H₂ Readiness Practical experiences

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Experiences in Vattenfall

- Retrofit of 3 x 440 MW CCGT Detailed feasibility study (2017-2019, NL)
- Participation in FlameSheet Burner

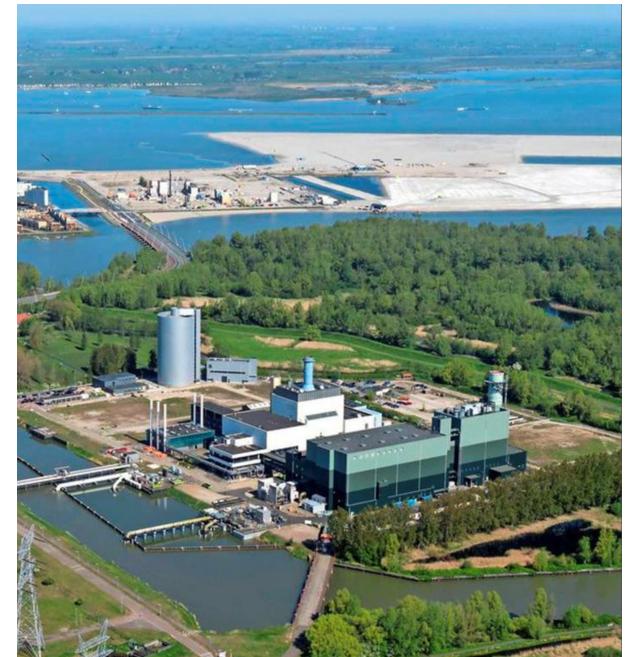
Development program led by Thomassen Energy (2019-2023)

Development new H₂ –Ready GT-CHP

Part of investment program for coal phase out (2020-2024, GER)

• Retrofits of CCGT-CHPs in NL (Diemen)

Initial feasibility studies (2023-2024, NL – Diemen; 440/260 & 250/180 MW_e/MW_{th})





Core Technology

- Two step approach:
 - Co-firing H₂ with NG in existing burners up to XX vol% with limited modification
 - XX..100 vol% with complete burner exchange
- Technology providers:
 - GT OEMs
 - Third parties
- Key characteristics:
 - Fuel flexibility NG-H₂
 - Emission control (diffusion vs pre-mix)
 - Startup fuel
 - Possibilities are evolving



Hydrogen supply

Infrastructure development

- Development of infrastructure needs to be synchronized with development or retrofit of plant
- Storage as part of the infrastructure is key due to demand and supply do not match
- Hydrogen sourcing:
 - Types of hydrogen
 - Blue hydrogen
 - Green hydrogen
 - Origination
 - Local production
 - Imports (e.g. ammonia)





Engineering Considerations

Fuel supply

- One or separate NG & H₂ pipeline(s)
- NG & H₂ Blending
- Required supply pressures
- Fuel compressor required?
- Materials & components suitable for H₂

Emissions

- Regulations & permit
- Diffusion vs DLE
- SCR

Permiting

- Emissions
- Other permit requirements

Operation & Performance

- Heat & Mass Balances
- Derating vs lifetime of hot gas parts
- Fuel flexibility (NG/H₂)
- Start-up (NG or other secondary fuel)
- Flue gas Condensation
- Debottlenecking (e.g. HRSG, Generator)

Future Proof Design

- Design future scope, equipment, systems)
- P&IDs
- Single Line
- 3D Modelling

HSE in Design

- Fire Safety
- Explosion Safety (ATEX-zoning)

Construction

Decide what to pre-construct

Certification

- Required?
- Design/build/retrofit

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- Impact on maintenance (LTSA, Derating?)
- Training of staff





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