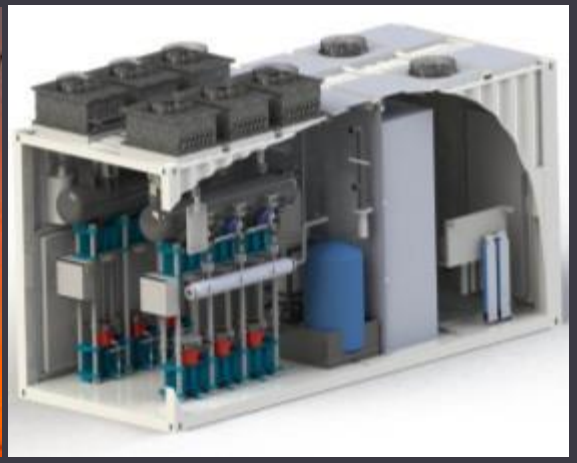
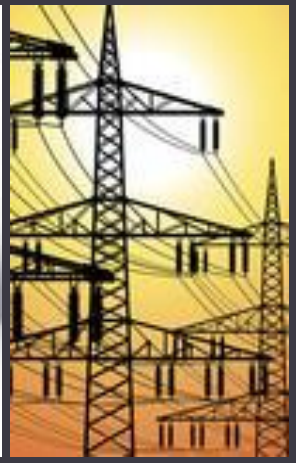
POWER-TO-GAS IN SMART GRIDS

29 JUNE 2016, SGTF, BRUSSELS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POWER-TO-GAS

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Contents

- Smart Grids
- Power-to-Gas: A Grid Balancing Tool
- Rapid Response P2G Plant
- Next Steps

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SMART GRIDS

- Two 20th century energy grids (electricity and natural gas)
- Similar but important key differences
- Mutually supportive?
- Decarbonise one or both?
- Power-to-gas systems facilitate smart use of the gas grid by the electricity grid

P2G

Value to the Power Grid

- Avoided wind curtailment
- Avoided infrastructure upgrades
- Reduce CO_2 impact of OCGT's
- Help manage voltage and freq.

Value to the Gas Grid

- Decarbonising gas
- Providing renewable heat
- Reducing GHG emissions from gas transportation

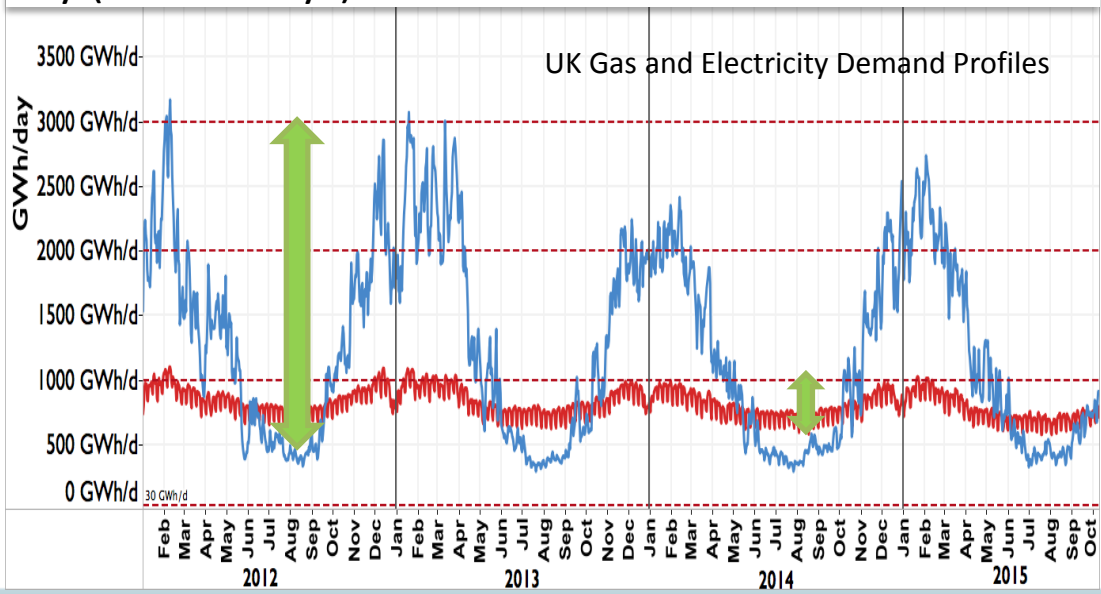
Value to the Economy

- Reducing fuel imports
- Reducing emissions
- Improving energy security
- Creating jobs in manufacturing

GAS GRID CHARACTERISTICS

Relative to the electricity grid:

- Transports energy of 200 gCO_2/kWh carbon intensity
- Transports more energy per annum (EU ~19,000 TWh gas versus 3,000 TWh electricity)
- Satisfies a much greater variation in transient demand
- Very well suited to meeting peak heat demands
- Has substantial inherent storage capacity (several days)
- Well hidden (under the ground)
- Almost 100% combustion efficiency

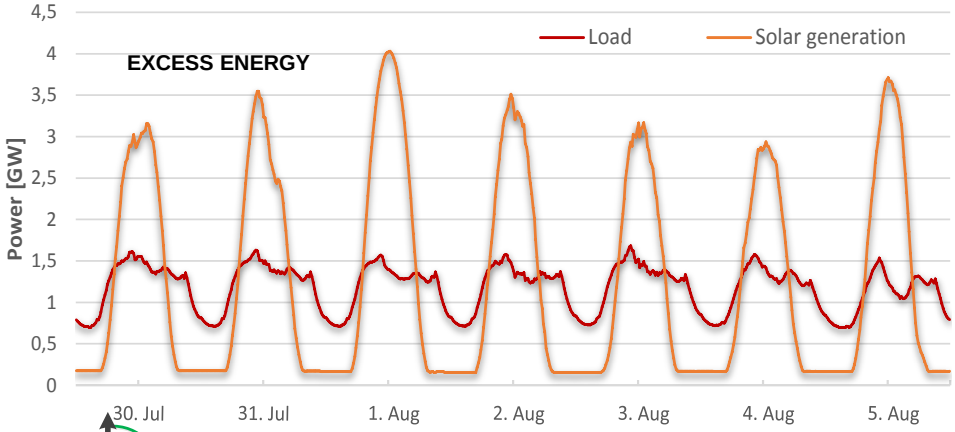


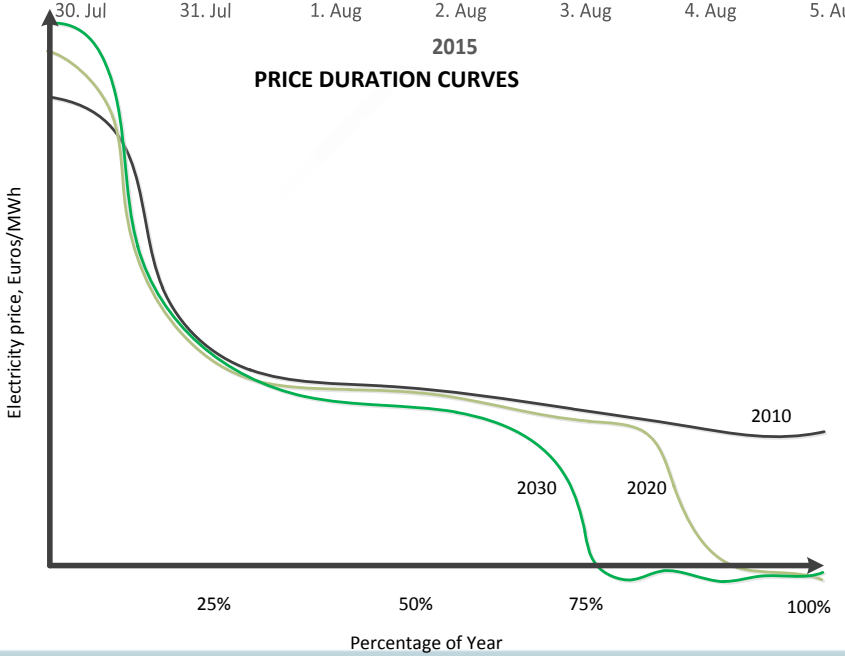
TOWARDS HIGH RENEWABLES

- Demanding decarbonisation targets
- Increasing renewables

Results in:

- Lower-carbon electricity ✓
- Excess energy in the power system ✗
- Wasting captured renewable energy ✗
- Decreasing system inertia ✗
- Increasing grid balancing requirements ✗





POWER-TO-GAS

A GRID BALANCING TOOL

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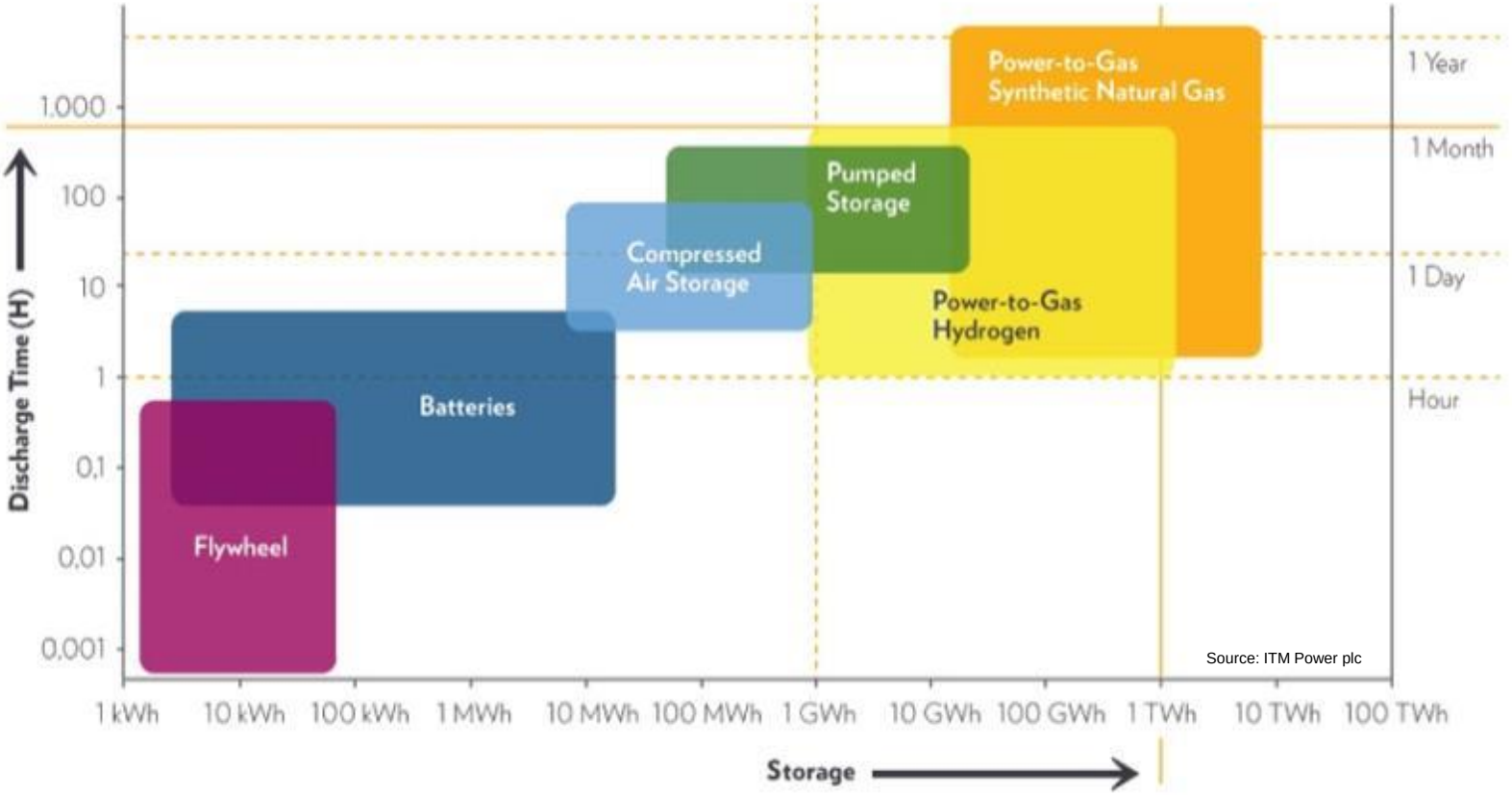
ENERGY STORAGE TECHNOLOGIES

Power-to-gas comparative position



ENERGY STORAGE TECHNOLOGIES

ENERGY STORAGE | CLEAN FUEL

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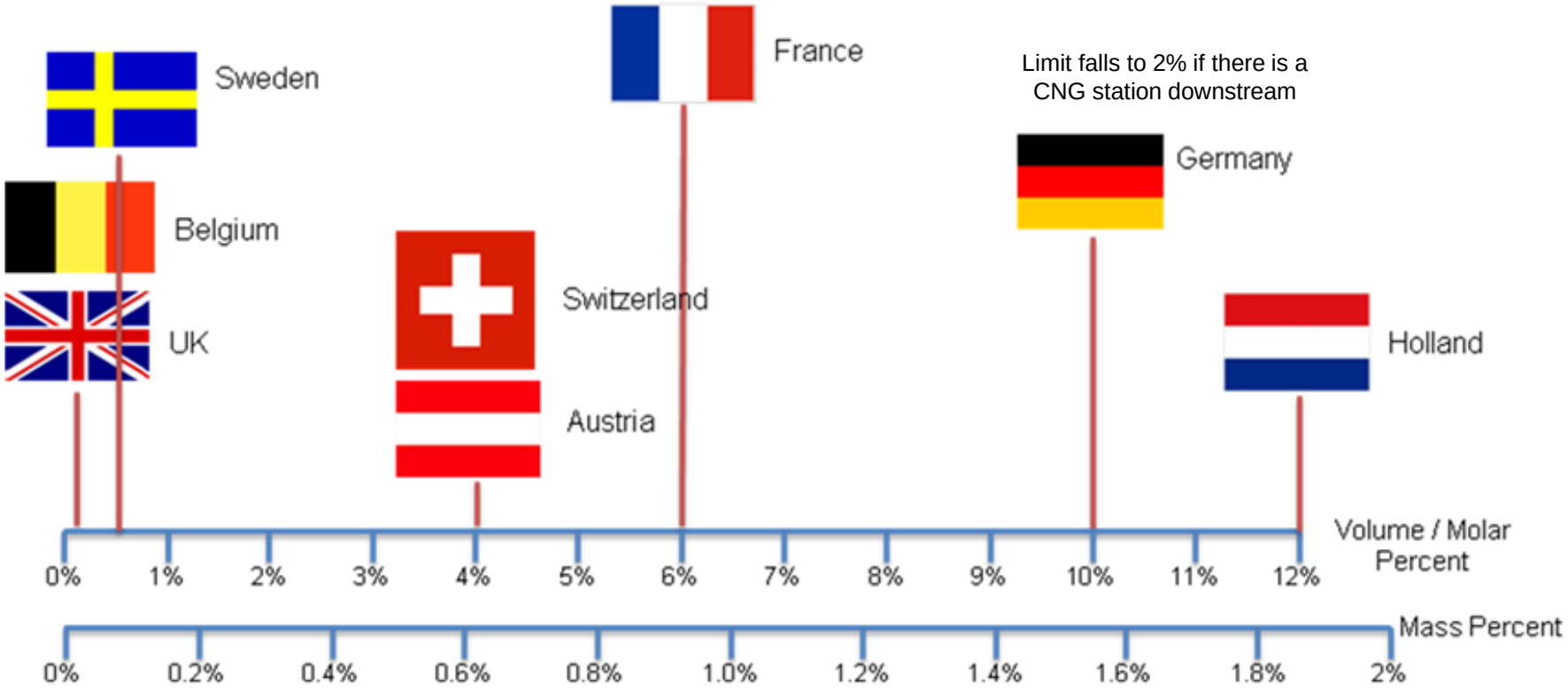
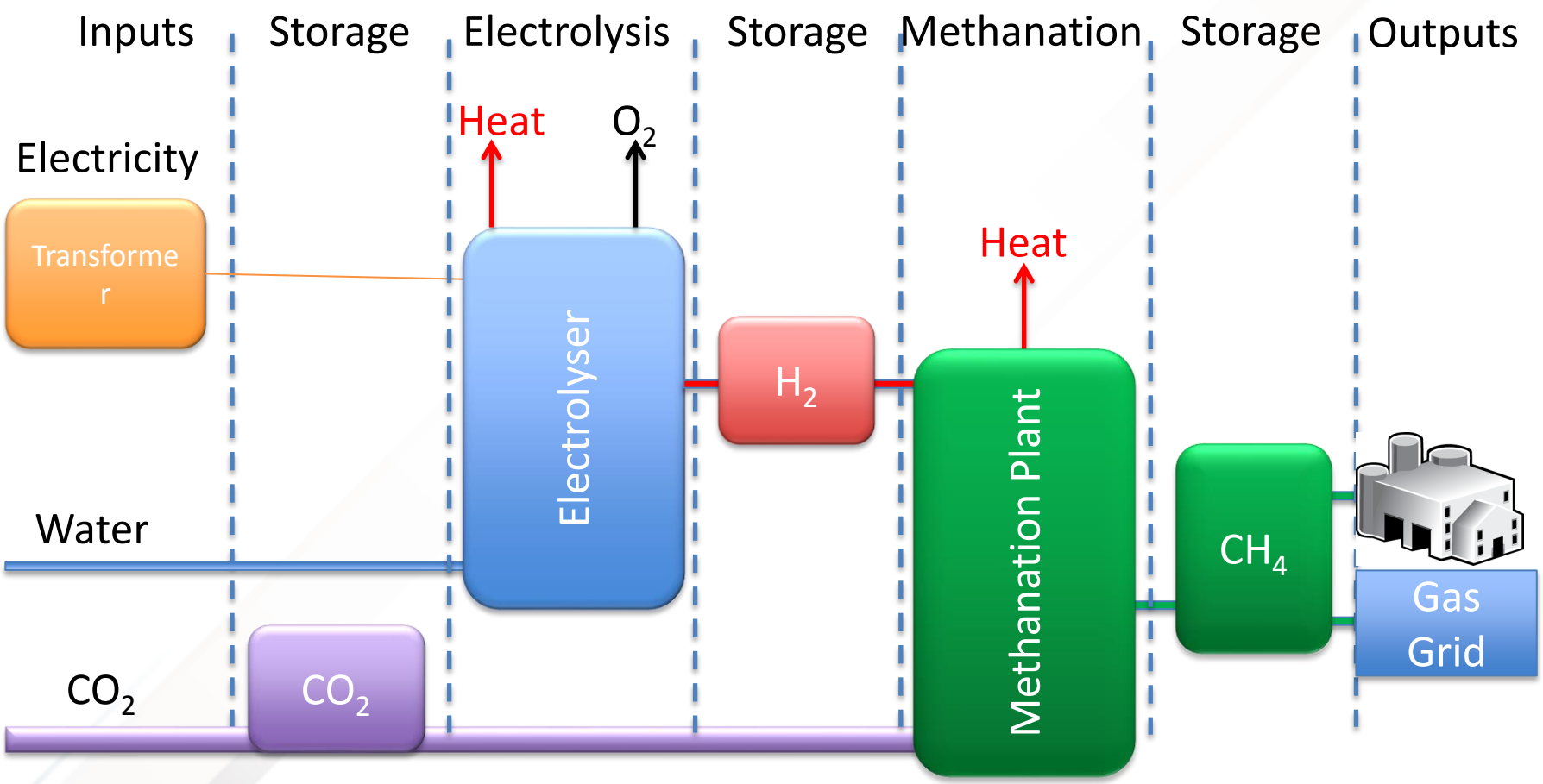
EU Hydrogen Limits for Injection into the Gas Grid

Covered by a range of local rules

Note: interpretation of these rules is complex



SNG POWER-TO-GAS



SYNTHETIC METHANE POWER-TO-GAS

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P2P OR P2G ENERGY STORAGE?

1. Power-to-Gas

- Gas grid = a large capacity conveyor/store that is largely sunk capital
- Hydrogen can be accommodated and combusted at small H2/NG concentrations
- SNG (via methanation of H_2 & CO_2) can be injected in large amounts (10's/100's of TWh)
- Annual utilisation factor for P2G can increase with renewables penetration

2. Power-to-Power

- P2P is constrained by electricity buy/sell price structures
- P2P is constrained by the irregular pattern of excess energy availability
- Annual utilisation factor for P2P becomes limited as renewables penetration increases

P2P OR P2G ENERGY STORAGE?

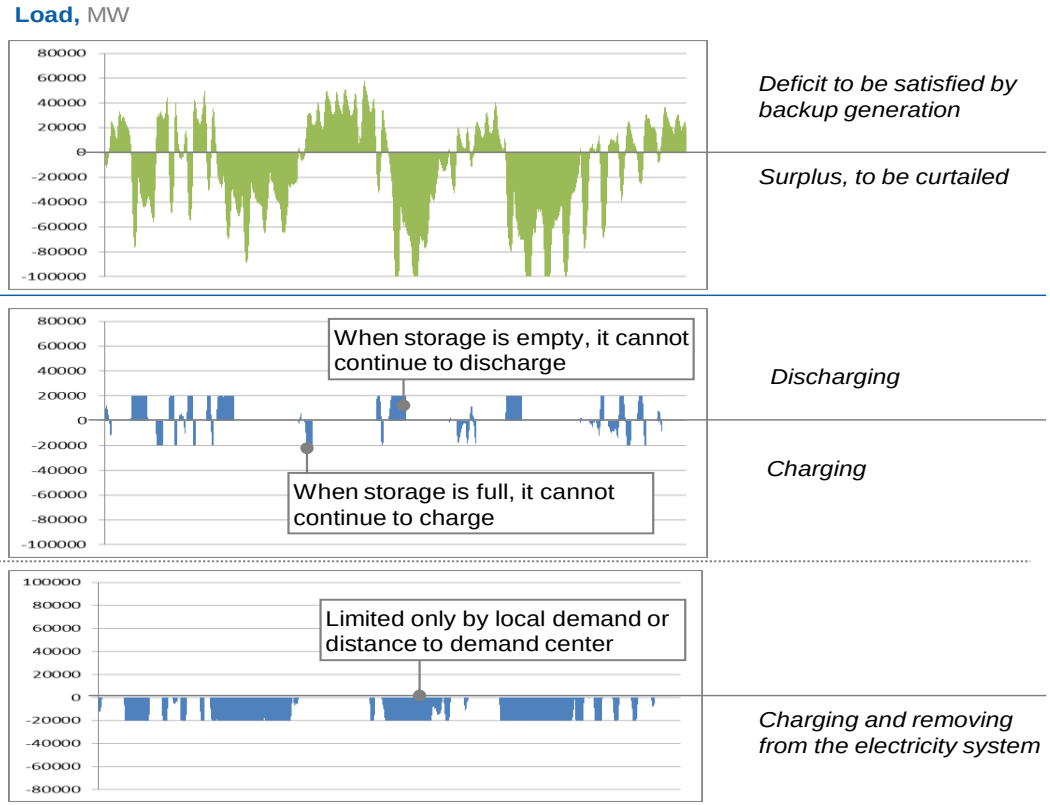
Low energy capacity is a limiting factor for utilization

Germany; High RES; March 2050

Starting point – periods with excess energy and deficit

P2P storage with limited energy capacity[1] can only utilize part of the excess electricity…

….while utilization is less limited for conversion to hydrogen



Source: Commercialisation of Energy Storage in Europe, FCHJU, 2015

1 1:8 power to energy example, 20GW power capacity

RAPID RESPONSE P2G PLANT

THUGA, FRANKFURT
RWE, IBBENBUREN

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PEM ELECTROLYSER PLATFORM

Rapid response on-site electrolysis

- Modular design
- Input water clean-up
- Power conversion
- Pressurised electrolysis
- Thermal management system
- Hydrogen purification
- PLC control and data comms
- Remote operation
- CE Marked
- Assistance with site approvals

A MODULAR OFFERING

HYDROGEN ENERGY SYSTEMS

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GAS MIXING & INJECTION PLANT

Ensuring compliance with the gas grid

- Hydrogen is injected directly into the gas distribution network
- Hydrogen concentration must not exceed 2%
- Controlled mixing of gases
- Dew point of H_2/natural gas mix must be <200mg/m^3
- Compliance: DVGW-ABG260 | TUV
- ITM have a partnership with NRM

NetzDienste RheinMain

DIRECT HYDROGEN INJECTION

HYDROGEN ENERGY SYSTEMS

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P2G SYSTEMS

1. Thuga P2G plant, Frankfurt

- 315 kW nominal, 385kW max
- Up to 77% efficiency (HHV)
- 60 Nm3/h hydrogen, 99.8% purity
- 2% H2 concentration limit
- Injection into 3.5 bar gas network
- Primary and secondary grid balancing

2. RWE P2G plant, Ibbenburen

- 150kW
- 86% efficiency (HHV)
- 30 Nm3/h, 99.9% purity
- 14 bar
- 2% H2 concentration limit
- 60kW heat recovery from stack water (offsetting 360 kW of gas burner use at pressure let-down station in gas grid)

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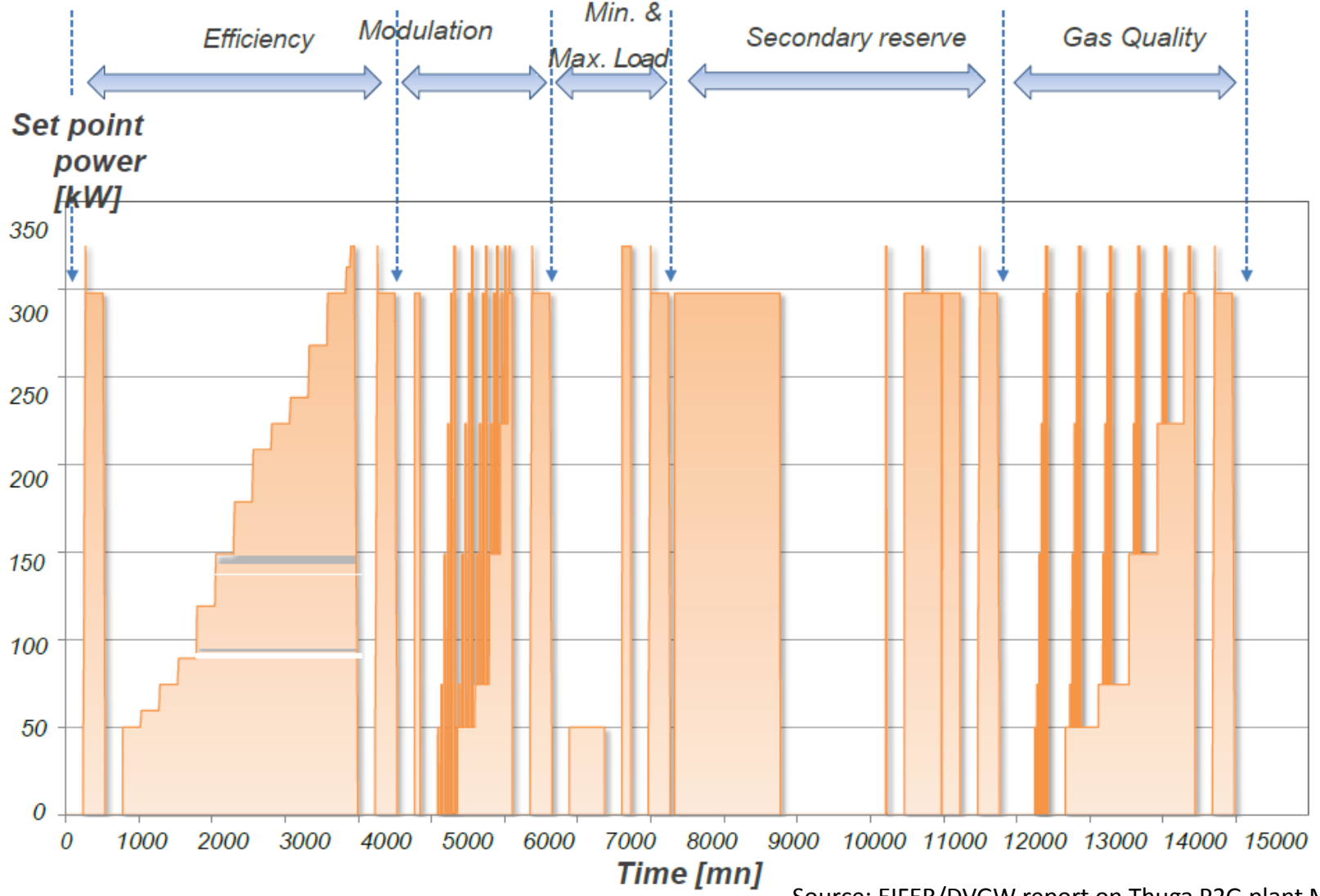

Source: EIFER/DVGW report on Thuga P2G plant March 2015

FIELD TESTING AND GRID SERVICES

HYDROGEN ENERGY SYSTEMS

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COMPLIANCE

CE Directives

- Approval of pressure vessels
- Witnessed pressure tests
- Acceptance of ATEX safety case
- Electro Magnetic Compliance
- Machinery Directive documents & technical file

- 5 boxes!
- Difficult translation of technical documents

NEXT STEPS

- Agree a policy framework for enabling P2G across the EU
- Agree hydrogen concentration targets for HP and LP gas networks, across the EU
- Agree balancing services provision and payment levels for P2G with electricity and gas grid operators
- Agree Feed-in-Tariff levels (or similar) for injecting hydrogen or SNG into the gas grid
- Ease the permitting process across the EU for P2G systems