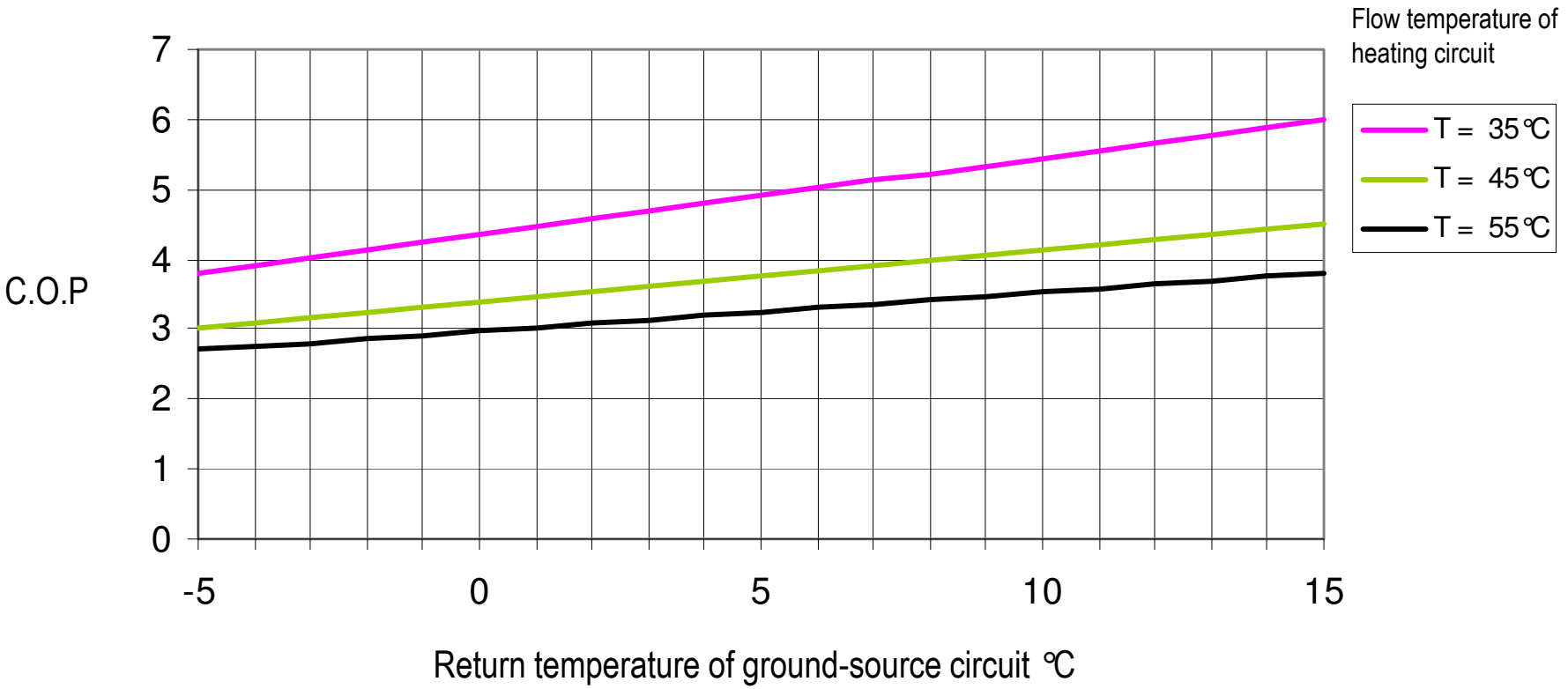
Ground loop (vertical / horizontal)

Space heating circuit
(ideally underfloor heating)



INTRODUCTION

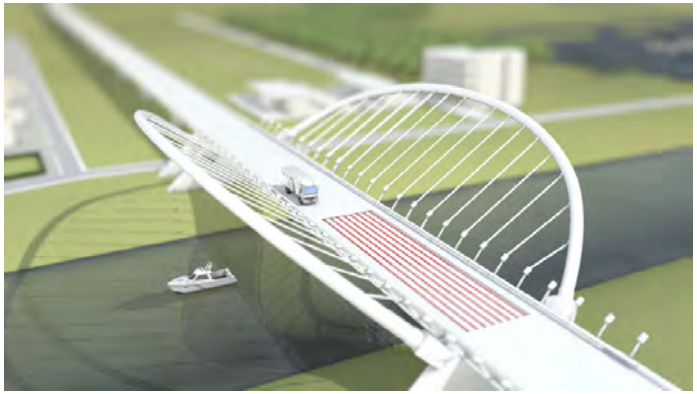
COEFFICIENT OF PERFORMANCE OF HEAT PUMP



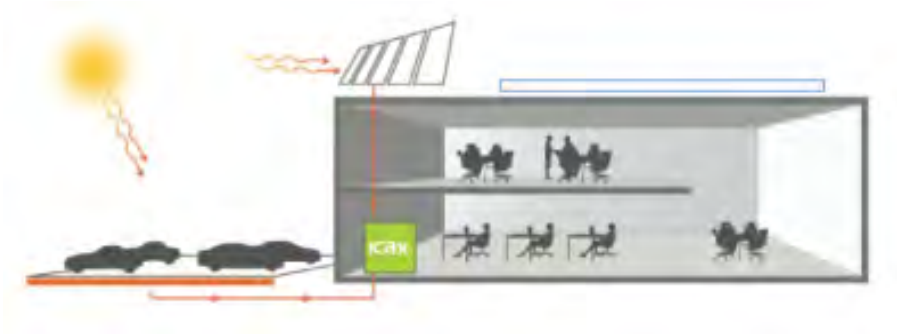
Underground Thermal Energy Storage

BESPOKE SOLUTIONS FOR INNOVATIVE PROJECTS

Underground Thermal Energy Storage



Using infrastructure as energy sources



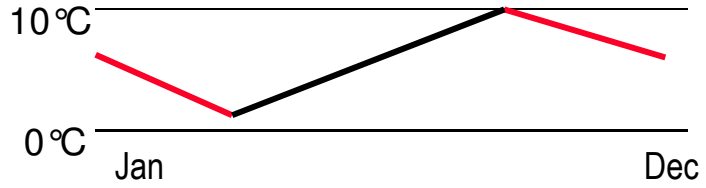
Interseasonal heat transfer

Geothermal Tunnel Lining

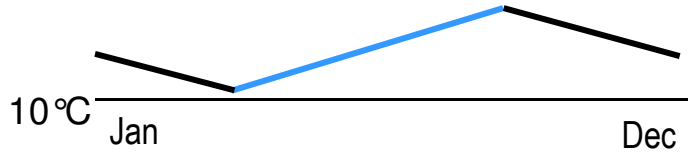
UNDERGROUND THERMAL ENERGY STORAGE - UTES

WHY GROUND REGENERATION IMPROVES THE PERFORMANCE

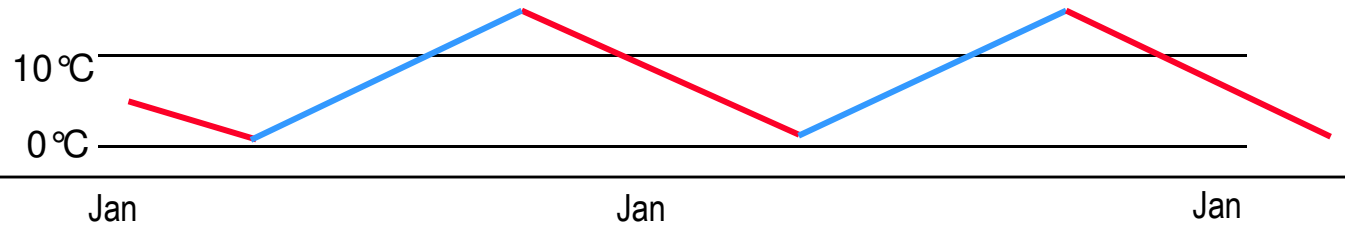
Ground temperature sinks during the heating period, requiring subsequent regeneration



Ground temperature rises during the cooling period, requiring subsequent regeneration



Best solution: Combine heating in the winter and cooling in the summer



Advantages:

+ Faster regeneration of ground temperature
+ Rise in efficiency and heat quality
+ Utilization of free cooling

UNDERGROUND THERMAL ENERGY STORAGE - UTES

TEMPERATURE OF RESISTANCE OF PE-XA vs PE 100

Due to the high temperature resistance of PE-Xa (-40°C to 95°C), PE-Xa probes can be combined with solar thermal systems to store excess thermal energy in the ground.

-> Increased COP & excellent ground recharging

Durability (safety factor SF=1,25) Pipe SDR 11(25x2,3 and 32x2,9)			
PE–Xa		PE 100	
20 °C	**100 year** / 15 bar	20 °C	**100 year** / 15.7 bar
30 °C	**100 year** / 13.3 bar	30 °C	50 year / 13.5 bar
40 °C	**100 year** / 11.8 bar	40 °C	50 year / 11.6 bar
50 °C	**100 year** / 10.5 bar	50 °C	15 year / 10.4 bar
60 °C	50 year / 9.5 bar	60 °C	5 year / 7.7 bar
70 °C	50 year / 8.5 bar	70 °C	2 year / 6.2 bar
80 °C	25 year / 7.6 bar	80 °C	-
90 °C	15 year / 6.9 bar	90 °C	-

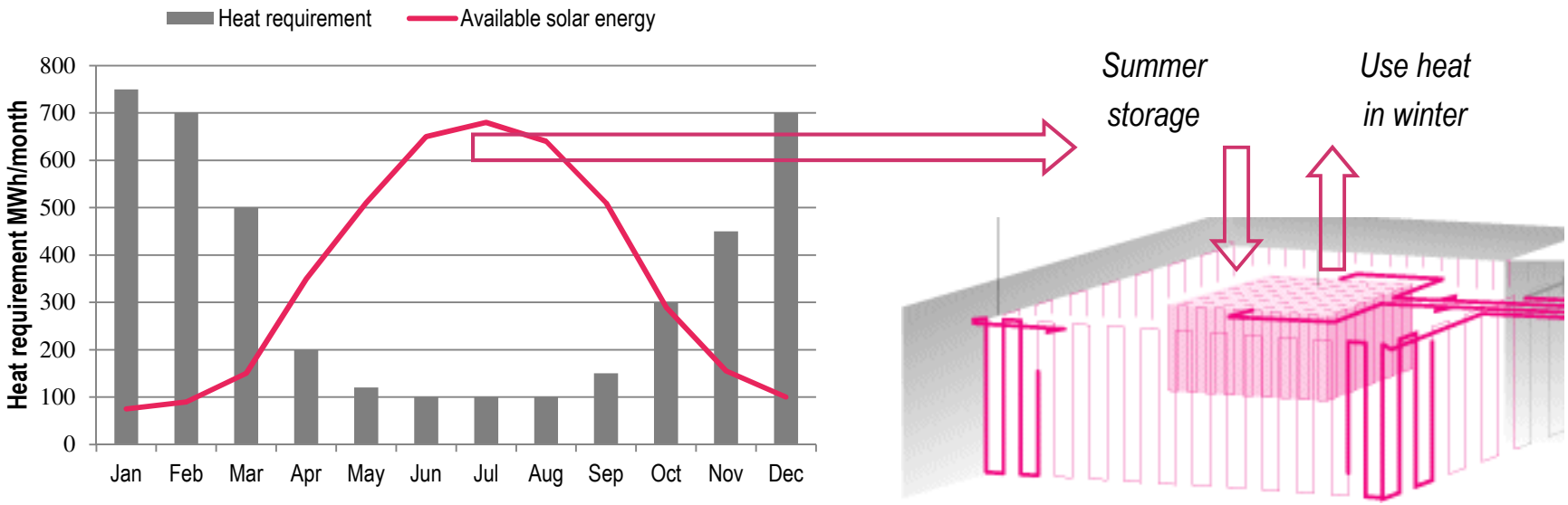
UNDERGROUND THERMAL ENERGY STORAGE - UTES

INTEGRATION OF HEAT STORAGE

In district heating networks with renewable energy sources (e.g. solar thermal), excess heat is wasted in the summer.

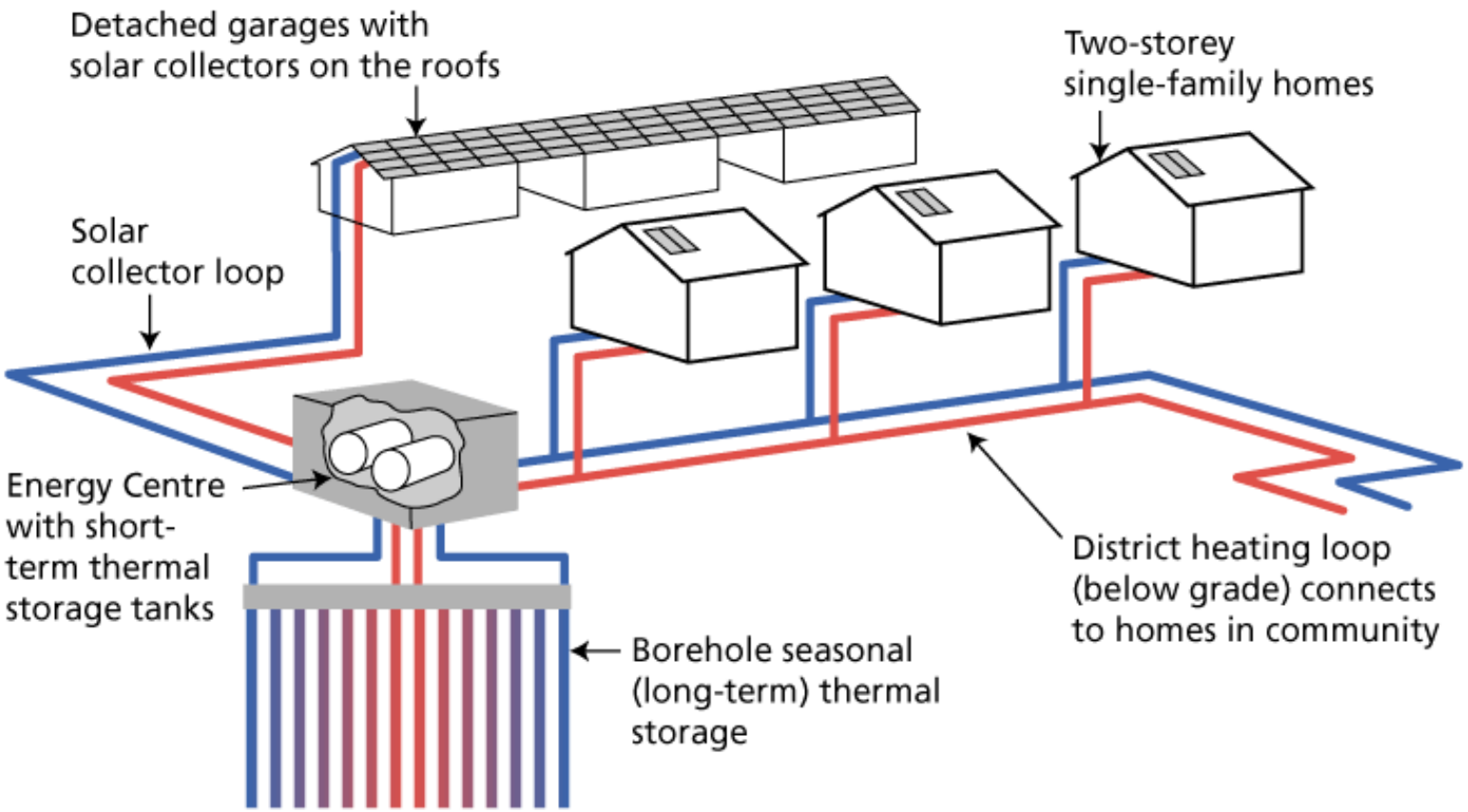
Using underground heat storage with intelligent controls, optimum use of all energy sources can be achieved.

The excess heat in summer can be efficiently stored and then utilised in winter with an increased efficiency.



UNDERGROUND THERMAL ENERGY STORAGE - UTES

TYPICAL SCHEMATIC

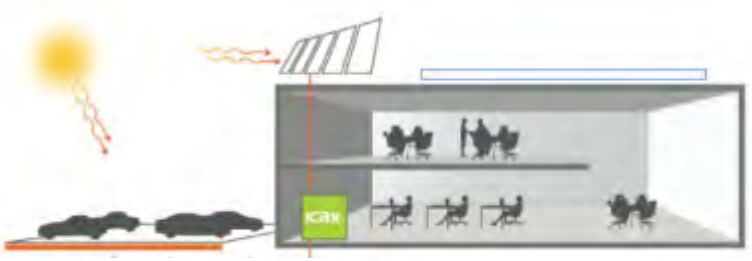


Source: Drake Solar Landing Community

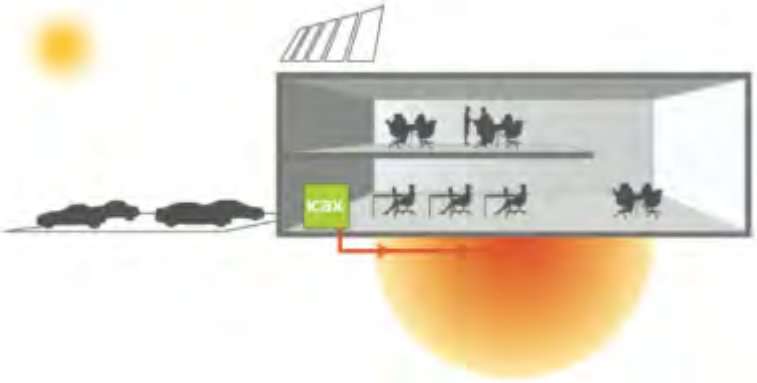
Live temperature data can be found here: **www.dlsc.ca**

SPECIAL APPLICATIONS

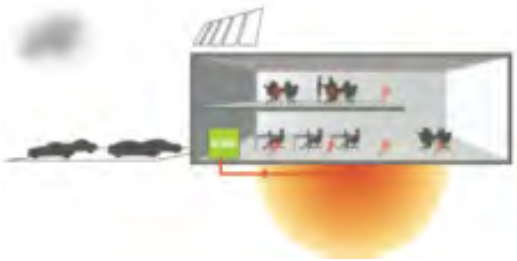
INTERSEASONAL HEAT TRANSFER – HEATING



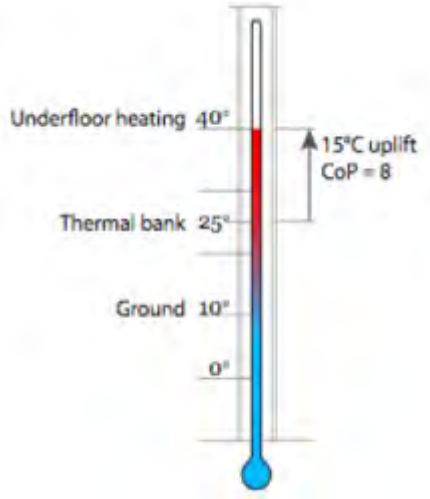
Captures solar energy either from asphalt collector or solar thermal panels



Stores heat in thermal store underground, raising ground temperature from 10°C to 25°C



In winter, heat is extracted using heat pumps. By starting with a higher ground temperatures, it can double the HP performance



SPECIAL APPLICATIONS

INTERSEASONAL HEAT TRANSFER – COOLING

Collects cold temperatures (coolth) in the winter, stores it in a seperate thermal bank. Reduces the ground temperature to ca. 3°C

Releases coolth back into the building (more cost-effective than air-conditioning). COP of 20 can be achieved by just using a circulation pump to allow heat to escape to thermal store.

SPECIAL APPLICATIONS

CASE STUDIES – UTES

Solar Storage Crailsheim, Germany

System description

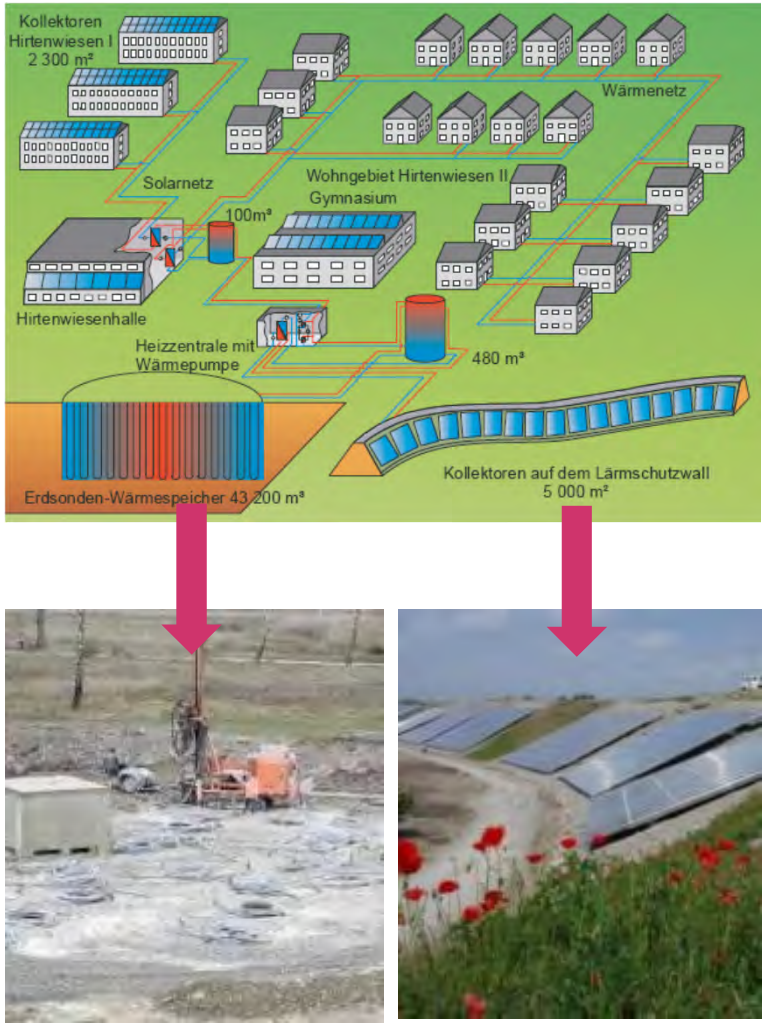
- 260 dwellings, school, sports hall
- 4100 MWh/a with network temperatures flow/return 65/35°C

Heat sources:

- 7,300m² solar collectors with 5,1MW peak output
- 750 kW heat pump
- Supplementary heating through district heating network

Heat storage:

- 100m³ high temperature peak load storage (hot water)
- 480m³ buffer storage (hot water)
- 43,200m³ ground-source probe underground storage (80 PE-Xa probes)



SPECIAL APPLICATIONS

CASE STUDIES – UTES

Braedstrup District Heating & Solar Park, Denmark

System description
-1,400 homes
- DH network owned by community
- 6MW system (3,800 MWh/a)

Heat sources:
- 16,000m² solar collectors
- Heat pump
- Peak heating through district heating network

Heat storage:
- 2,500m³ buffer tank(hot water)
- 50 PE-Xa probes at 50m deep

SPECIAL APPLICATIONS

CASE STUDIES – INTERSEASONAL HEAT TRANSFER

Suffolk One College, Ipswich

Used ICAX interseasonal heat transfer system for 20,000m² building.

Absorber: 1,560m² bus turning area, using 14km of 25mm RAUGEO PE-Xa

Underground storage: 18 x 100m PE-Xa probes

SPECIAL APPLICATIONS

CASE STUDIES – INTERSEASONAL HEAT TRANSFER

Tesco supermarket – Greenfield, Oldham

Interseasonal heat transfer with 9 x 150m RAUGEO probes for heating and cooling 25,000 ft² store.
Recovers heat from store in summer and stores it in ground for extraction in winter.

TURNING INFRASTRUCTURE INTO ENERGY SOURCES

CURRENT PROBLEMS FACED

Risks caused by ice and snow in the winter

- Risk of accidents
- High maintenance costs

In summer, heating up to over 60°C

- Softening of the road surface
- Ruts / grooves / pot holes

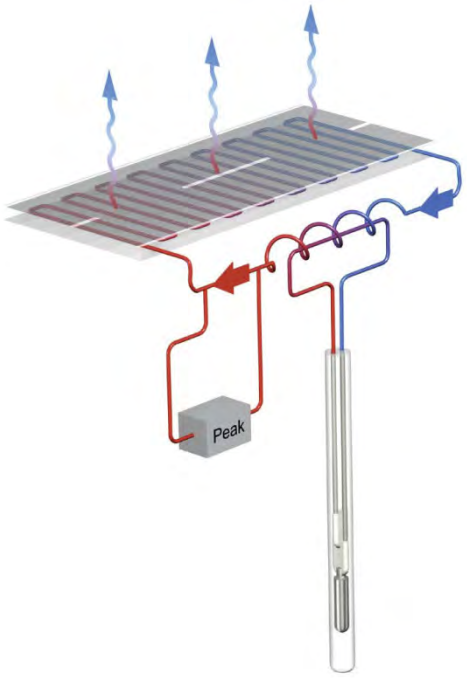
TURNING INFRASTRUCTURE INTO ENERGY SOURCES

PRINCIPLES

In winter, heat is extracted from the ground via probes and transferred to the road surface

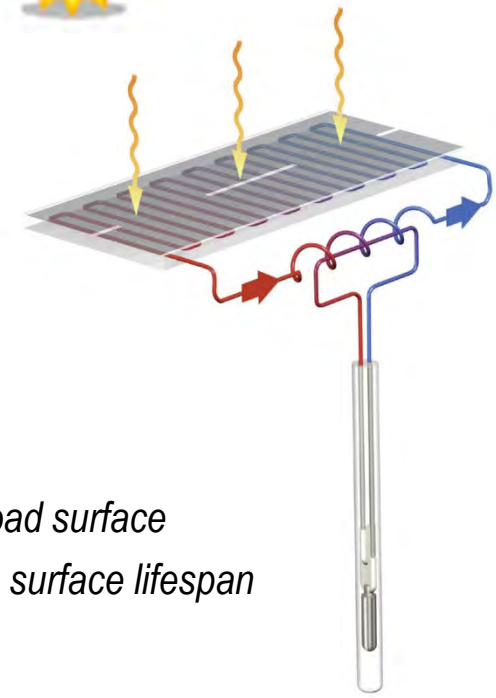
free from ice or free from snow

160 W/m² up to 300 W/m²



In summer, the traffic area acts as a solar thermal collector and the heat can be stored in the ground via PE-Xa probes.

Sun up to 600 W/m²

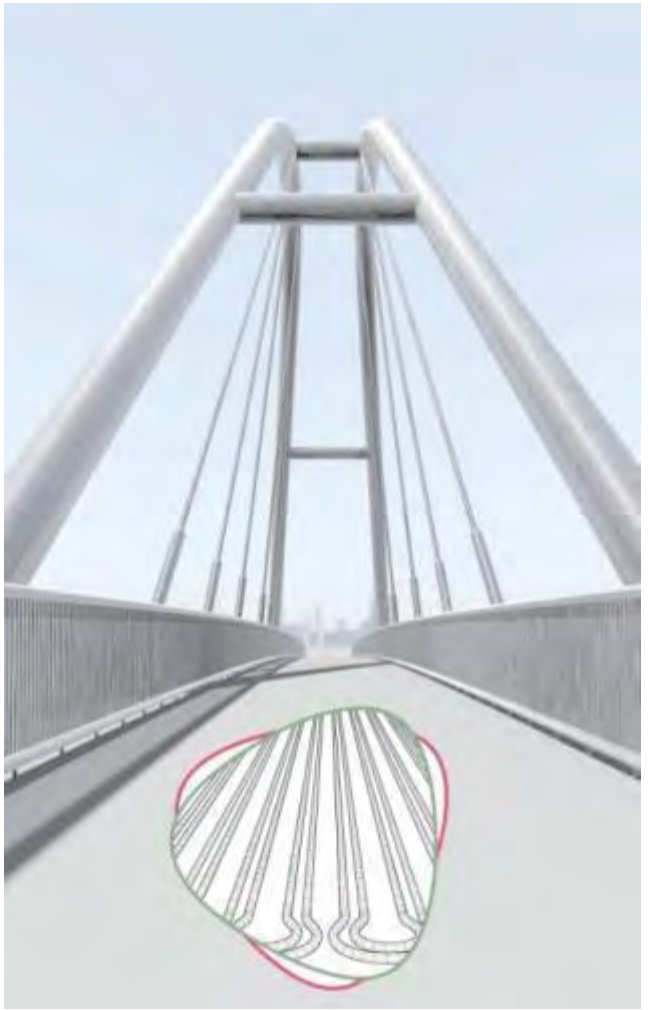


- *Cools road surface*
- *Extends surface lifespan*

TURNING INFRASTRUCTURE INTO ENERGY SOURCES

APPLICATION AREAS

- Bridges
- Hospital access roads
- Station platforms
- Pedestrian zones
- Loading ramps
- Garage entrances
- Helicopter landing place
- Tunnel exit roads
- Airports



TURNING INFRASTRUCTURE INTO ENERGY SOURCES

PIPE MATERIAL OPTIONS

PE-Xa multilayer pipe

Made of cross-linked PE-Xa with integrated aluminium layer and a protective layer made of PE for:

Installation in cast & rolled asphalt – up to 240°C

Standard PE-Xa pipe

Made of cross-linked PE-Xa and protective layer made of PE for:

Installation in concrete and other surface coverings

Resistant up to 95°C

TURNING INFRASTRUCTURE INTO ENERGY SOURCES

GEOTHERMAL TUNNEL LINING

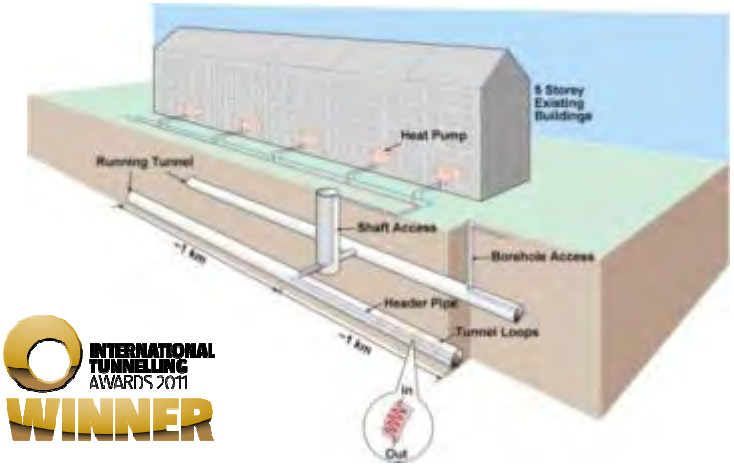
- PE-Xa pipes installed in concrete tunnel segments via off-site manufacturing

- Extracts heat from the tunnel which can be used for GSHPs above the tunnel

- Cools the tunnel to increase comfort levels for any passengers

Applications:

- Rail tunnels
- Road tunnels
- Sewer canals
- Underground service ducts
- Large drainage channels



INTERNATIONAL TUNNELLING AWARDS 2011
WINNER

INFRASTRUCTURE APPLICATIONS

CASE STUDY - BRIDGE TEMPERING

Berkentin Bridge, Germany

Winter operation:

• Keeps the road snow and ice free - less requirement for gritting

Summer operation:

• Thermal regeneration of the ground

• Cools the asphalt surface -increasing lifespan of the road

Uses open loop aquifer GSHP system

6,300m of 25mm RAUGEO stabil PE-Xa pipe

INFRASTRUCTURE APPLICATIONS

CASE STUDY - ROAD TEMPERING

MAN Acoustic Testing Facility, Munich, Germany

Target:

- To keep the test track free of ice & surface water
- Fast drying of the road surface

Benefits:

- No weather-related delays to the tests
- No influence of the test results by fluctuations in the road surface factors

340m² area heated using RAUGEO Stabil PE-Xa pipe

INFRASTRUCTURE APPLICATIONS

CASE STUDY – PLATFORM HEATING

Platform Heating Bad Lauterberg, Germany

Objective:

Keep platform free from snow & ice

2 platforms measuring 150 x 2.5m, using platform boards 2.5m²

Each board has 25m of RAUGEO stabil pipe included.

Heat storage:

9 ground-source probes at 200m

Connected via RAUTHERMEX

Operational since 2005: concept proven over several winters

INFRASTRUCTURE APPLICATIONS

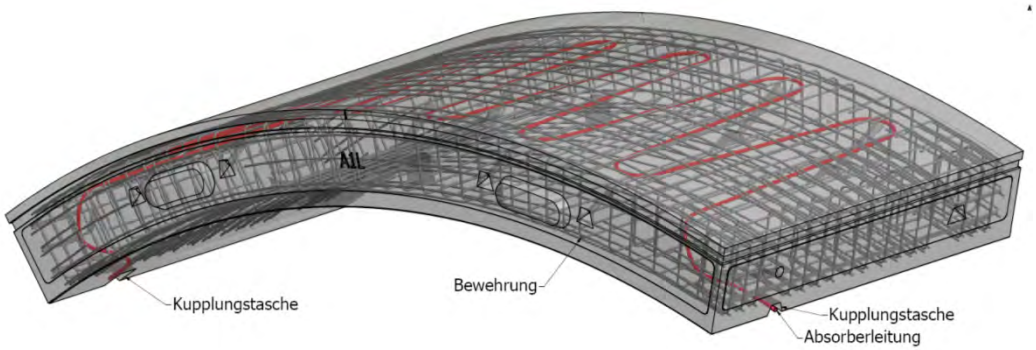
CASE STUDY – GEOTHERMAL TUNNEL LINING

Jenbach Tunnel, Austria

Test project conducted on new high-speed rail tunnel passing below town on Jenbach.

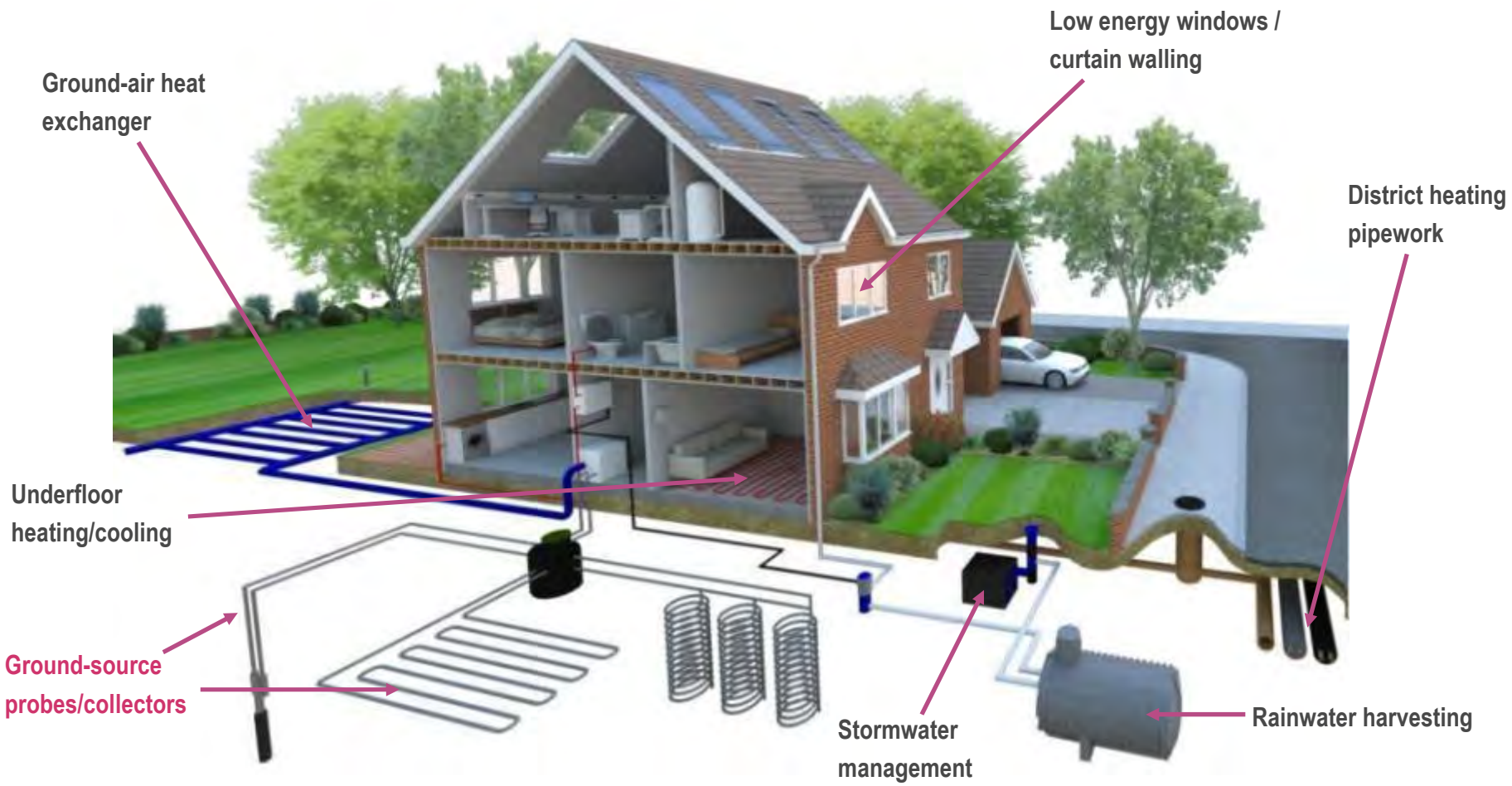
Tunnel was 12m diameter. Estimated outputs ca. 10-15W/m²

Heat extracted was used to heat the buildings above the tunnel.



RENEWABLE ENERGY SOLUTIONS

RELIABILITY FOR GENERATIONS



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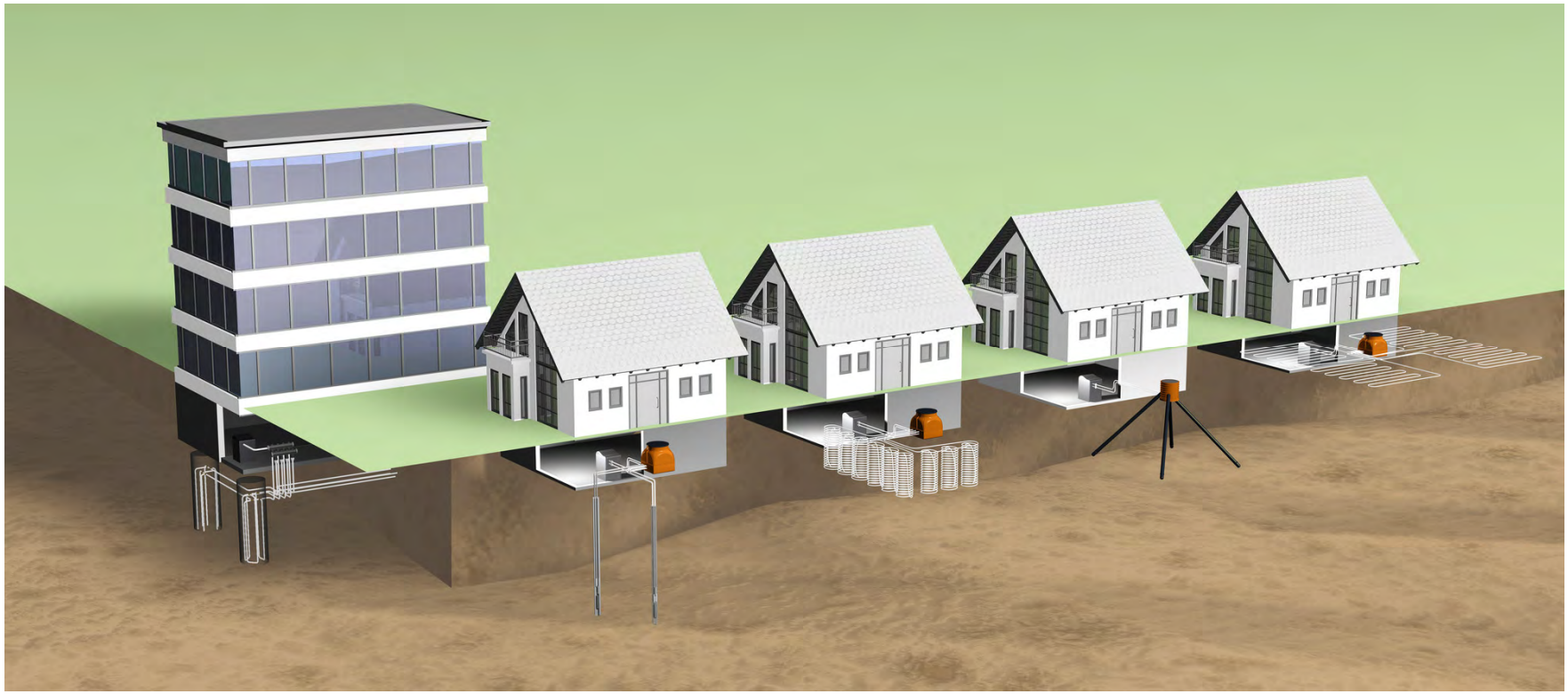

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?

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