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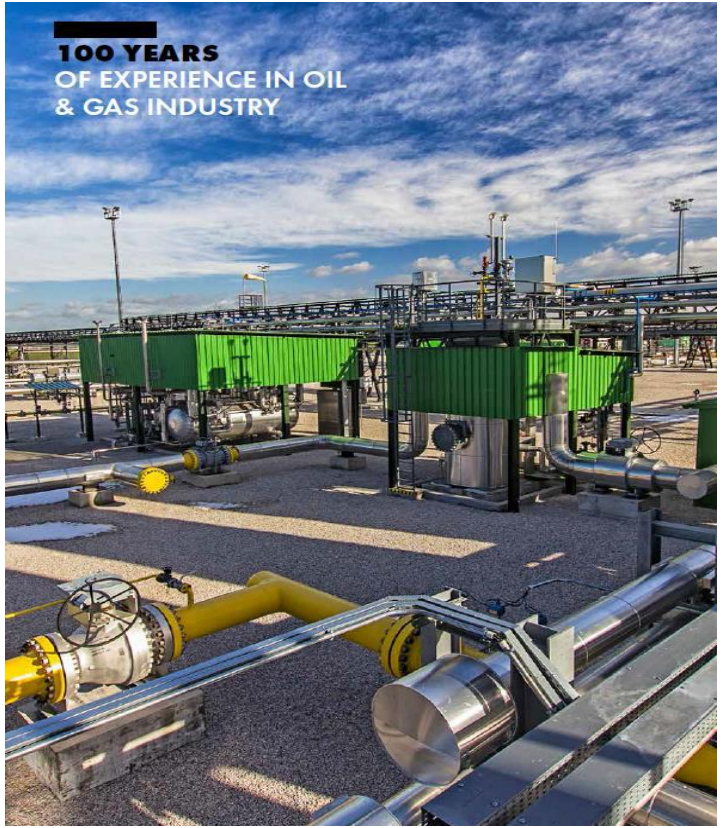
UTILIZING WASTE HEAT IN A GAS RESERVOIR ENVIRONMENT

Zavada Roman
NAFTA a.s.

WGCPARIS2015
WORLD GAS CONFERENCE

INTRODUCTION OF NAFTA a.s.



- Modern and innovative company
- Key underground gas storage operator in Slovakia – NAFTA´s current storage capacity amounts to **2,5** bcm
  - Max Withdrawal Rate **38,3** mcm/d
  - Max Injection Rate **31,9** mcm/d
  - Technical operator of UGS for third party

POZAGAS SPP Storage

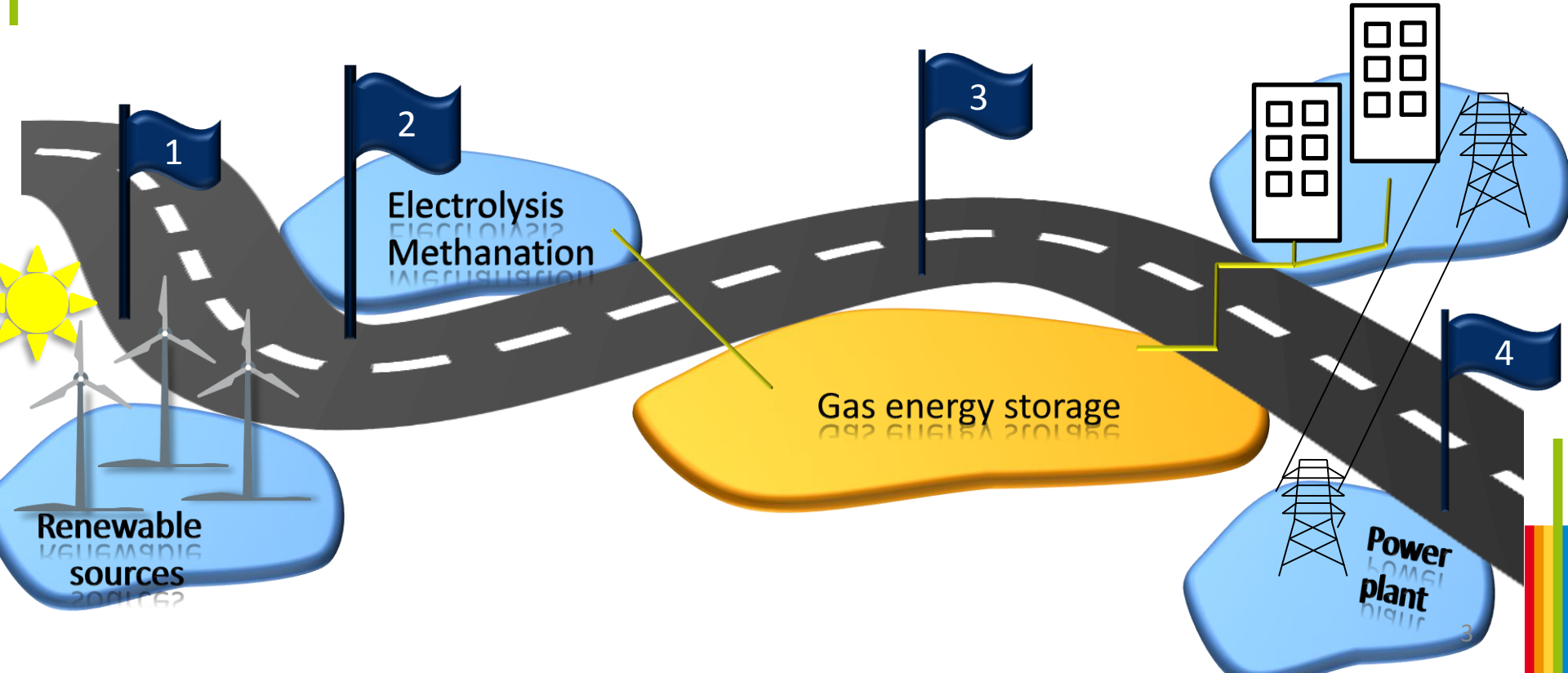
- More than **40** years experiences with gas storage and **100** years with exploration and production of hydrocarbons
- Partner of RAG in project **SunStorage**

UNDERGROUND SUN.STORAGE

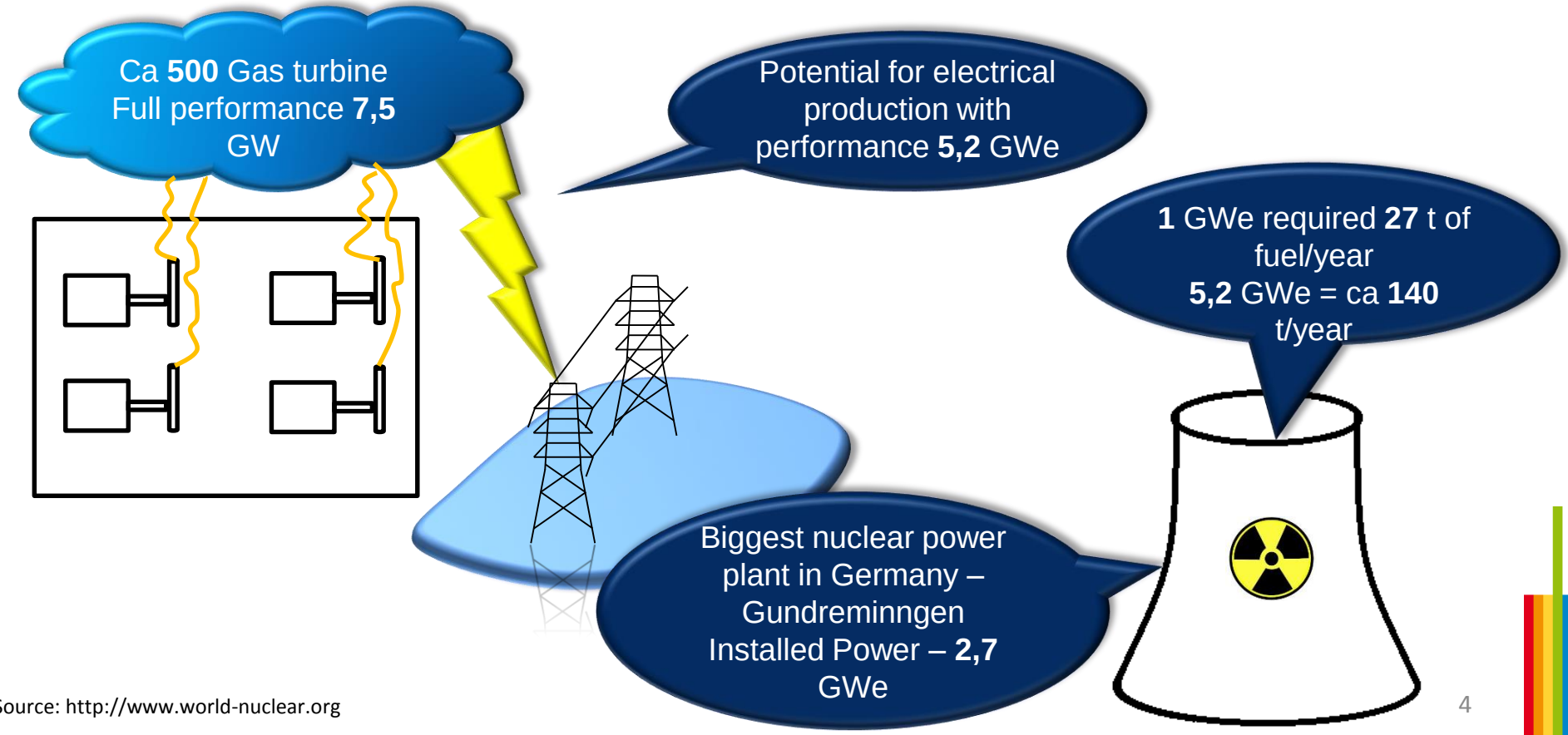
Source: www.nafta.sk as of 01.05.2015

Introduction

Natural gas and electricity are exchangeable sources, **but gas is storable**

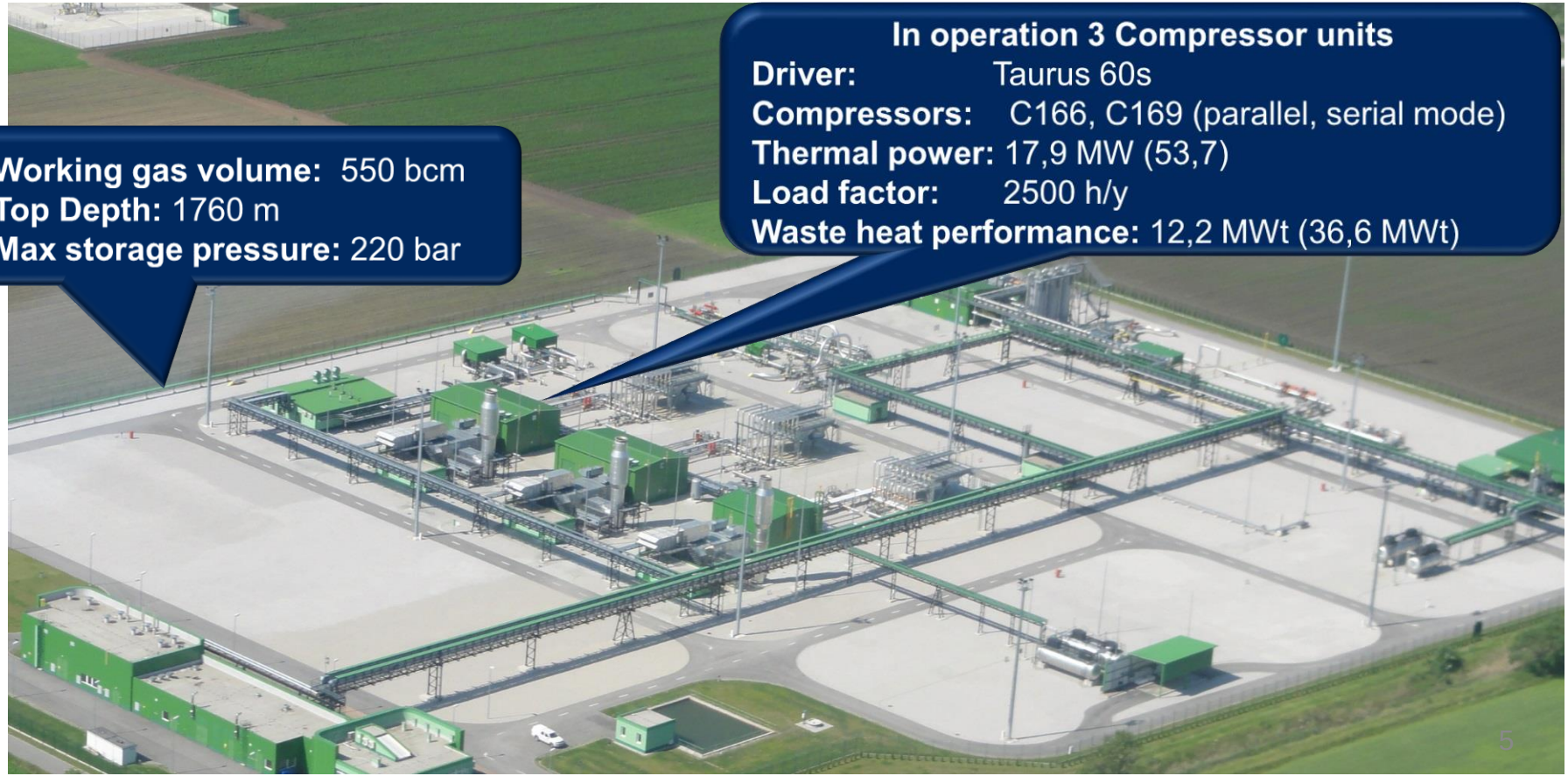


Waste heat recovery – Situation in the Europe



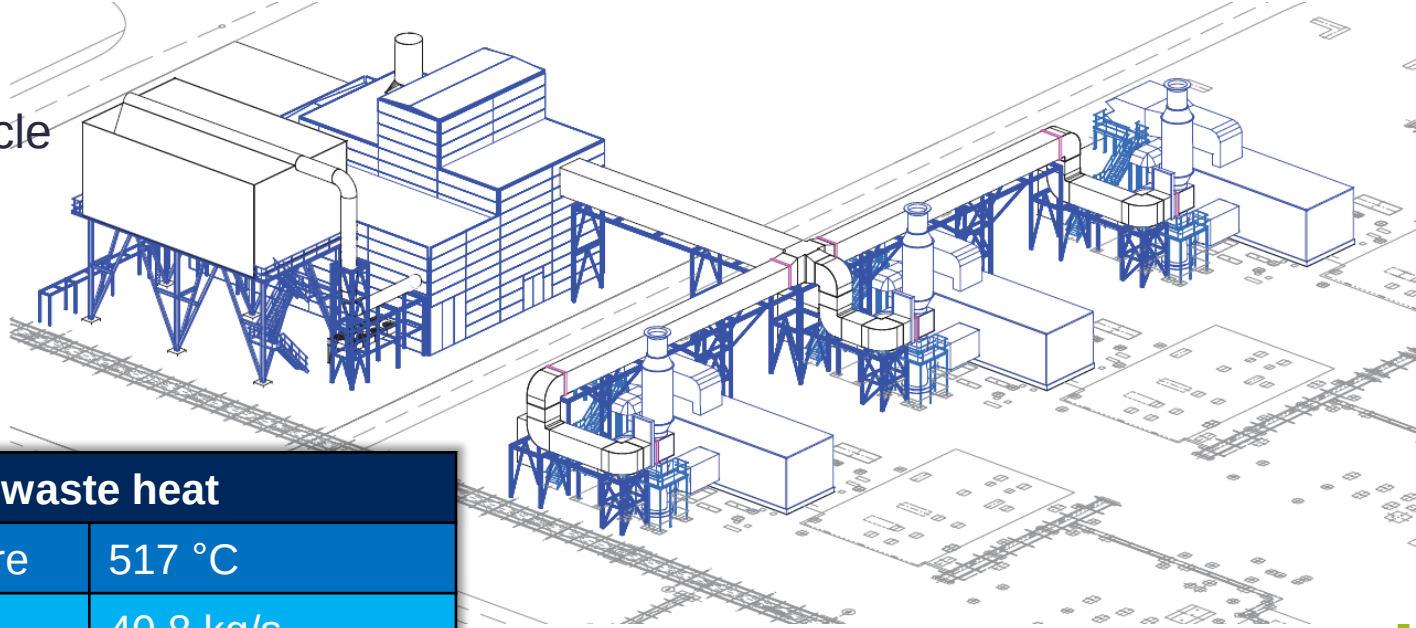
Source: http://www.world-nuclear.org

UGS Gajary Baden Slovakia



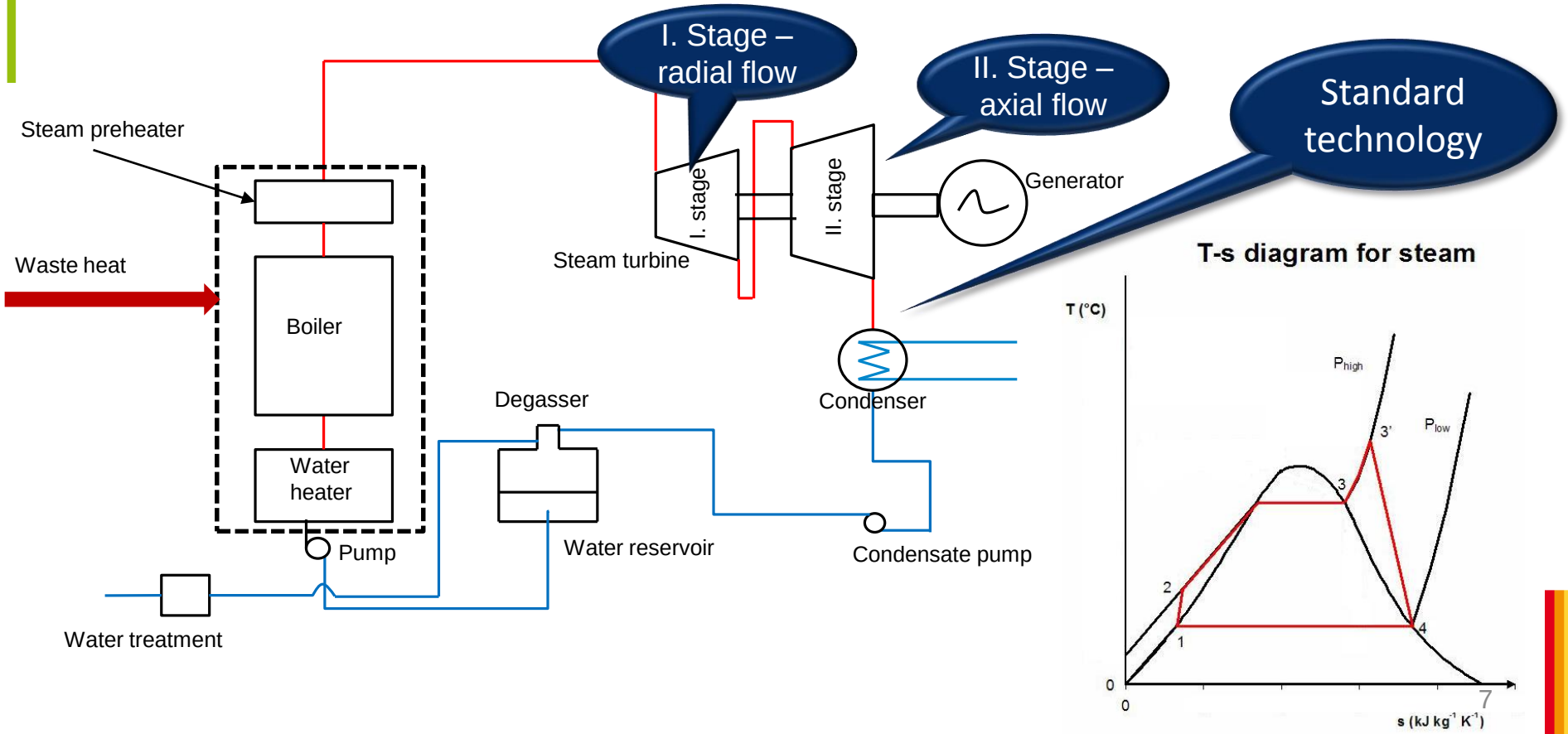
Feasibility study for using waste heat at UGS Gajary Baden

- **Methods**
  - Water steam cycle
  - ORC cycle



Design parameters of waste heat	
Exhaust gas temperature	517 °C
Exhaust gas flow	40,8 kg/s
Exhaust gas pressure	5000 Pag
Possible pressure drop in steam boiler	1500 Pa

Water steam cycle



Water steam cycle

Design parameters I. stage	
Water steam temperature	440 °C
Inlet water steam pressure	38 bar(a)
Water steam flow	18,2 t/h
Discharge water steam pressure	2,0 bar(a)
Discharge water steam temperature	178 °C

Design parameters II. stage	
Water steam temperature	178 °C
Inlet water steam pressure	1,9 bar(a)
Discharge water steam pressure	0,13 bar(a)
Discharge water steam temperature	50 °C

Design parameters - generator	
RPM	1500
Terminal power	3790 kWe

Steam turbine

- Simple double stage steam turbine
- Lower thermodynamic efficiency by 11 % compare to the multistage steam turbine
- Advantages of this type of steam turbine:
  - Small compact device
  - Quick start from cold state
  - Sealing system is not needed

Water steam cycle

Condenser

- Air cooler – lack of water in the area
- Large size due the noise emission limits
- Control of air cooler by VFD

Other technological devices

- Cooling for steam turbine oil circuit
- Chemical water treatment
- Thermal water treatment
- Control system

ECONOMICS	
Investment costs	8 400 000 €
Operation costs	€ 6 / MWh
Sales prices of electricity	€ 40 / MWh *
Load factor	2500 hours / year
Simple payback	20 years

Higher load factor 6000 h/year

Decreasing technology price

Higher efficiency

* Market price for electricity

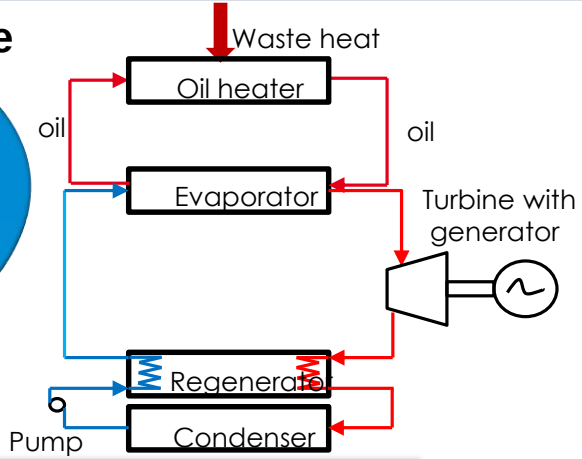
Organic rankine cycle

Advantages and disadvantages comp… cycle

- Higher price of organic fluid
- Lower vaporization heat
- Some of them are harm
- Lower vaporization te
- Simple construction o

Economically not feasible, compared to water steam cycle

- Lower terminal power
- Similar capex



Design parameters	
Used organic fluid:	n-Hexane
Organic steam temperature	120 °C
Organic steam pressure	248,1 kPa
Organic steam flow	66 t/h
Terminal power	1100 kWe

Economics	
Investment costs	9 000 000 €
Operation costs	€ 6 / MWh
Sales prices of electricity	€ 120 / MWh *
Simple payback	N/A

- State subsidized energy prices
- Prices are related to 2013

Conclusion

Water steam cycle and also ORC cycle are technically feasible but not commercially

Waste heat is still produced and also will be produced in the future

We are still looking for the solution, how to use this waste heat, because we have to care to use energy sources more efficiently

Thank you for attention !

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