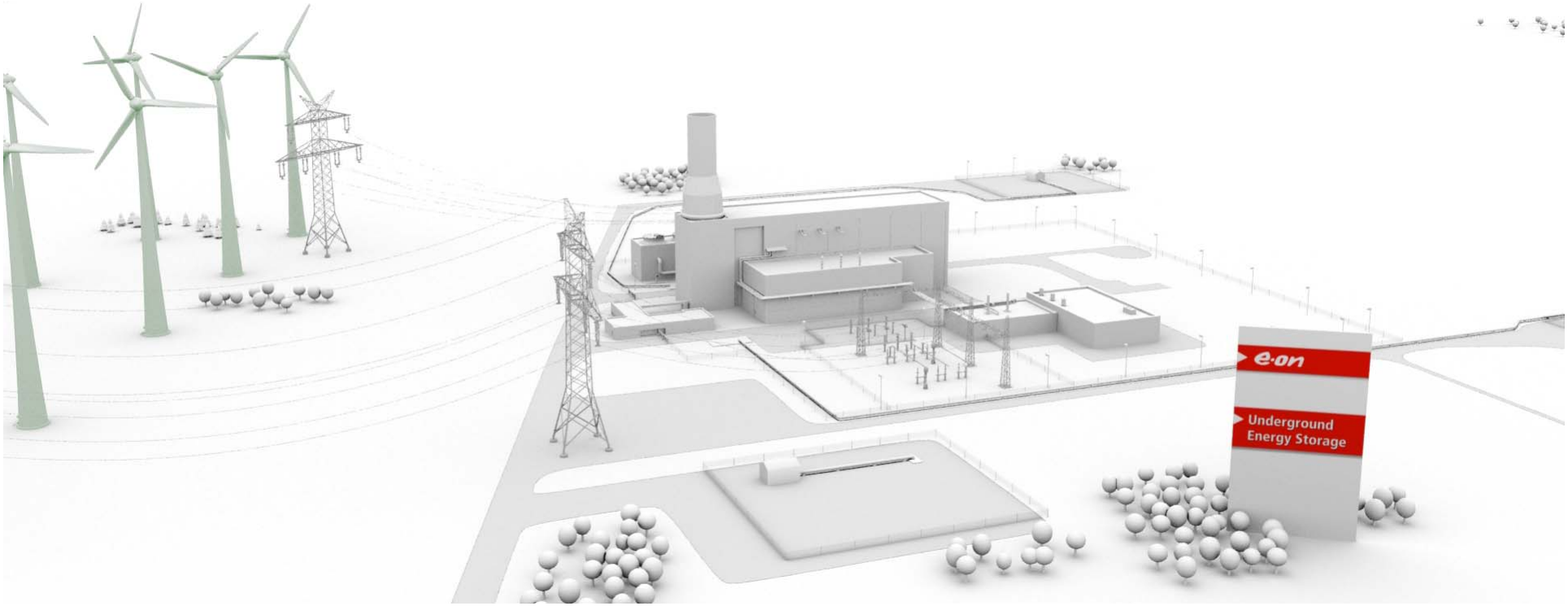


Compressed Air Energy Storage

– one promising technology in the future energy storage business

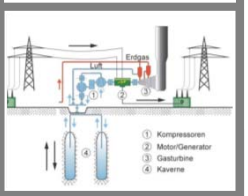
Dr. Andrei Zschocke
Technology & Innovation
E.ON Innovation Center Energy Storage

IPHE Workshop
Sevilla, 15.11.2012

Energy storage technologies at E.ON

Proven Technology - Potential for improvement - New Technology

Availability, Specification, Cost Effectiveness, Acceptance, Dimension

Battery	Capacitor	Pumped Storage P.	(A) CAES	Power to Gas to Grid or to Caverns or to Power
				
Heat	Fly wheel			
				

E.ON Gas Storage is the hosting unit for innovation in energy storage business

Key figures

working gas in bill. m³

Germany and Austria:
E.ON Gas Storage GmbH

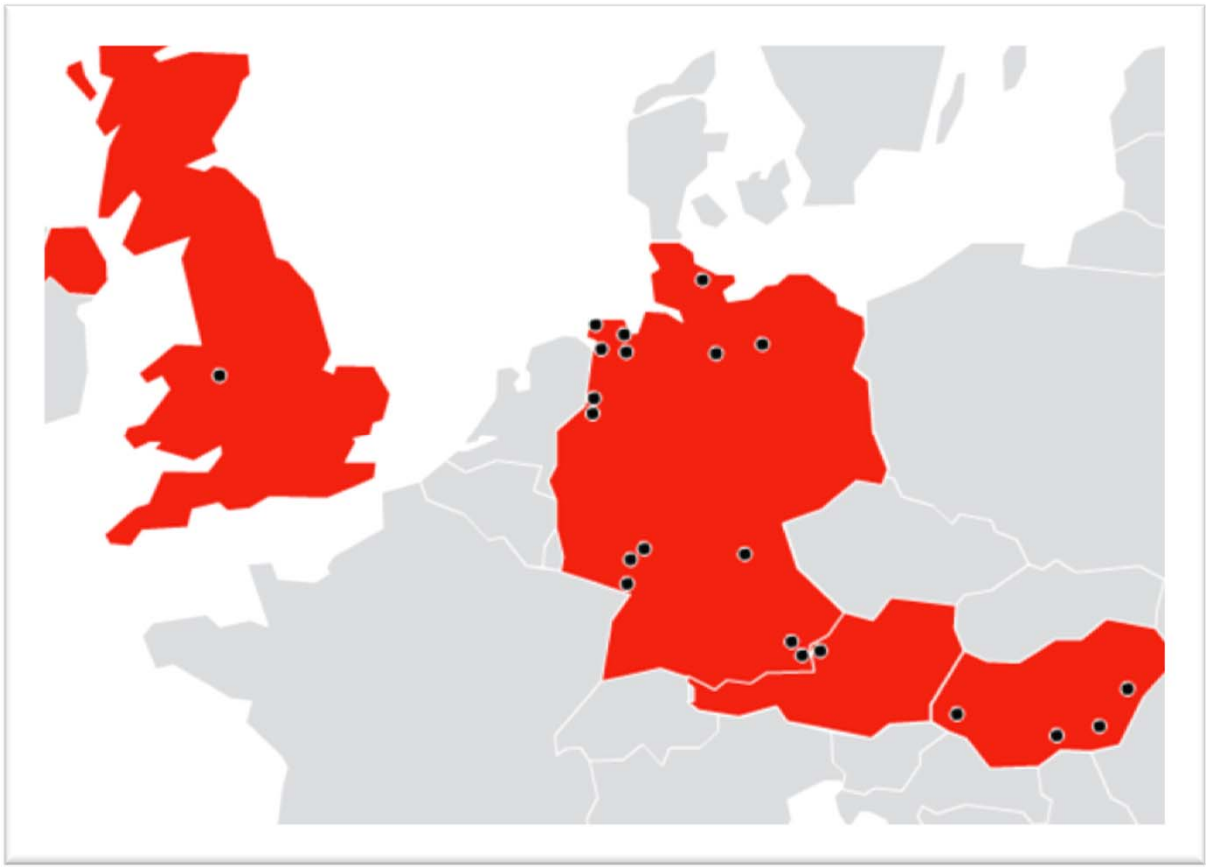
Status	8,5
Projects	1,3

Hungary: E.ON Földgáz Storage

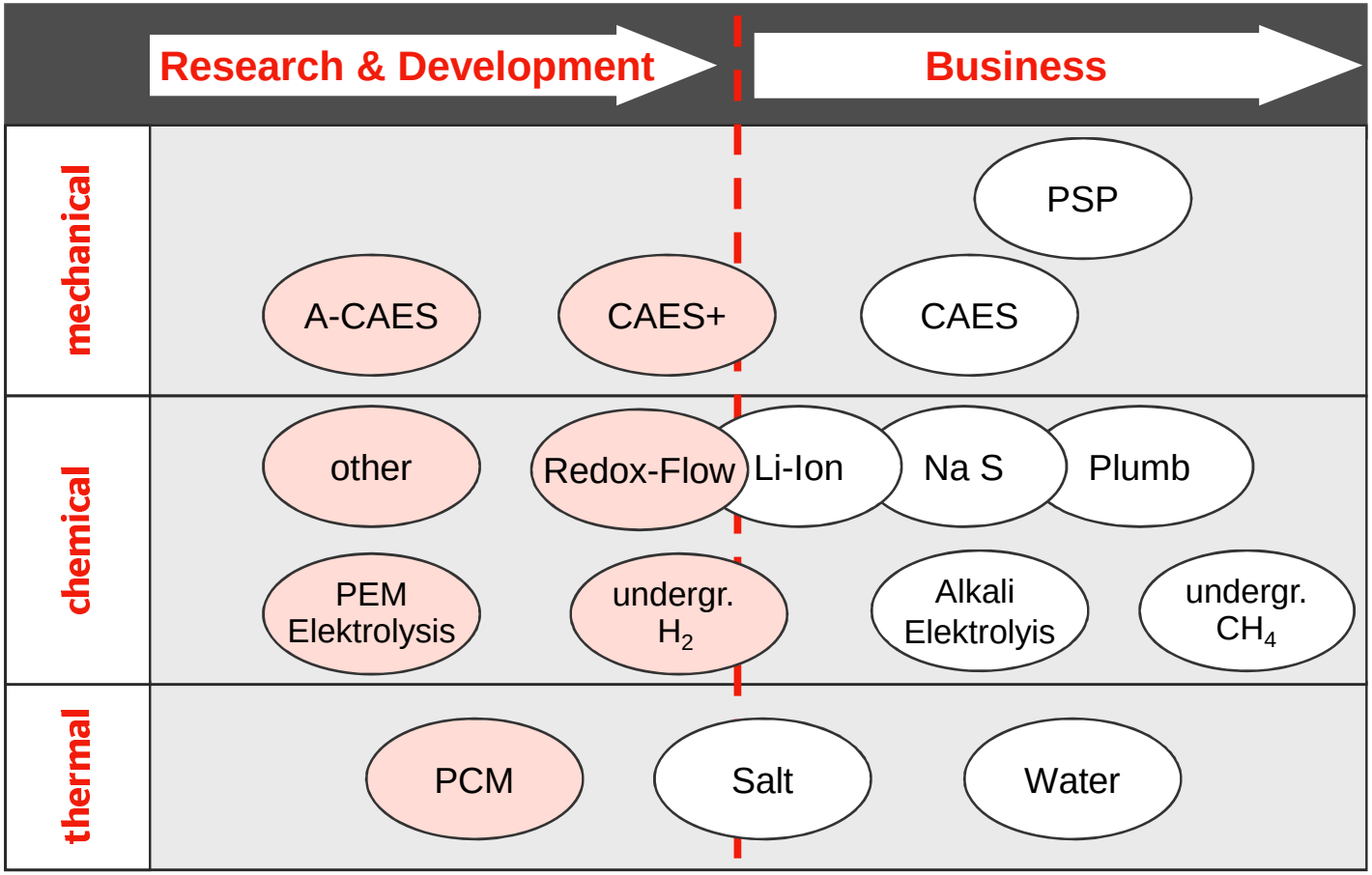
Status	4,2
Projects	0,0

UK: E.ON Gas Storage UK

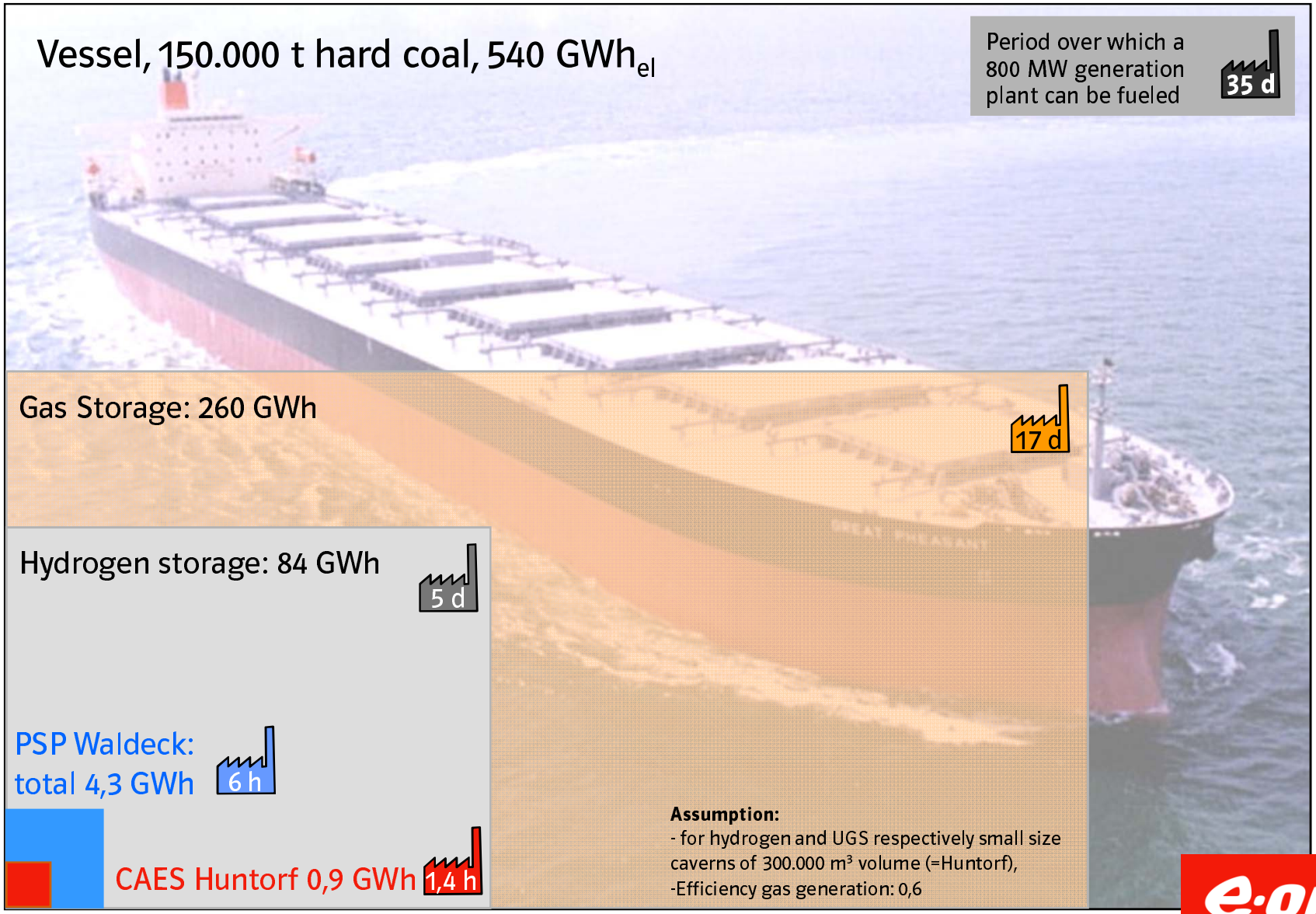
Status	0,2
Projects	0,0



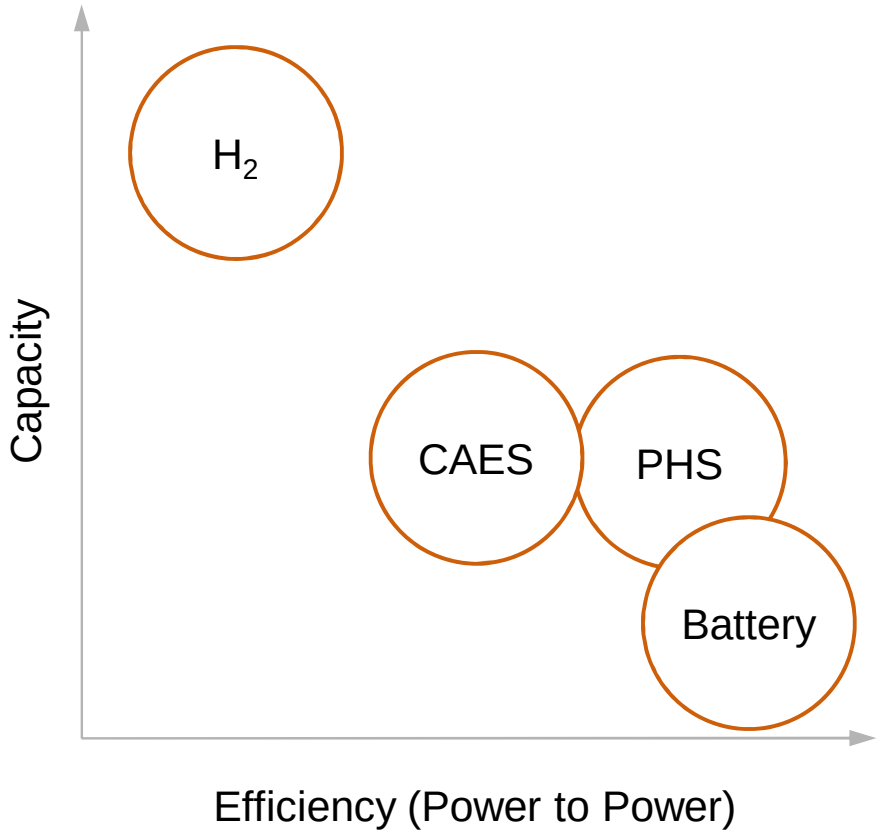
Estimated development status of storage technologies (selection)



Comparing the energy content

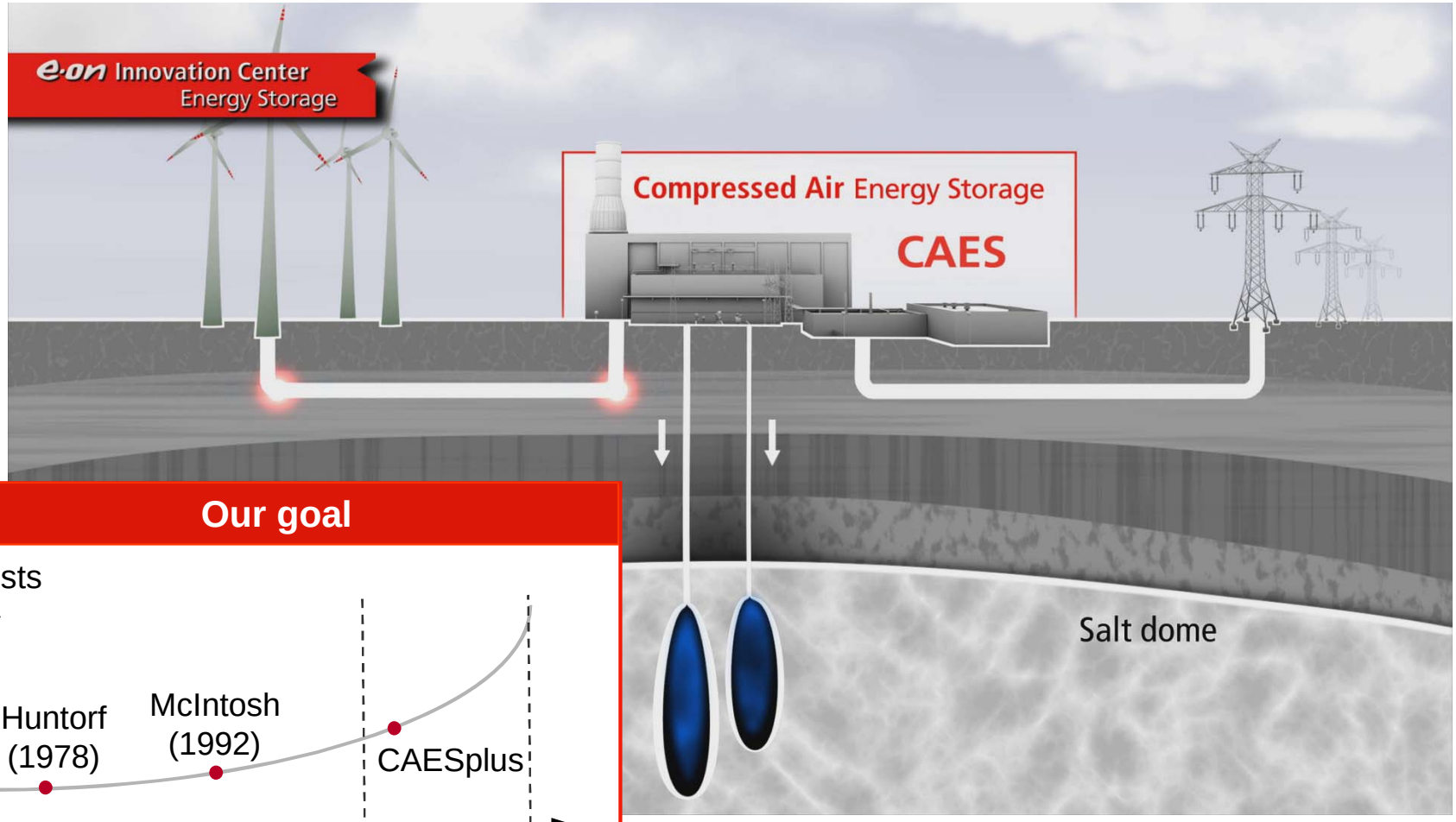


Which technology fits best to which problem?
-don’t compare “apples with pears”



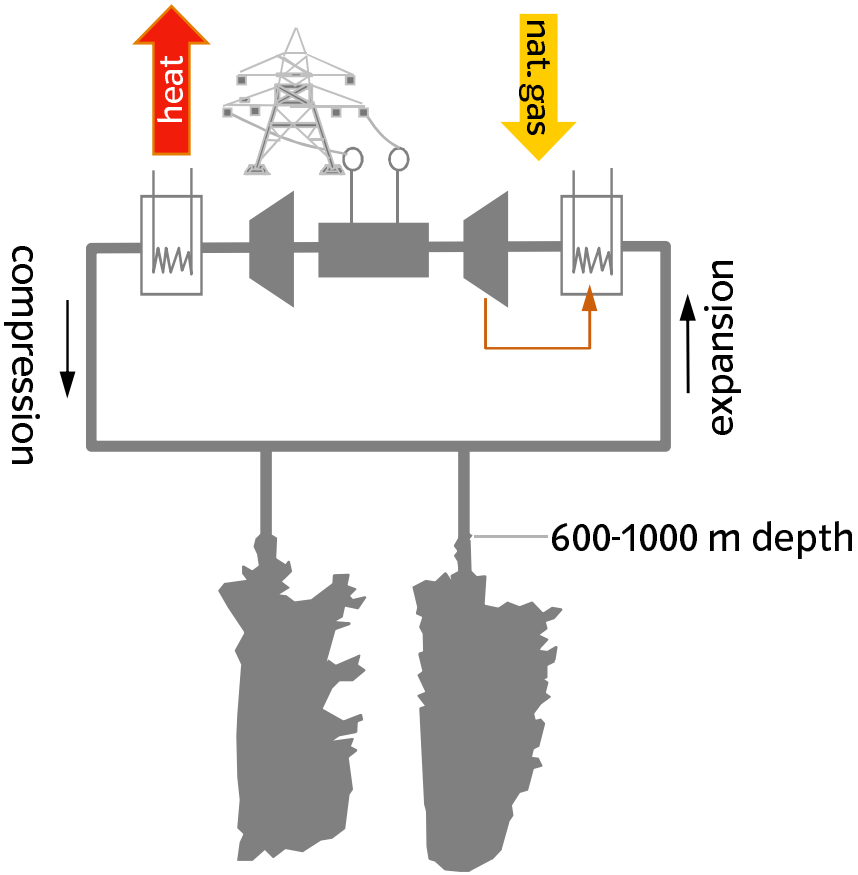
- Capacity
- Power
- Ramp-up time
- Efficiency
- Availability
- Costs
- Acceptance
- …and 50 more!

The general concept of CAES

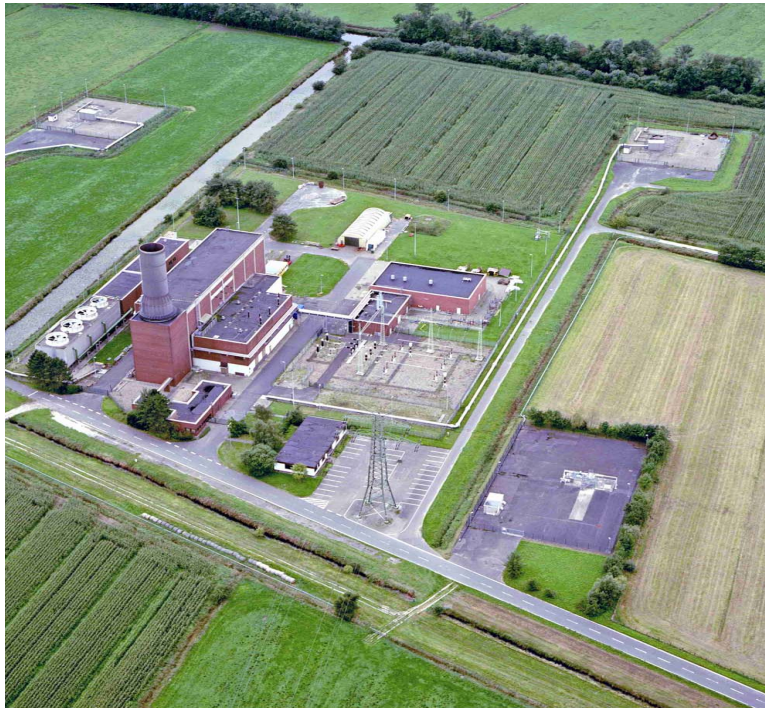


Our goal

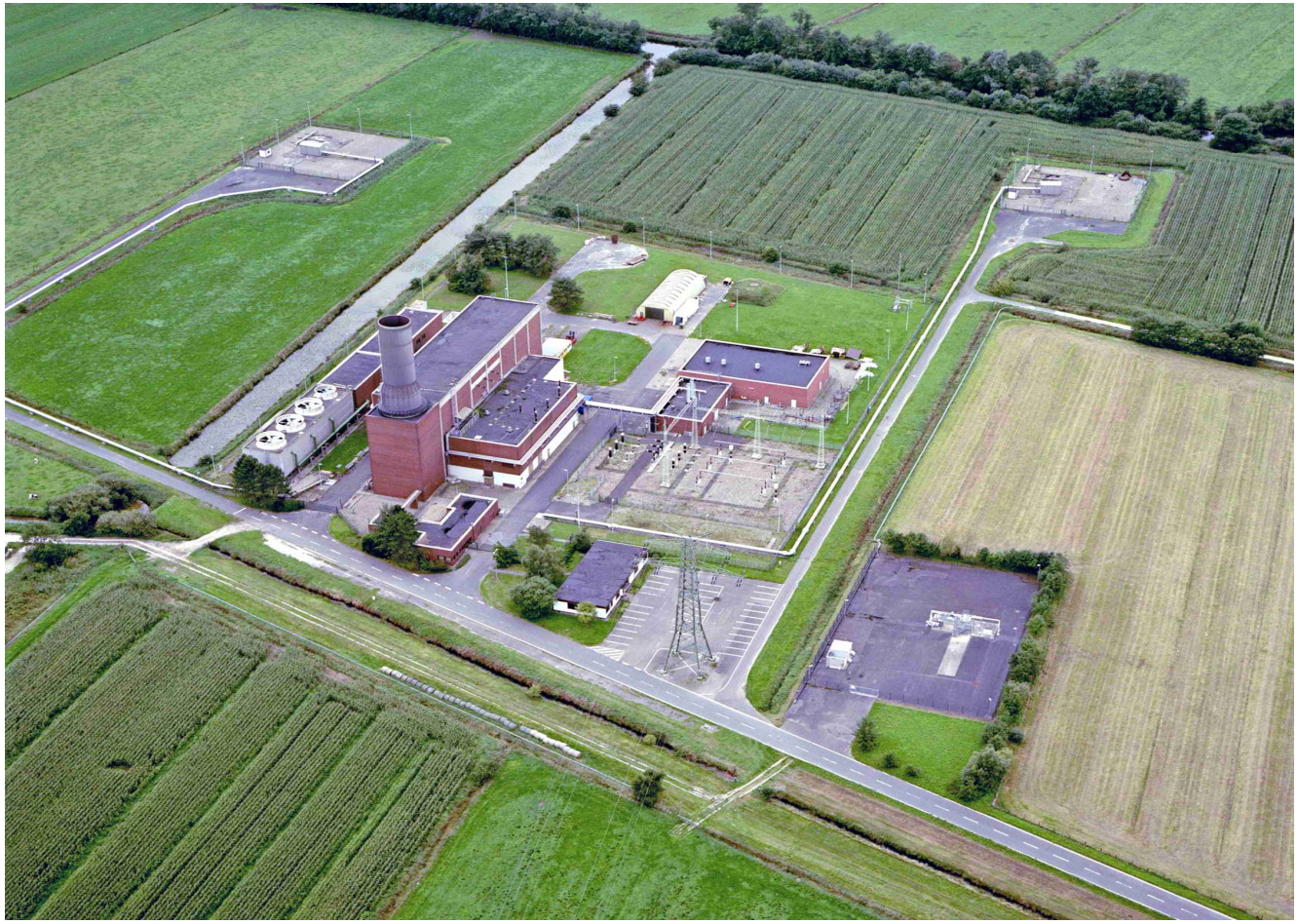
Huntorf as diabatic CAES is state of the art



Huntorf



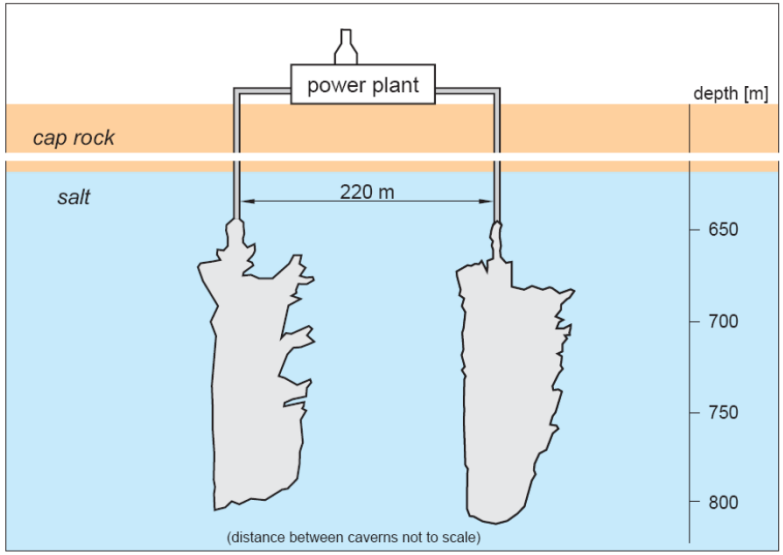
Huntorf as diabatic CAES is state of the art



Huntorf CAES – Key figures

Diabatic system – compression waste heat is not used

In operation since	1978
Power	290 MW
Production time	4h
Efficiency	42%
Ramp up time	10 min.
Ramp up time, warm start	6 min.
Air production rate	417 kg/s
Compression power	60 MW
Depth of Cavern	650 m
Cavern pressure	43-70 bar
Start per year	100-200



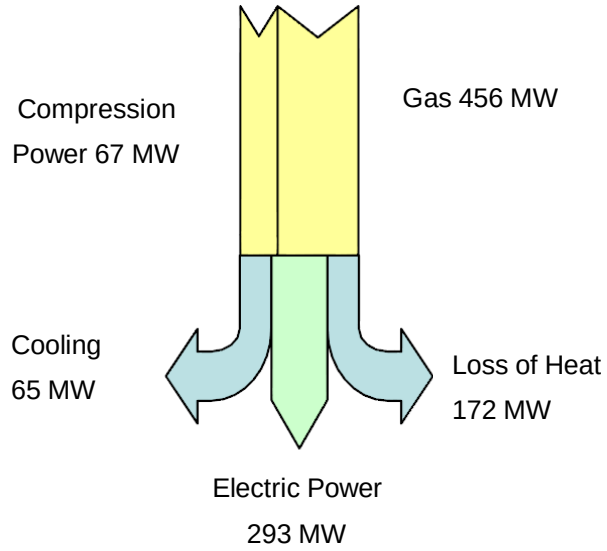
Note: ideal cavern depth for CAES is shallower than for the purpose of underground gas storage

Comparison of the two CAES sites

	Huntorf	McIntosh
Power	290 MW	110 MW
Prod. Period	4 h	26 h

Energy streams of the diabatic system

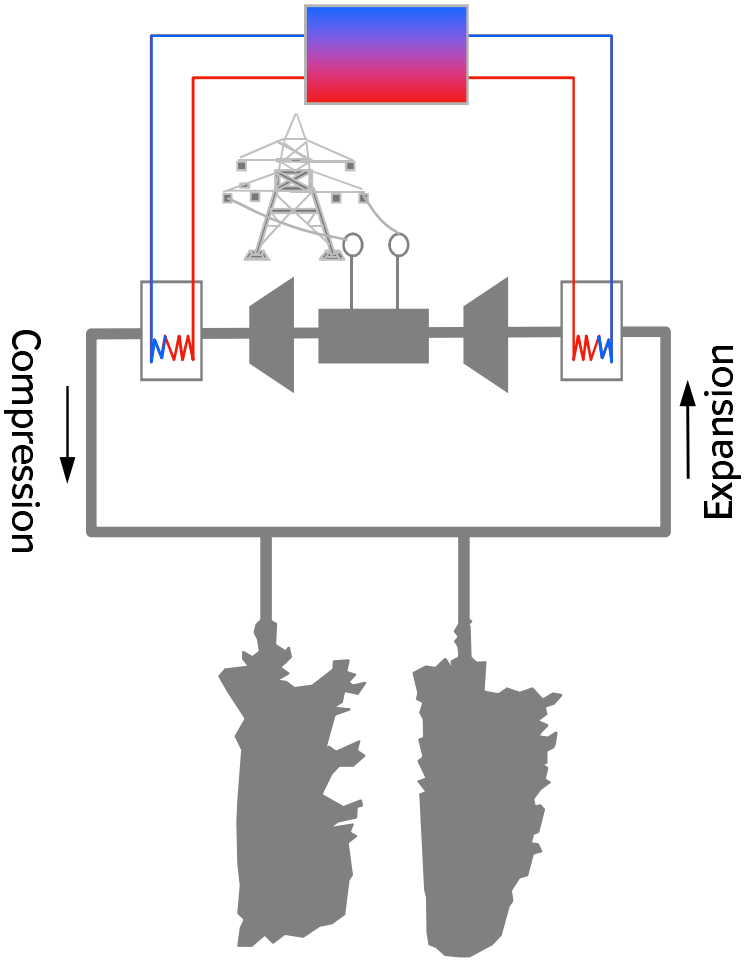
Diabatic CAES



Comparison of diabat with adiabat

	Diabat	Adiabat
Compress.	70 MW	150 MW
Load time	10 h	10 h
Compression Energy	700 MWh	1500 MWh_{el}
Production Energy	1000 MWh_{el}	1000 MWh_{el}
Storage Vol.	324 000 m^3	416000 m^3

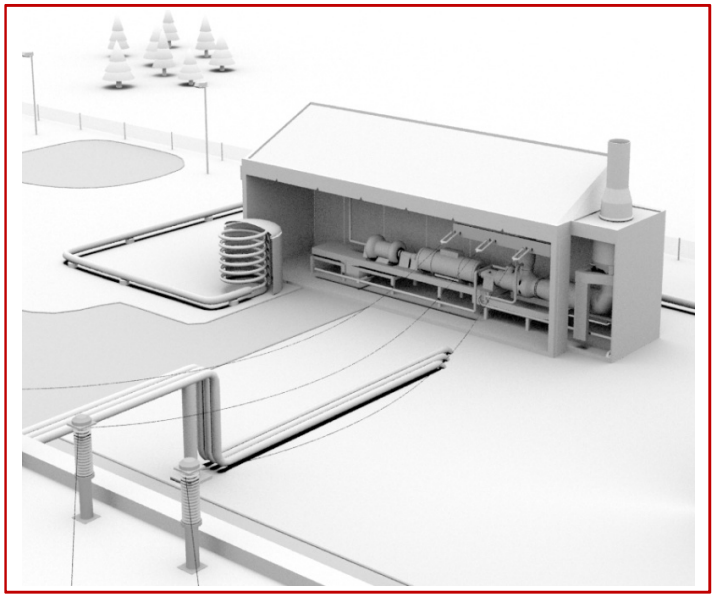
Adiabatic CAES (A-CAES)

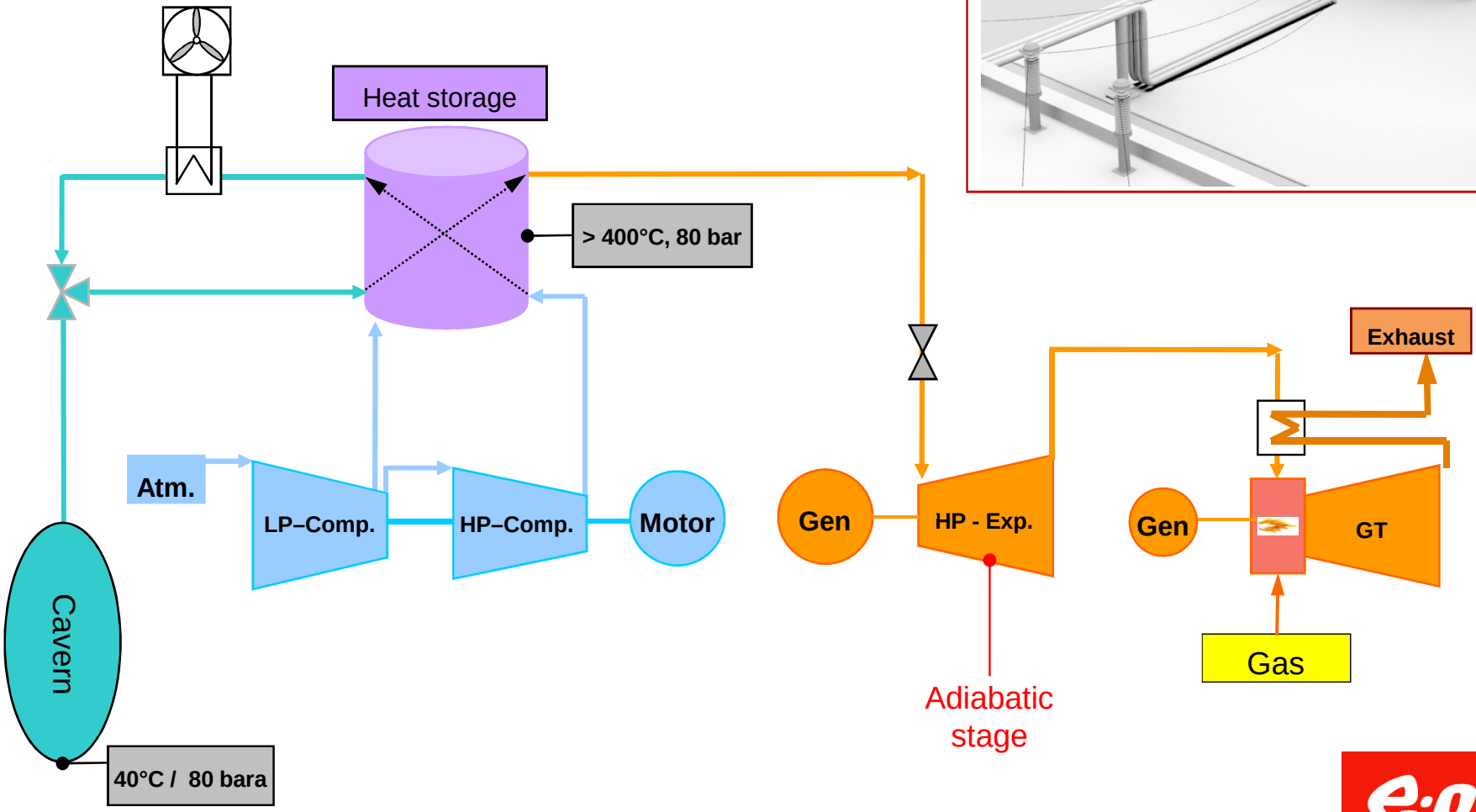


ADELE

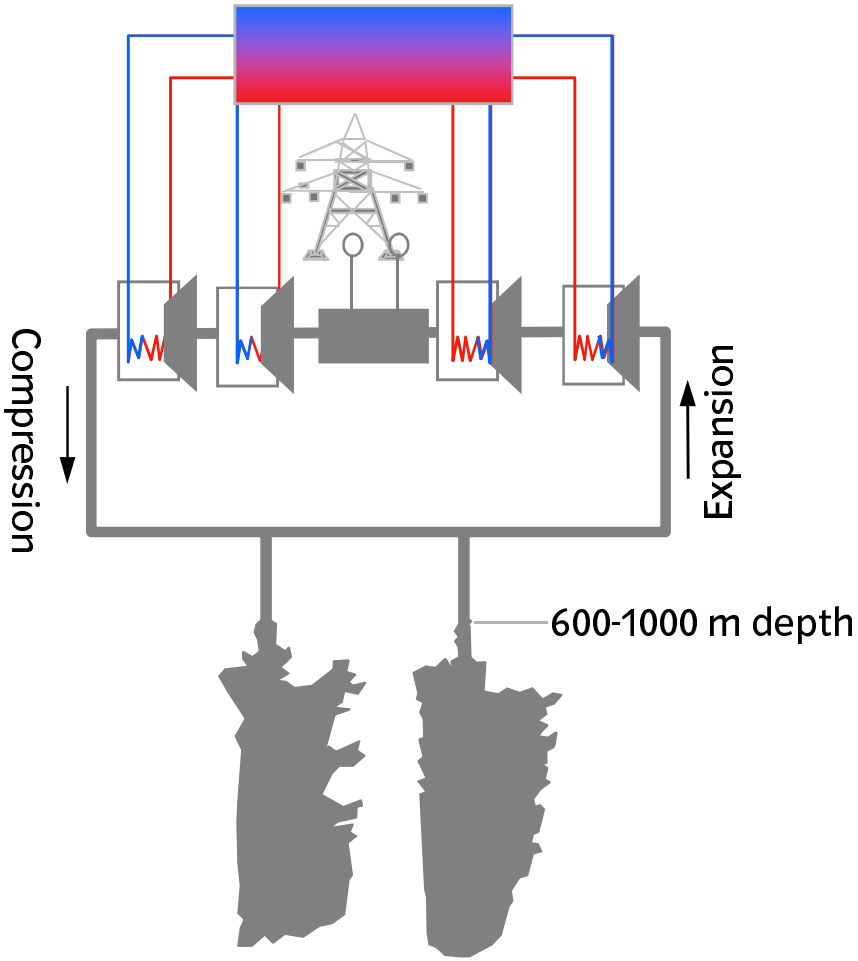
e·on

CAESplus concept

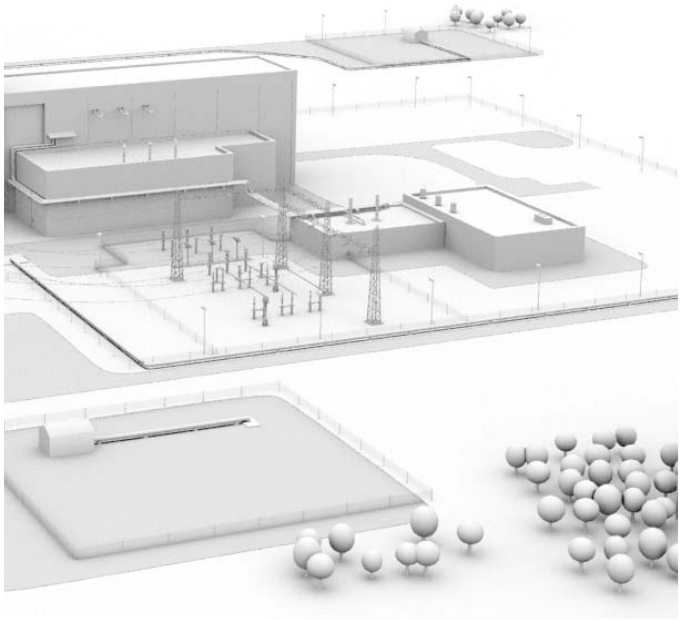




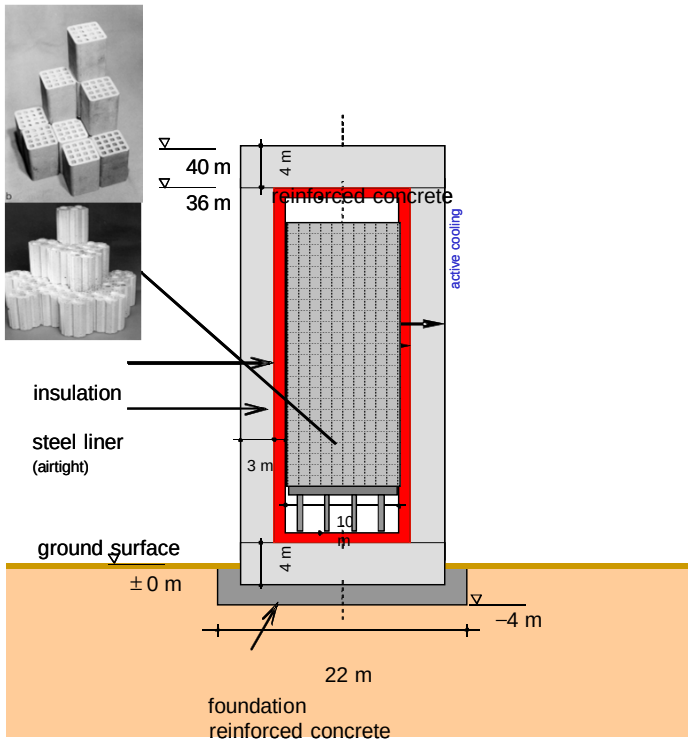
Low Temperature CAES (LT CAES)



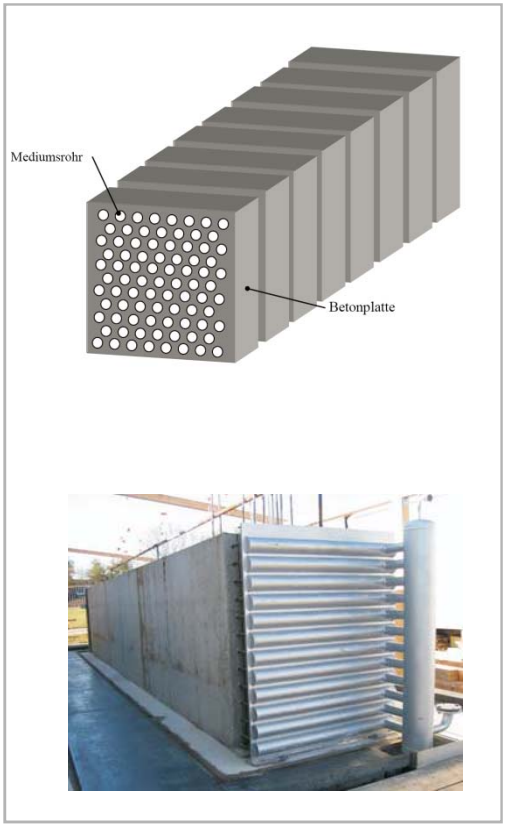
Allows to use water as heat storage medium.
Requires more compression stages.



The Challenge: Which is the appropriate heat storage?



Pressure tank



concrete

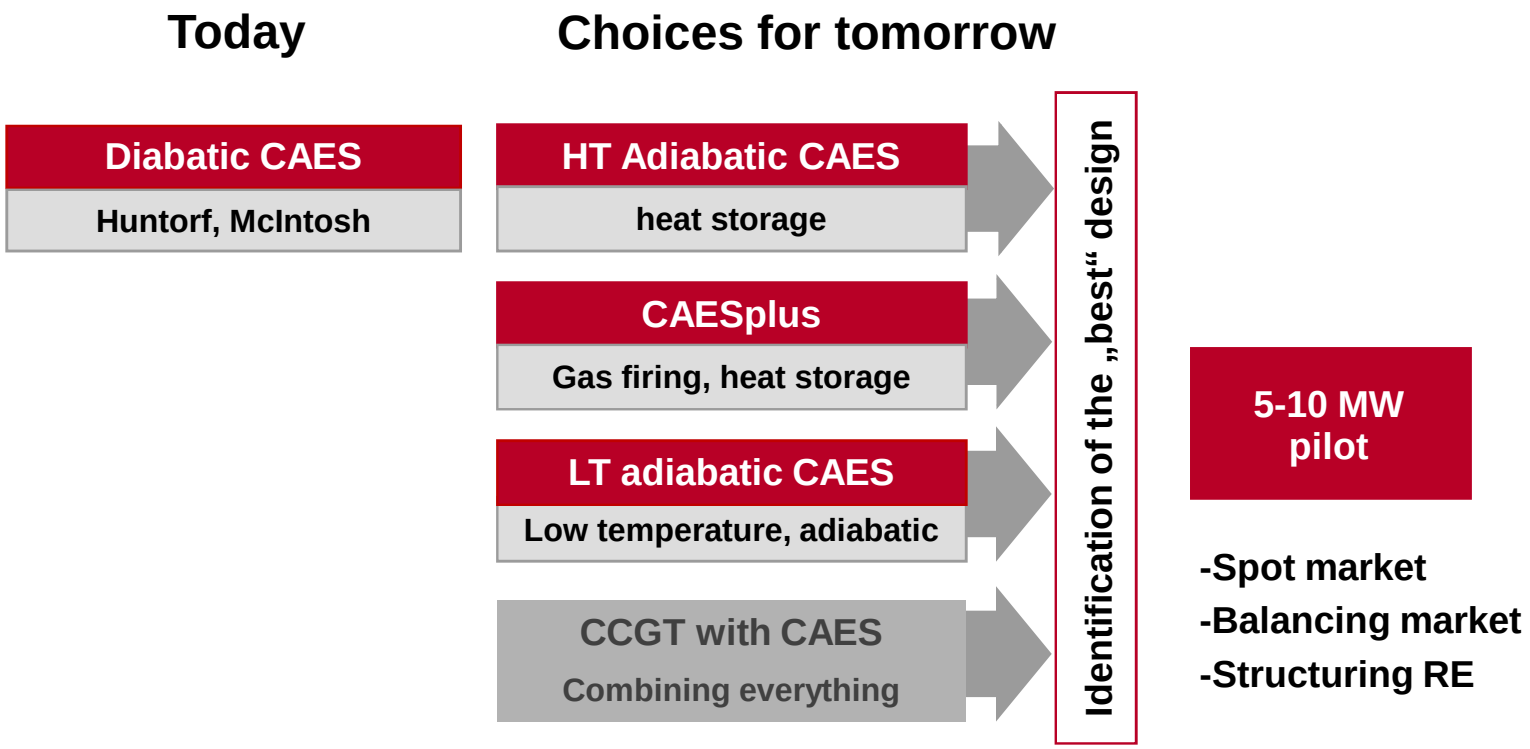
Oil or molten salt

Occurrence of salt deposits in Europe as geographical constrain for cavern based CAES

- Potential for wind power matches partly with the occurrence of salt deposits.
- It complements geographically pumped hydro.
- Potential is very high, however, there is a geographical constrain.

Artificial pressure tanks are the alternative.

Which is the best CAES concept?



1. Large scale solutions require salt caverns.
2. High temperature requires innovative components.
3. Low temperature solutions can use water as storage medium.
4. High temperature solutions are the choice to co-fire gas.

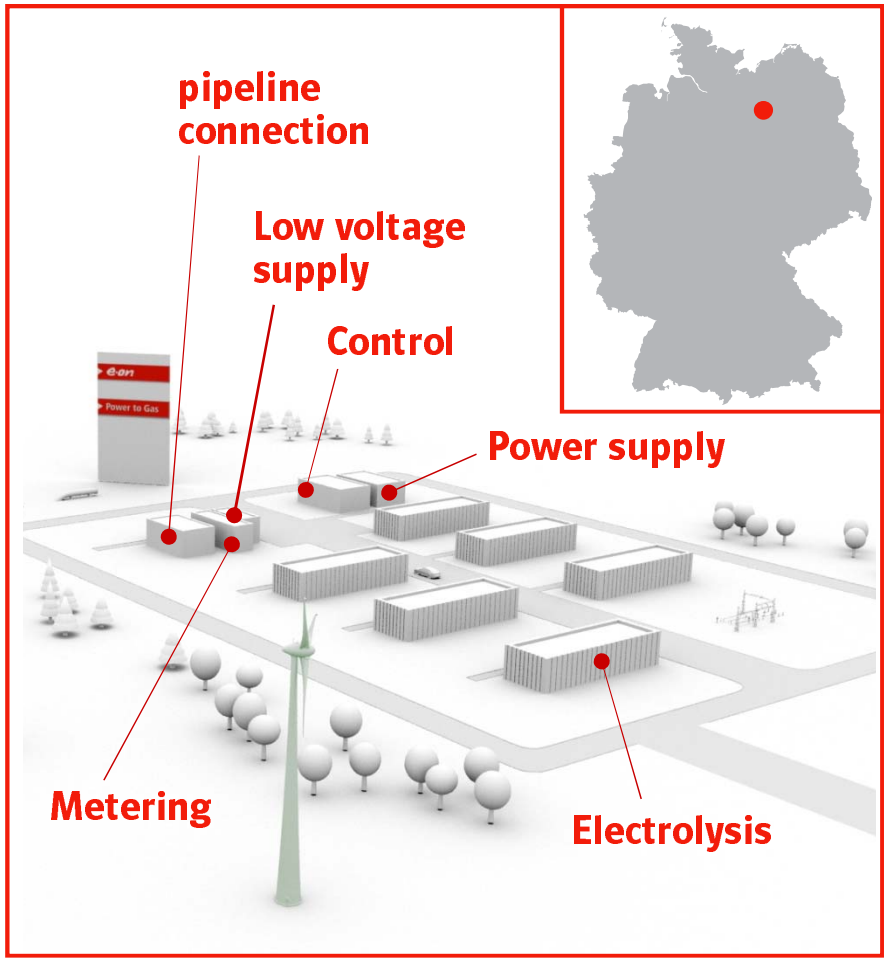
Further example: E.ON PtG-Pilot "Falkenhagen"

Key Parameters

- Power: 2 MW_{el}
- Hydrogen production: 360 m^3/h
- Fed into the local gas grid (ONTRAS)
- Planned start of operation Q3/2013
- Owner is E.ON Gas Storage

Goals

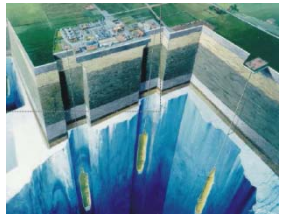
- Demonstration of the process chain
- Optimize operational concept (fluctuating power from wind vs. changing gas feed)
- Gain experience in technology, costs, consenting



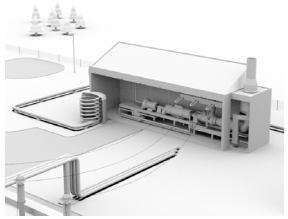
Thank you for your attention!

Summary

Energy storage is needed to integrate intermittent renewable energy generation.



CAES has the potential to be a competitive solution among batteries, power to gas, pumped storage plants and others. Different technologies render different services on spot and reserve markets.



CAES can also be built for decentralized applications. Which of variants is best, is not clear today.

Decentralized storage plants are widely accepted in the public