Underground Hydrogen Storage

Application of UNFC – Injection Projects

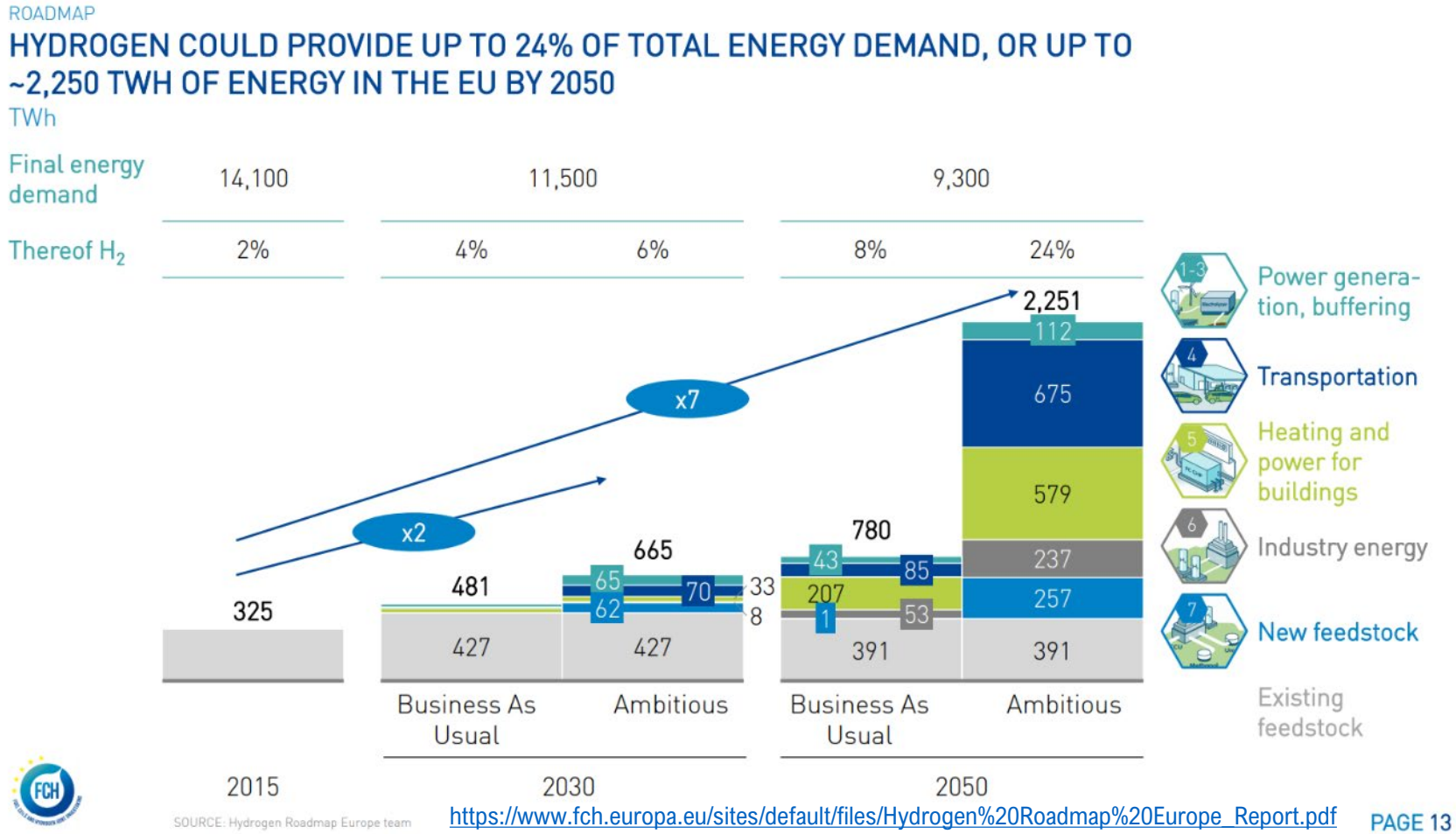
RESOURCE MANAGEMENT WEEK 2021

ENABLING SUSTAINABILITY PRINCIPLES IN RESOURCE MANAGEMENT

UNECE

Hydrogen

Forecast of Production & Demand



Underground Hydrogen Storage

Expected demand for large scale storage

UNECE

Natural Gas - FACTS

Key drivers for storage

- Heating (seasonal demand)
- Back-up power generation (peak demand)
- Arbitrage, Import dependency

Global:

- 2019 gas demand: ~3.986 bcm[1]
- 2019 gas storage market size: ~483 bcm[2]
- Ca. 10% of demand in storage

EU:

- 2019 gas demand: ~470 bcm[3]
- 2019 gas storage capacity: ~105 bcm[4]
- 2019 storage levels: ~90%[5]
- Ca. 20 - 22% of demand in storage

Large scale underground storage and transport will be essential to meet potential demand between 2030 and 2050

Hydrogen - OUTLOOK 2030/2050

Key drivers for storage

- Variable production renewable vs demand (peak)
- Heating (seasonal demand)?
- Arbitrage, Import dependency?

EU 2030[6]:

- Hydrogen demand 481 – 665 TWh
- Assumption 10 - 20% storage: ca. 16 bcm – 44 bcm

EU 2050[6]:

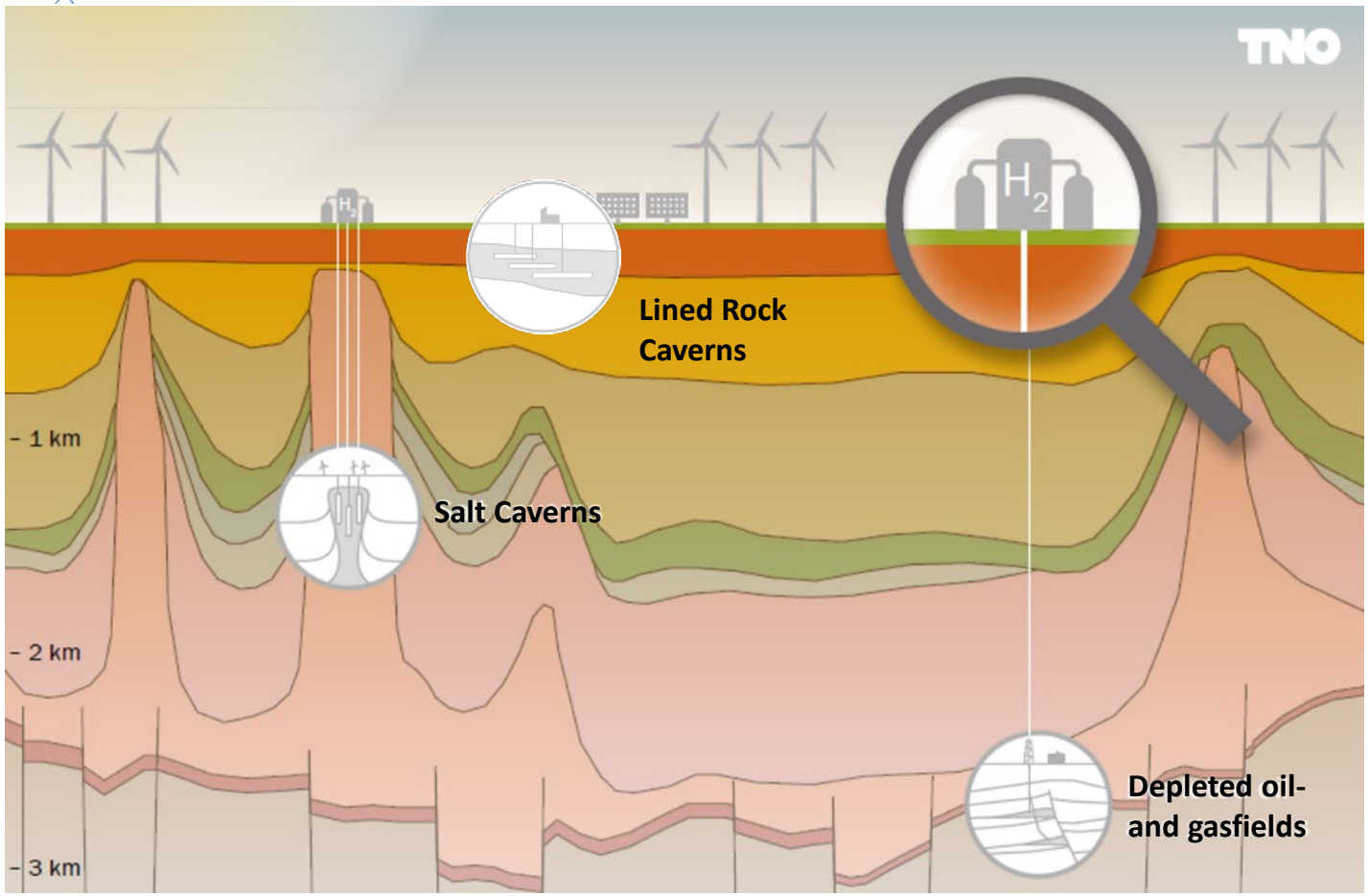
- Hydrogen demand 780 – 2.251 TWh
- Assumption 10 - 20% storage: ca. 26 bcm – 150 bcm

(bcm = billion cubic metres)

1) IEA 2020: Natural Gas Information: Overview
2) Grand View Research 2020: Natural Gas Storage Market Size, Share & Trends Analysis Report
3) Statista 2020: Natural gas consumption in the European Union from 1998 to 2019
4) GIE gas storage database (dec. 2018)
5) EC – DG Energy 2019: Quarterly Report Energy on European Gas Markets
6) FCH-JU 2019: Hydrogen Roadmap Europe

Underground Hydrogen Storage

Geological and Technical Feasibility



Salt Caverns:

- Concept proven
- Demonstrate safety & fast cyclic storage

Gasfields / Aquifers & other stores

- Concept to be proven
- Assess geological feasibility
- Pilot/demonstration needed

Long lead times for demonstration and development (10-15 years) !

Groenenberg, R.M. et al., Large-Scale Energy Storage in Salt Caverns and Depleted Fields (LSES) – Project Findings (2020). TNO report 2020 R12006. Link

IEA Hydrogen TCP

https://www.ieahydrogen.org

New Task - Underground Hydrogen Storage

UNECE

CONTRACTING PARTIES

1	Austria	10	Germany	19	Norway
2	Australia	11	Greece	20	Portugal
3	Belgium	12	Israel	21	Spain
4	Canada	13	Italy	22	Sweden
5	China	14	Japan	23	Switzerland
6	Denmark	15	Korea	24	UK
7	EC	16	Lithuania	25	UNIDO
8	Finland	17	Netherlands		
9	France	18	New Zealand		

SPONSORS

1	HyChico (Argentina)	4	RIL (Reliance Industry Limited, India)	
2	Hydrogen Council (International)	5	Shell Global Solutions (International)	
3	NOW GmbH (Germany)	6	Southern Company (USA)	

- **IEA-TCP**: Global technology network open to IEA members and non-member countries, cross-cutting energy topics
- **Objective**: to advance the research, development and commercialization of energy technologies and related issues
- **Hydrogen TCP**: over 40 R&D&D and analysis tasks (since 1977)
- Currently 25 contracting parties and 6 sponsors
- **New task**: Underground Hydrogen Storage

IEA Hydrogen TCP

https://www.ieahydrogen.org

New Task - Underground Hydrogen Storage

UNECE

Task proposal – Netherlands Ministry of Economic Affairs & Climate Policy
Task coordination – TNO , **Coordination support**: Delft Technical University

- **Rationale**: Expected increasing importance of hydrogen as future clean fuel and large-scale storage medium for the balancing of intermittent renewable energy production, seasonal heat demand and static supply of industry feedstock

- **Challenge**: Development of large scale hydrogen storage in underground formations (UHS) may become critical in a decade (balancing, H2 economy & backbone):
  - Solution-mined salt caverns and porous formations are considered primary targets for UHS (proof of concept)
  - Lined rock caverns and buried vessels could provide alternatives in absence of salt caverns / gas fields / aquifers

- **Objective**: Prove technical, economic and societal viability of UHS > Accelerate pilots/demonstration and support large-scale development and commercialization of UHS (through international cooperation and information exchange)

IEA Hydrogen TCP

https://www.ieahydrogen.org

New Task - Underground Hydrogen Storage

UNECE

Academic/Research Institutes, Laboratories, Geological surveys

National / International R&I Programmes

Industry Pilots and Demonstration

Policy support, Regulation, Energy systems & market

Technical Feasibility

Subsurface characterization, impacts & monitoring

Technology development

Site screening, performance, classification

Technology deployment

Engineering, design, risks, safety, monitoring

Planning and efficiency

System integration, economics, regulation, societal embedding & ethics

Underground Hydrogen Storage

Application of UNFC – Injection Projects

UNECE

UNFC-2009 Classes Defined by Categories as Applied to Injection Projects for the Purpose of Geological Storage

Total Geological Storage					
	Injected and Stored Quantities				
	Lost Quantities[a]				
		Class	**Categories**		
			E	F	G[b]
	Future storage by commercial injection projects	Commercial Injection Projects[c]	1	1	1, 2, 3
	Future storage in known reservoirs by injection projects	Potentially Commercial Injection Projects[d]	2[e]	2	1, 2, 3
		Non-Commercial Injection Projects[f]	3	2	1, 2, 3
	Storage Not Feasible[g]		3	4	1, 2, 3
	Potential future storage in undiscovered reservoirs by injection projects	Screening Projects	3	3	4
	Storage Not Feasible[g]		3	4	4

E) Economic viability

- Hydrogen market, production
- Volatility, balancing, price fluctuations
- System integration, transport, consumers
- Merit order, LCOE, CAPEX/OPEX
- Regulatory framework, licensing
- H2 Quality & Certification

F) Technical feasibility

- Demonstrating subsurface conditions
- Safety, integrity, losses, monitoring
- Engineering concepts/design
- Portfolio screening and maturation
- Re-use, infra, dependency & timing

G) Geological confidence

- Mapping, exploration and appraisal
- Characterization and uncertainties
- Capacity & performance

Underground Hydrogen Storage

Application of UNFC – Injection Projects

UNECE

Existing undergrounds hydrogen storage (static storage in salt caverns)

- UK - Teeside
- US Texas– Clemens Dome, Moss Bluff, Spindetop

Pilot & Demonstration projects:

- RAG – SunStorage (Austria – gas field)
- HyChico (Argentina – gas field)
- Energystock - HyStock (Netherlands – salt cavern)
- Storengy - HyPster (France – salt cavern)

Mapping, Characterisation & Screening projects:

- Various national appraisal studies
- H2020 – HyUnder (potential/actors/business cases for large scale underground hydrogen storage in Europe)
- H2020 – ESTMAP (European Energy Storage Mapping and Planning)
- H2020 – HyStorIES (Underground storage of renewable hydrogen in depleted gas fields and other geological stores)
- Horizon-Europe call – CSA Geological Services for Europe > EU database and atlas for underground storage (CCS/Heat/Energy)

UNFC-2009 Classes Defined by Categories as Applied to Injection Projects for the Purpose of Geological Storage

Total Geological Storage	Injected and Stored Quantities / Lost Quantities[a]	Class	Categories E	F	G[b]
	Future storage by commercial injection projects	Commercial Injection Projects[c]	1	1	1, 2, 3
	Future storage in known reservoirs by injection projects	Potentially Commercial Injection Projects[d]	2[e]	2	1, 2, 3
		Non-Commercial Injection Projects[f]	3	2	1, 2, 3
	Storage Not Feasible[g]		3	4	1, 2, 3
	Potential future storage in undiscovered reservoirs by injection projects	Screening Projects	3	3	4
	Storage Not Feasible[g]		3	4	4

Underground Hydrogen Storage

Take-away messages

- **Need for Large scale Underground Hydrogen Storage (UHS) demand expected** with increasing share of Hydrogen in energy mix after 2030
- **UHS Technical feasibility under investigation**, need for pilots and demonstration
- **Varying technical readiness levels** for UHS in salt caverns, gas fields/aquifers and lined rock caverns
- **IEA Hydrogen TCP** aims to advance the research, demonstration and commercialization of Underground Hydrogen Storage through global research collaboration and supporting a technology network.
- **Mapping, screening and characterization of potential underground storage sites** in various National and European projects (including H2020, Horizon Europe)
- **UNFC for Injection Projects** provides a classification framework that can be linked to screening of potential sites (demonstration/upscaling), spatial planning and system/market integration of storage projects, regulation and societal embedding

Thank you!

Serge van Gessel
TNO – coordinator Underground Hydrogen Storage

UNECE
Date 30 I 04 I 2021, Geneva

RESOURCE MANAGEMENT WEEK 2021

ENABLING SUSTAINABILITY PRINCIPLES IN RESOURCE MANAGEMENT

UNECE