

# ECOVAT IN HYBRID ENERGY NETWORKS



Seasonal Thermal Energy Storage

Aris de Groot, Founder and Managing Director

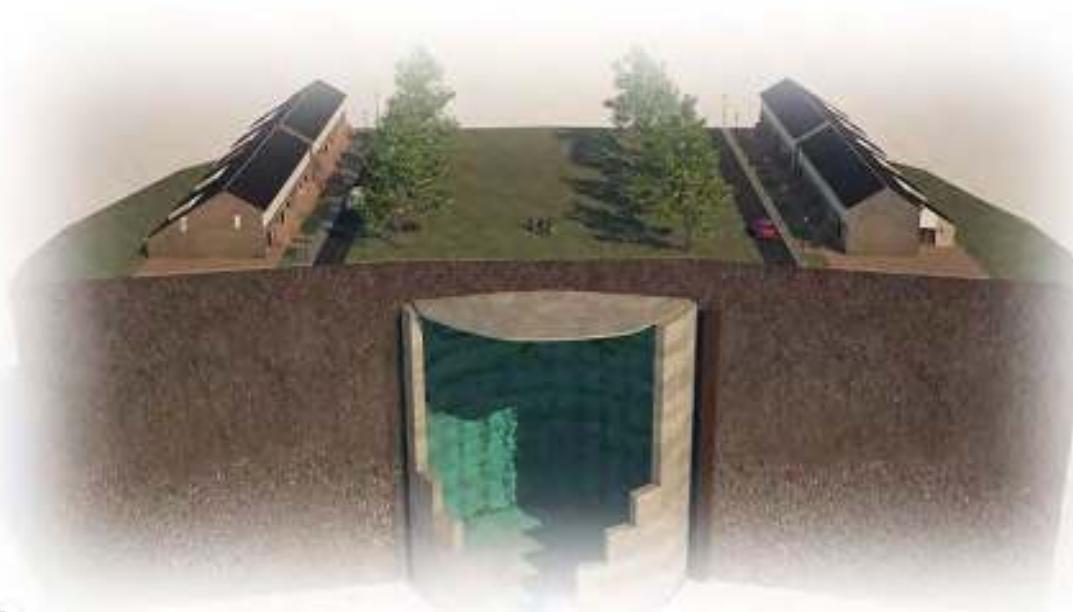
Wiet Mazairac, R&D Engineer

# CONTENTS

1. Research: Optimization of Hybrid Energy Networks
2. Ecovat: Heat Storage in Hybrid Energy Networks

# RESEARCH

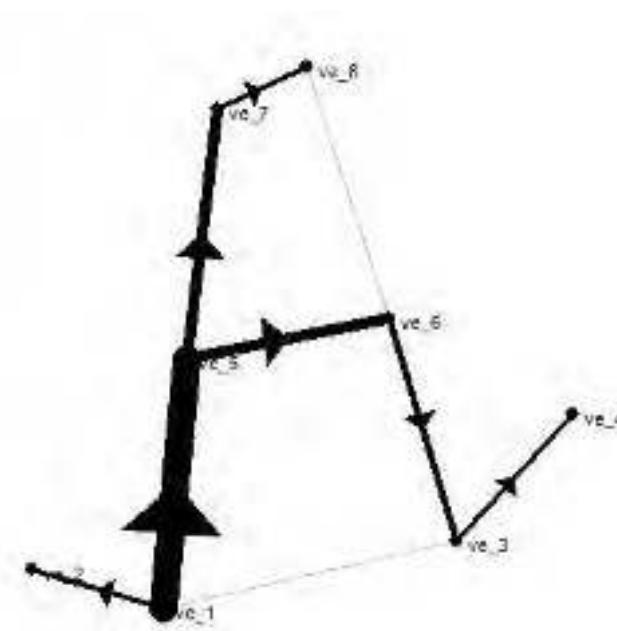
- Research and Development Engineer (Ecovat)
  - Optimization of System Design and Operation



 **ecovat**®

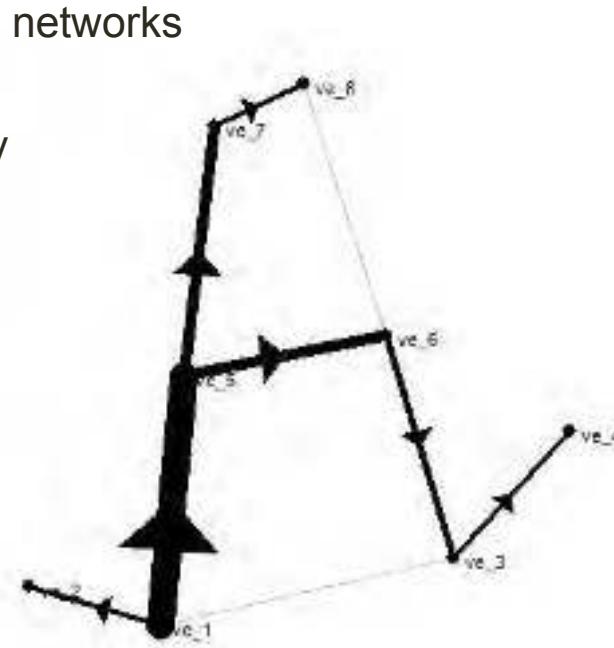
# RESEARCH

- PhD Researcher (TU/e, VITO)
  - Integrated optimization of multi-carrier energy networks



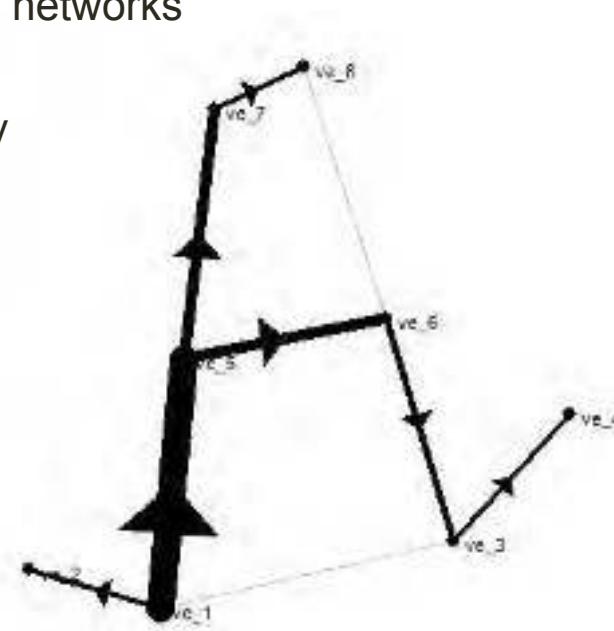
# RESEARCH

- PhD Researcher (TU/e, VITO)
  - Optimization of energy networks
  - Integrated optimization of multi-carrier energy networks
  - Subject to technical and economic uncertainty



# RESEARCH

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  - Subject to technical and economic uncertainty



Global warming



Demand growth



Reserve depletion



Political issues



Global warming



Demand growth



Reserve depletion



Political issues



Clean



Inexhaustible



Local

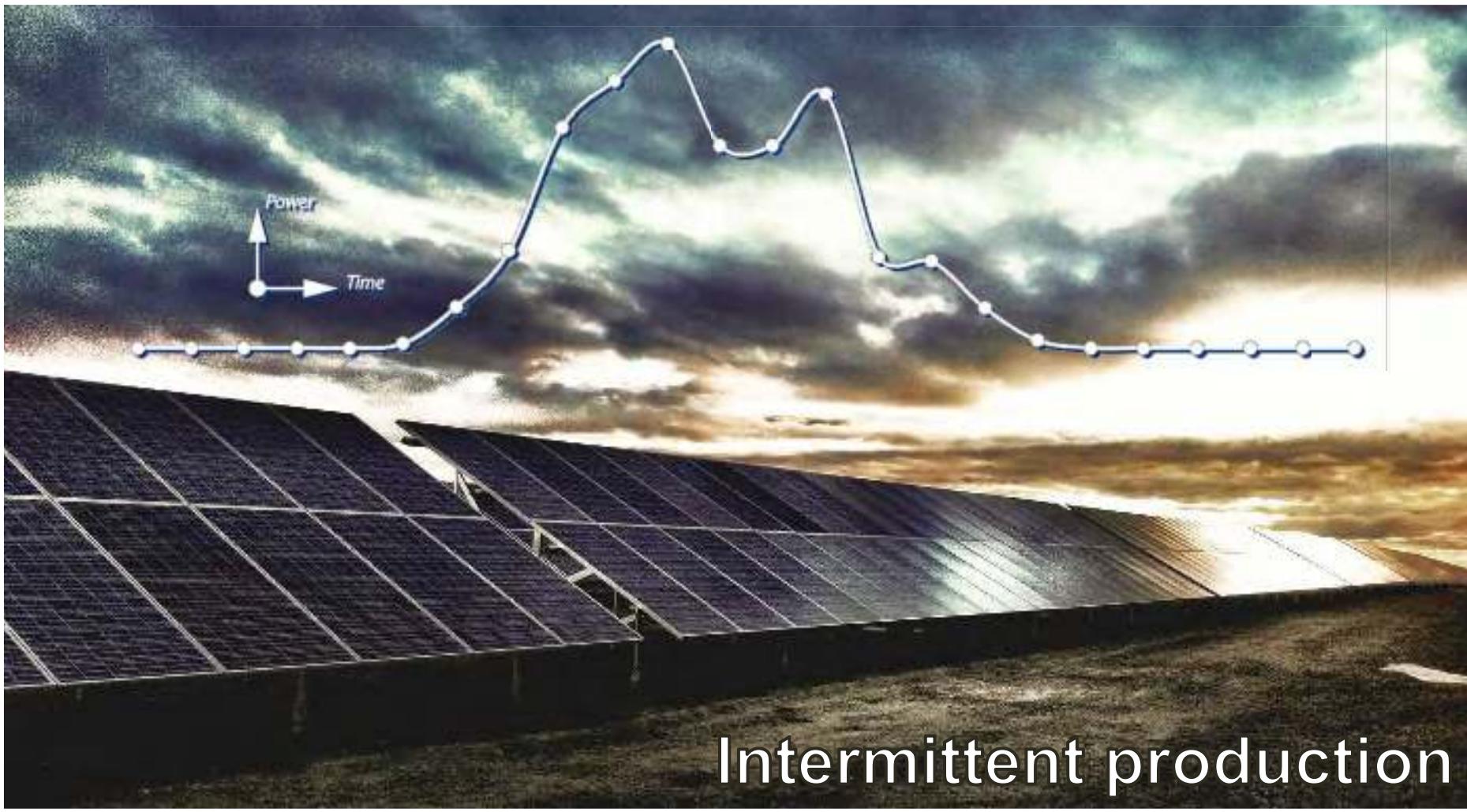




Distributed production

# RESEARCH





PLUGGED IN

# Germany had so much renewable energy on Sunday that it had to pay people to use electricity

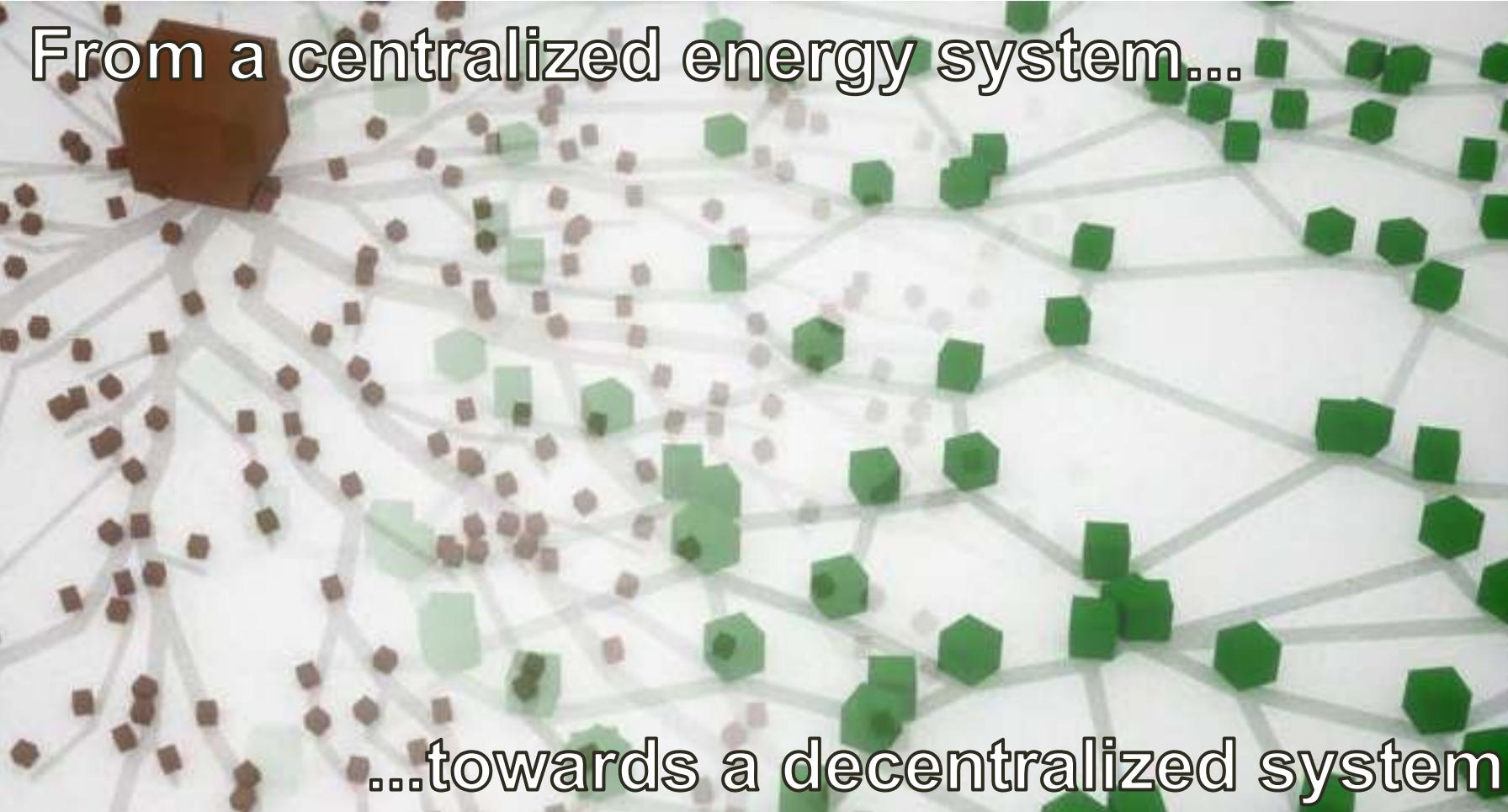
By Michael J. Coren

May 10, 2016



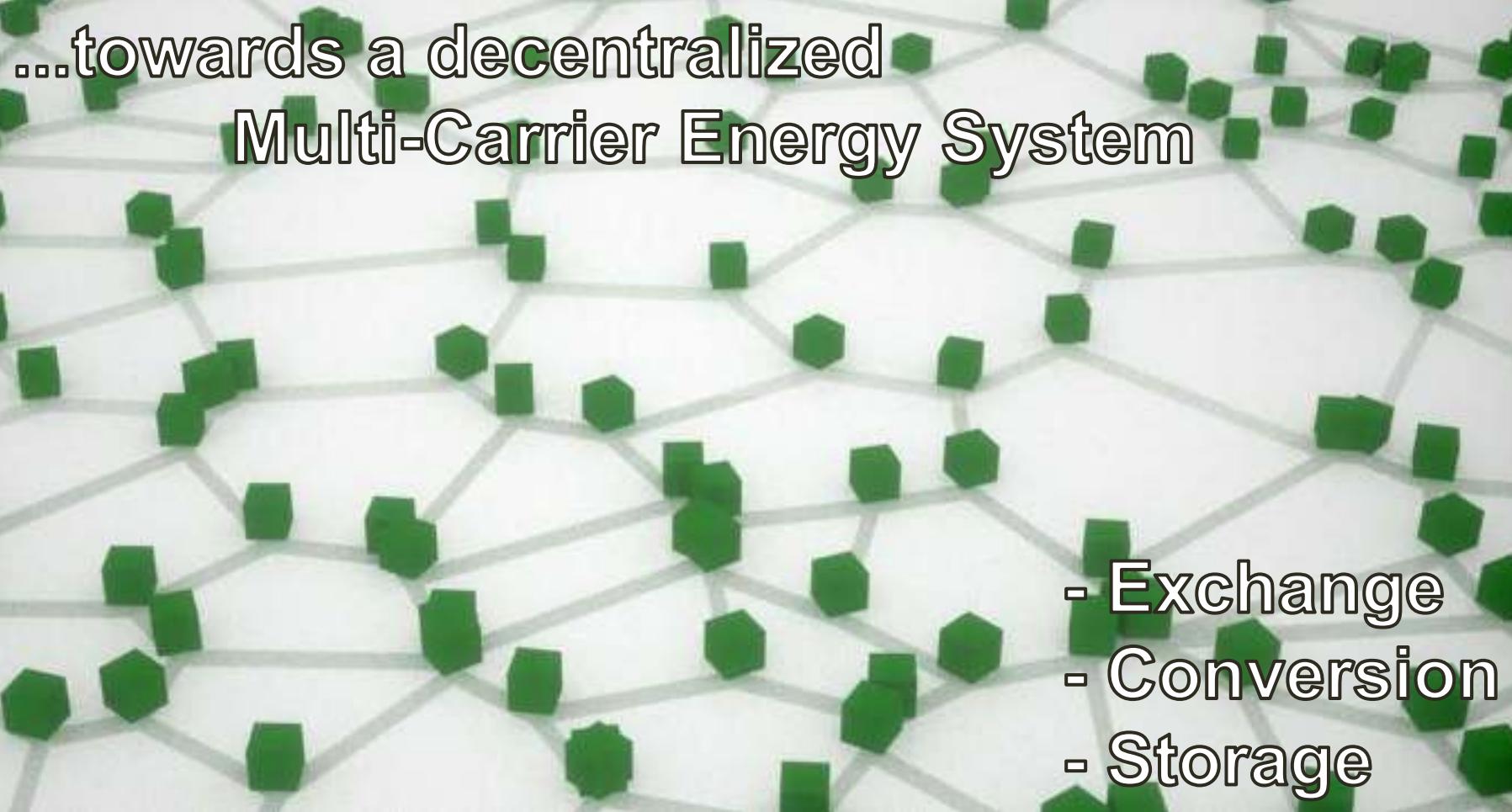


Controllable production



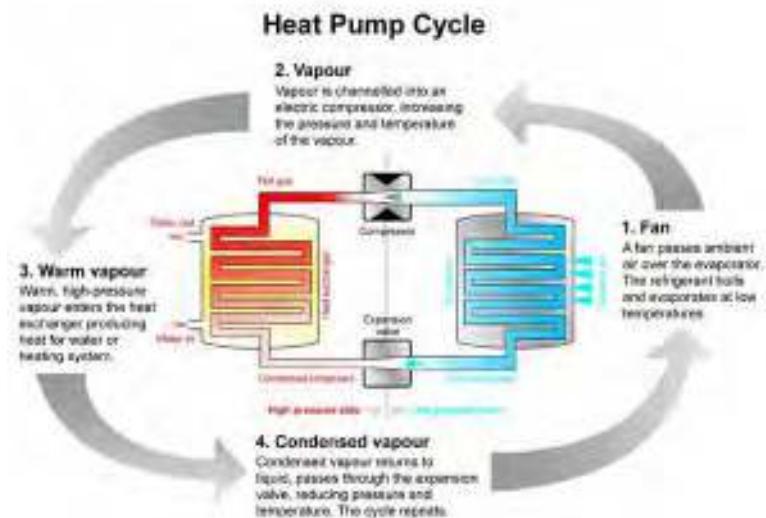
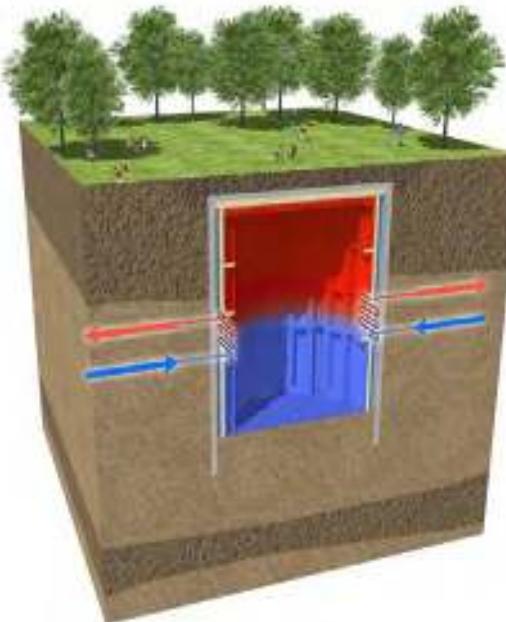
From a centralized energy system...

...towards a decentralized system

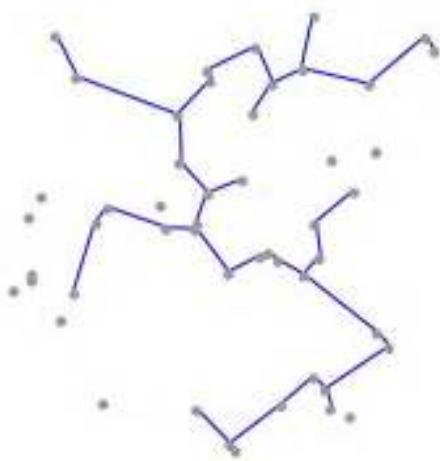


...towards a decentralized  
Multi-Carrier Energy System

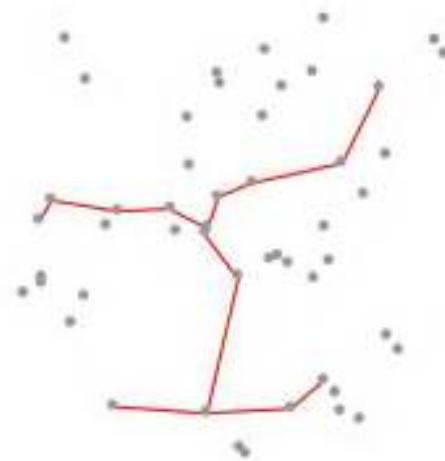
- Exchange
- Conversion
- Storage



- From non-integrated to integrated optimization

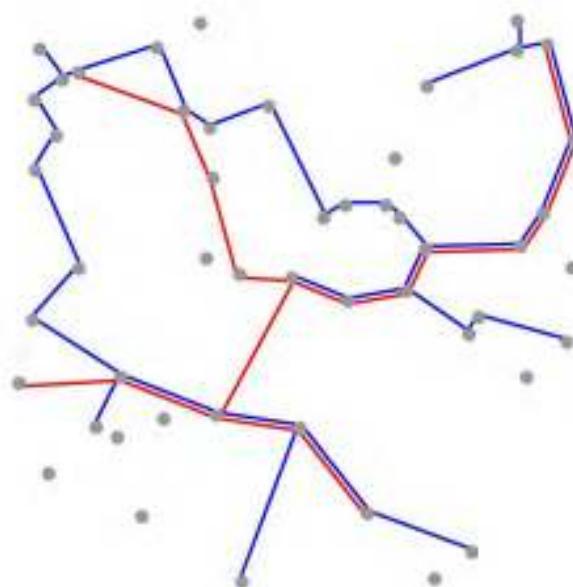


Electric Power Network



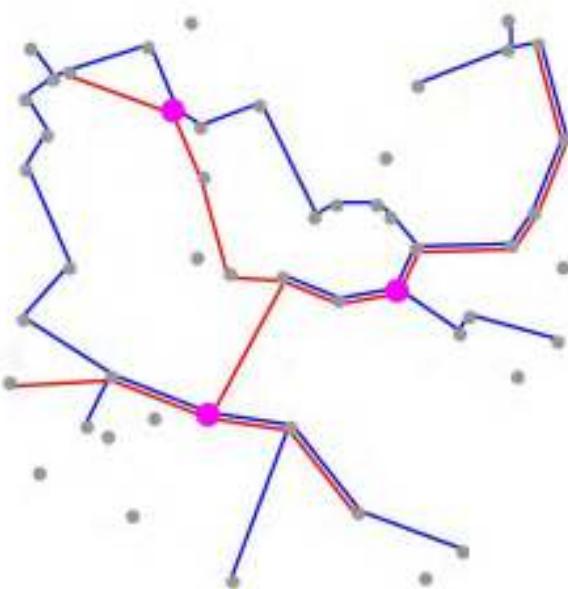
District Heating Network

- From non-integrated to integrated optimization



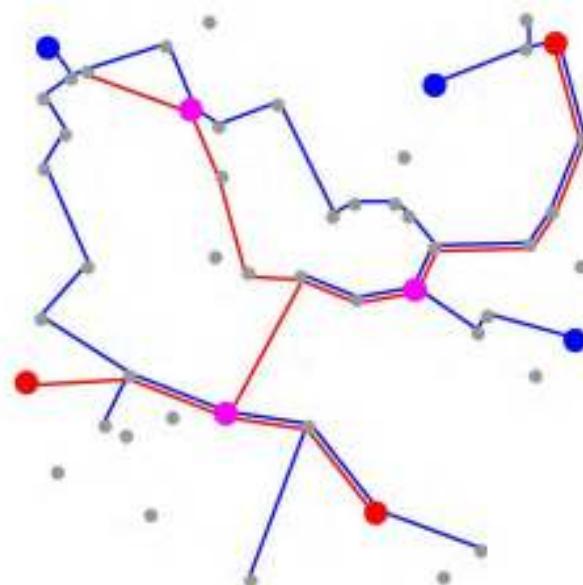
Multi-Carrier Energy Network

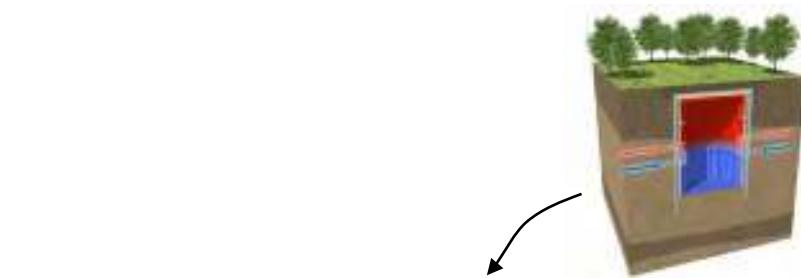
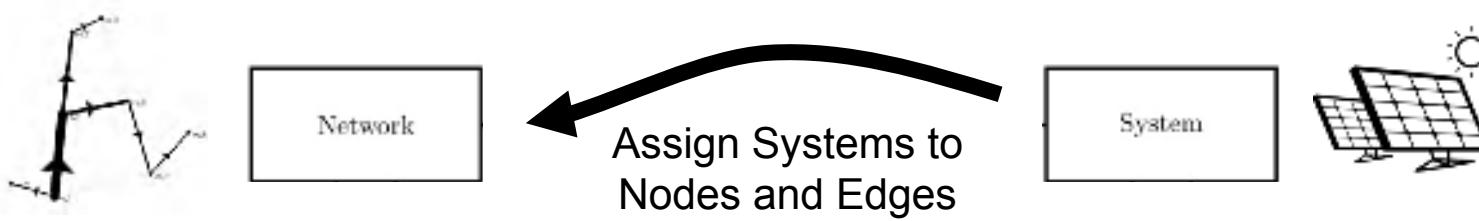
- From non-integrated to integrated optimization
- Optimal location and capacity of ...
  - Conversion units



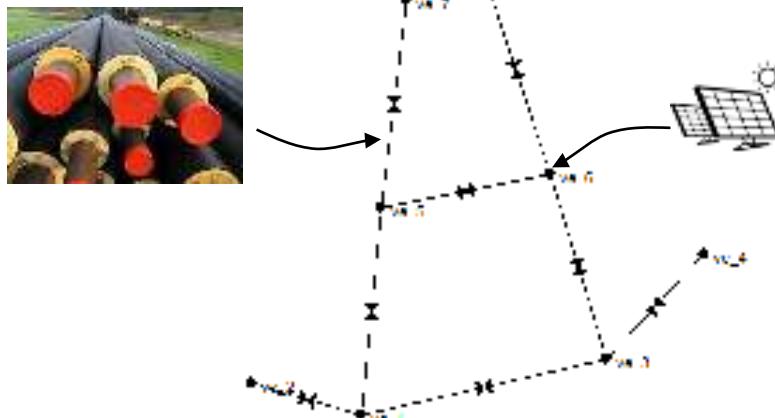
Multi-Carrier Energy Network

- From non-integrated to integrated optimization
- Optimal location and capacity of ...
  - Conversion units
  - Storage units





### Mixed Integer Linear Program (MILP)



- Assigns Systems
- Finds an Optimal Solution
  - Minimize Costs
  - Minimize Emissions

# STORAGE IS THE MISSING LINK



Project title: **Flexible Heat and Power**, Connecting heat and power networks by harnessing the complexity in distributed thermal flexibility.

**Power to heat solutions** can be used for **absorbing the excess of renewable generation and avoiding curtailment** while managing local power congestion, voltage stability in the grid and avoiding reversal power flows, as well as minimizing Renewable Energy Sources (RES) production imbalance.



FHP project is funded by European Union under the grant agreement no. 731231.



Ecovat de oplossing voor gasloos?

Particulieren of collectief?

Dimensies en efficiëntie?

Schaalgrootte?



Doorlooptijd?

Energiebedrijven?

Seasonal Thermal Energy Storage

100% renewable heating and cooling

## Na Aardgas komt Ecovat

Periodiek onderhoud?

Fundering onder Ecovat?

Beperkingen?

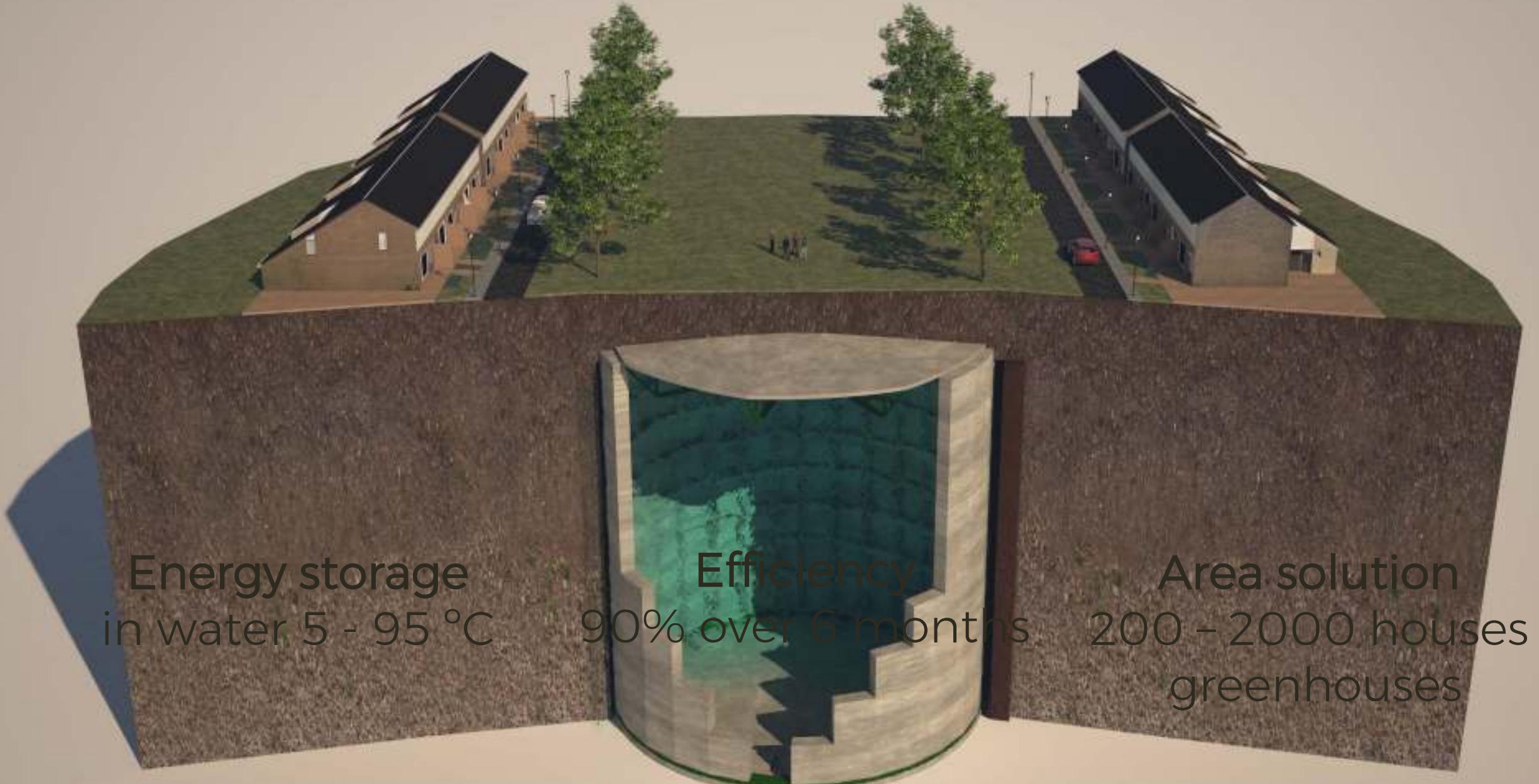
Gemeenten?

Stakeholders?



90%



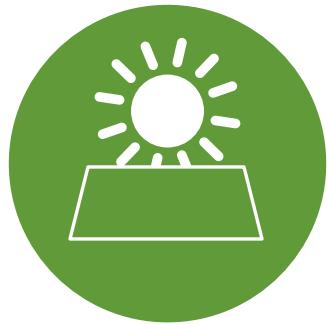


Energy storage  
in water 5 - 95 °C

Efficiency  
90% over 6 months

Area solution  
200 - 2000 houses  
greenhouses

# 100% RENEWABLE ENERGY



Solar thermal

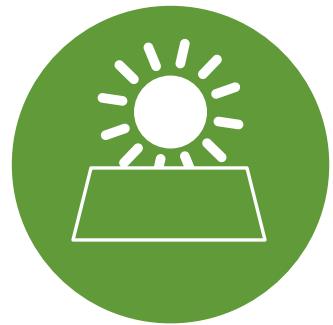


Heat pumps &  
Power2Heat



Waste heat

# 100% RENEWABLE ENERGY



Solar thermal



Heat pumps &  
Power2Heat



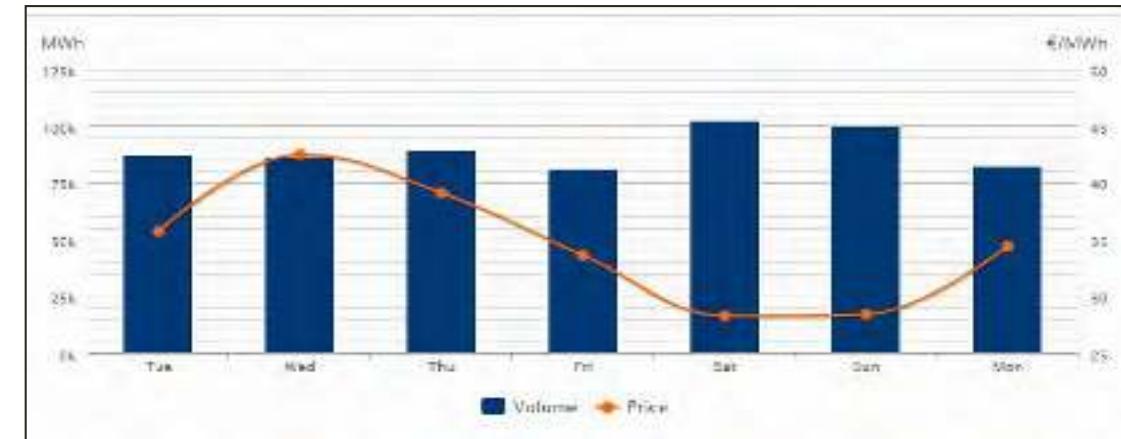
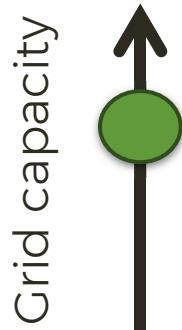
Waste heat

**FLEX OPPORTUNITIES**

# FLEX OPPORTUNITIES

Grid congestion at DSO:

- Stedin
- Enexis
- Liander



Commodity (supply and demand)



Balance management by TSO (Tennet):

- Imbalance market

Energy trading at:

- APX
- Intraday

# FLEX OPPORTUNITIES

Energy trading at:  
• APX

**2015**

APX average      €40/MWh

APX lowest 25%    €26/MWh



**2030**

APX average      > €50/MWh

APX lowest 25%    < €10/MWh

APX highest 25% >> €50/MWh

# FLEX OPPORTUNITIES

Congestion management for DSO:

**2018**

90% natural gas



10% district heating & all-electric

**2020-2030**

All-electric boom (NOM = Dom)

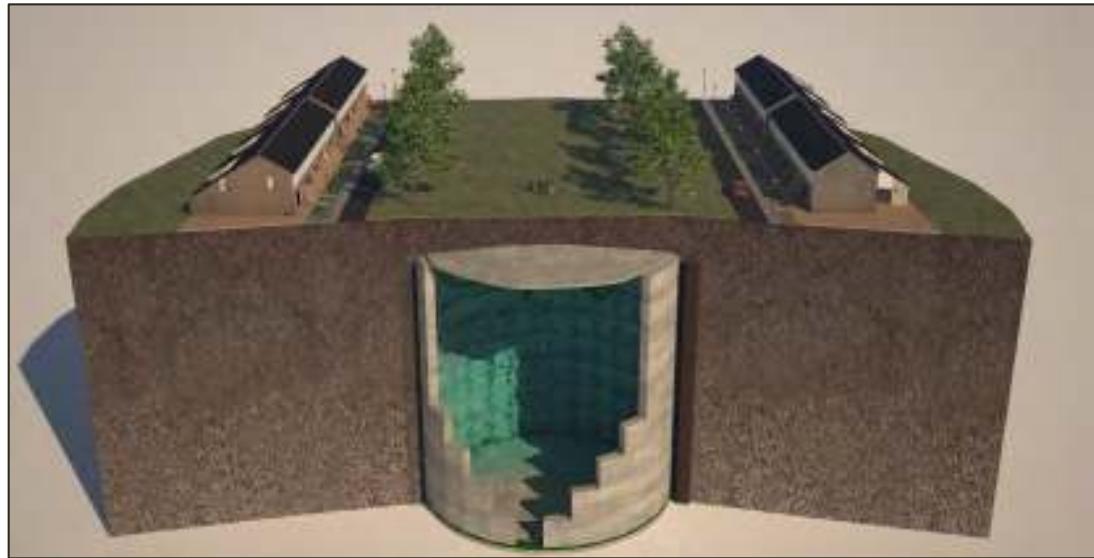
Vs.

District heating (Smart multi energy grid)

# ECOVAT PORTFOLIO

	layers (#)	depth (m)	diameter (m)			
			30	36	42	48
<b>Volume</b>			Volume (m <sup>3</sup> )			
	8	28,8	20.347	29.300	-	-
	11	39,6	27.977	40.287	54.836	71.622
	15	54	38.151	54.937	74.776	97.667
<b>Usable heat capacity (dT = 50K)</b>			Usable heat capacity (MWh/cycle)			
	8	28,8	1.184	1.705	-	-
	11	39,6	1.628	2.345	3.191	4.168
	15	54	2.220	3.197	4.352	5.684
<b>Natural gas equivalent (AEQ)</b>			Natural gas equivalent (m <sup>3</sup> /cycle)			
	8	28,8	121.197	174.524	-	-
	11	39,6	166.646	239.970	326.626	426.613
	15	54	227.244	327.232	445.399	581.745
<b>CO2 reduction</b>			CO2 reduction (ton/cycle)			
	8	28,8	239	344	-	-
	11	39,6	328	473	643	840
	15	54	448	645	877	1.146
<b>Storage temperature (cooling and heating)</b>			0-95 °C			
<b>Efficiency 6 months</b>			91%	93%	95%	95%
<b>Technical life expectancy</b>			>100 years			
<b>Storage medium</b>			natural water (H <sub>2</sub> O)			

# ECOVAT IN PERSPECTIVE



# 1  
Ecovat  
1.000 MWh



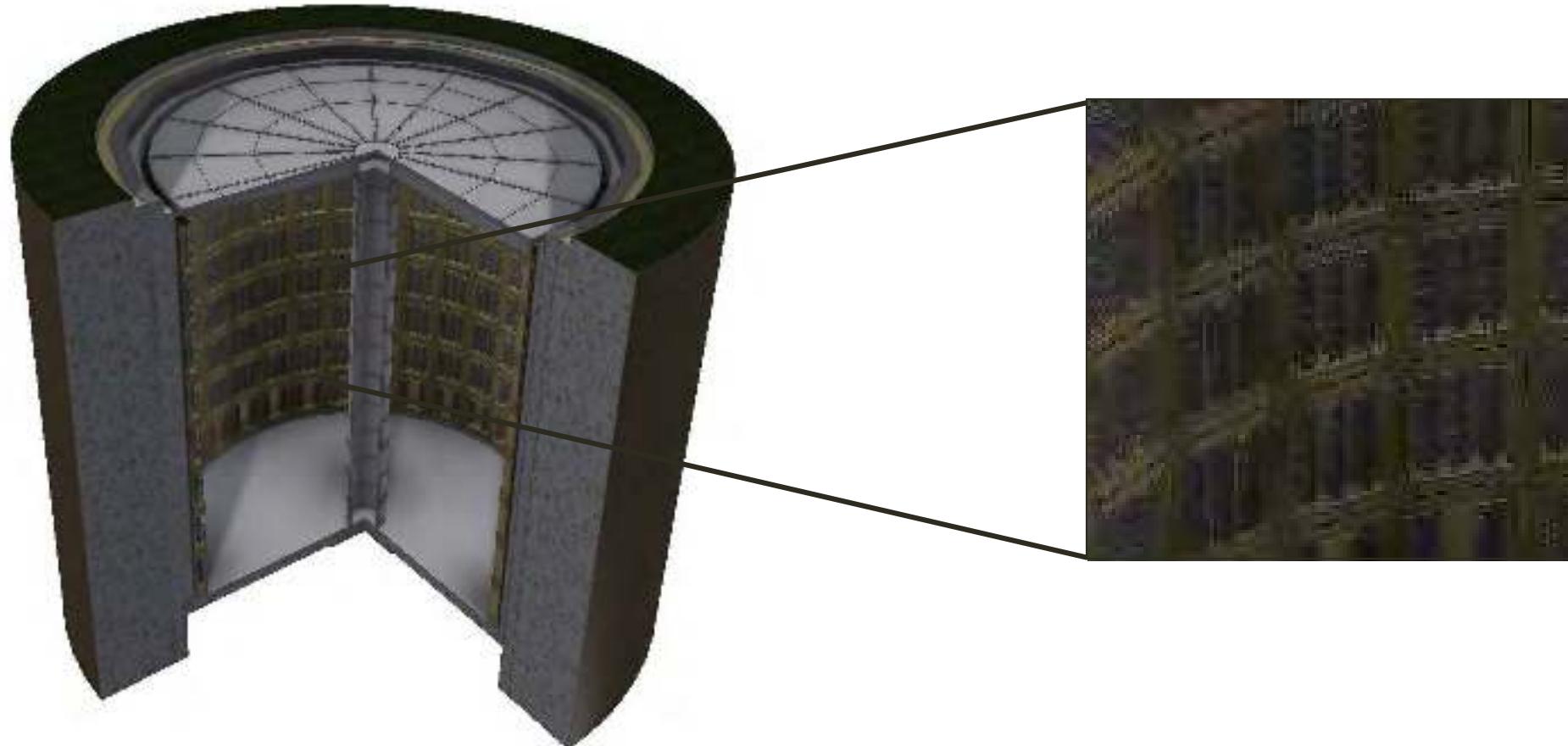
# 70.000  
Tesla Powerwall 2  
1.000 MWh

# TECHNOLOGY VALIDATION

EU and US patented technologies



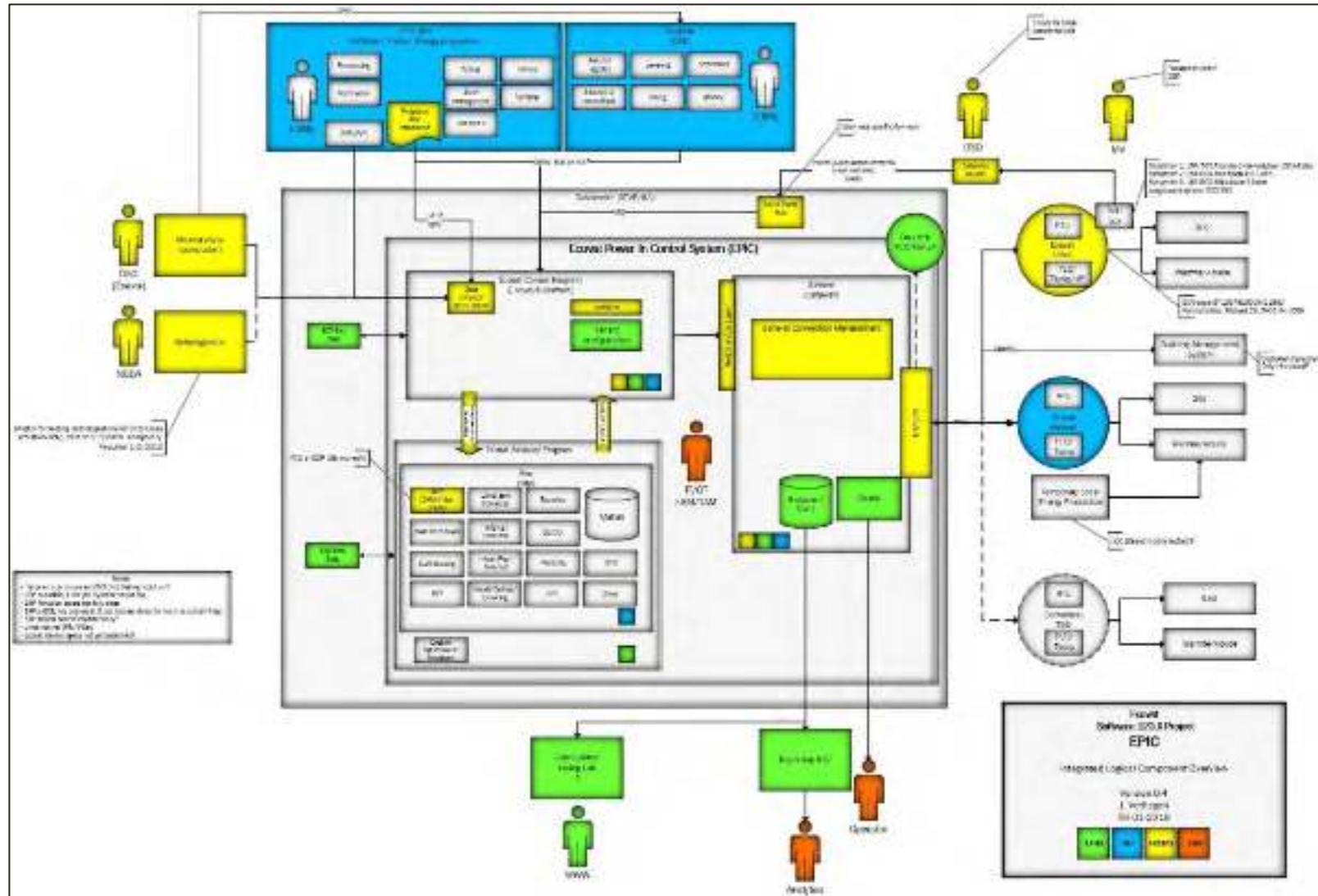
# ECOVAT CONSTRUCTION



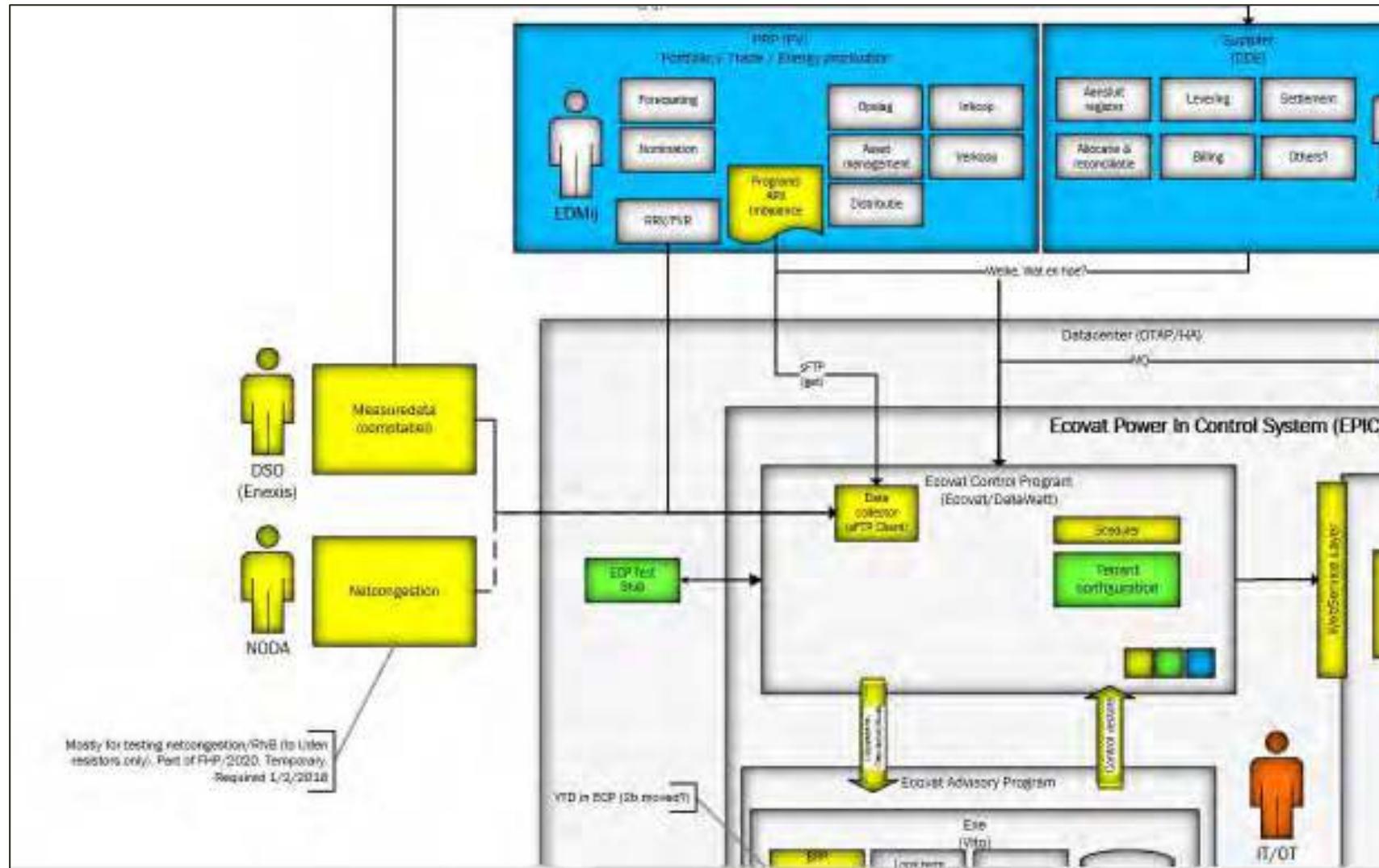
# ECOVAT CONSTRUCTION



# ECOVAT SOFTWARE



# ECOVAT SOFTWARE



# PROJECT APPROACH



# ECOVAT PROJECTS



Gemeente Den Haag

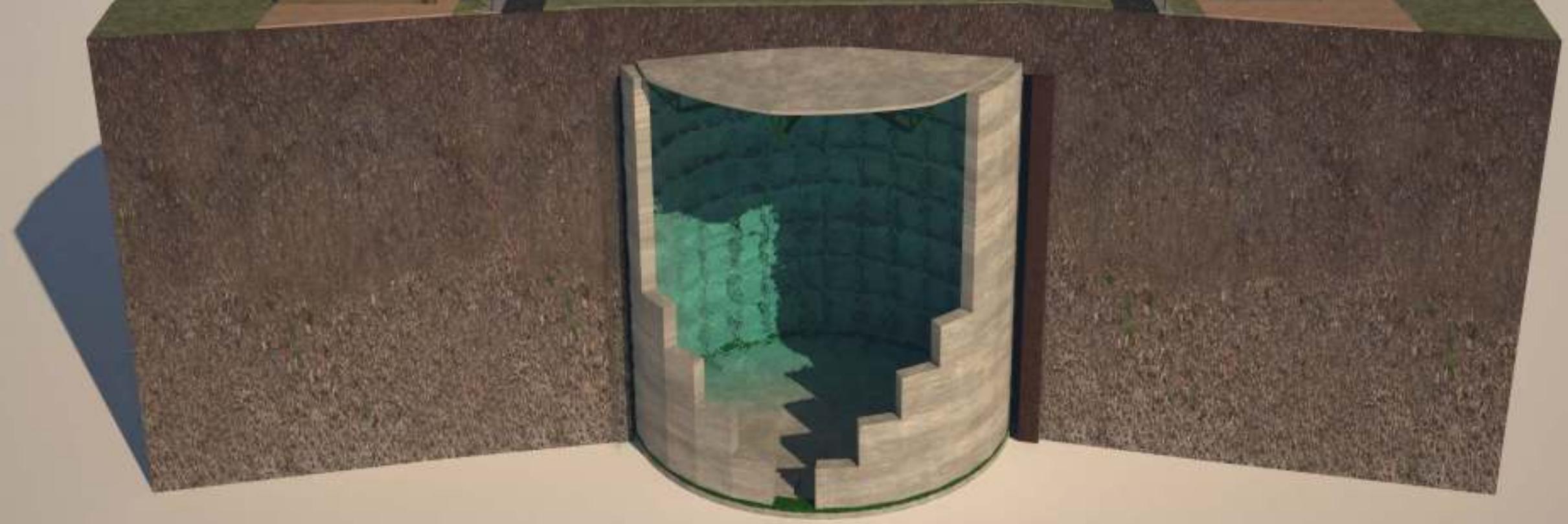


energy now



Deliscious  
Colorful freshness!

e ecovat



Seasonal Thermal Energy Storage

Aardgas uit de woning en uit het energiesysteem