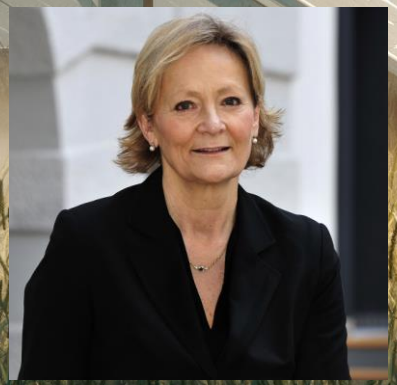
Feasibility study green hydrogen Upper Rhine Innovation Region

Barbara Koch



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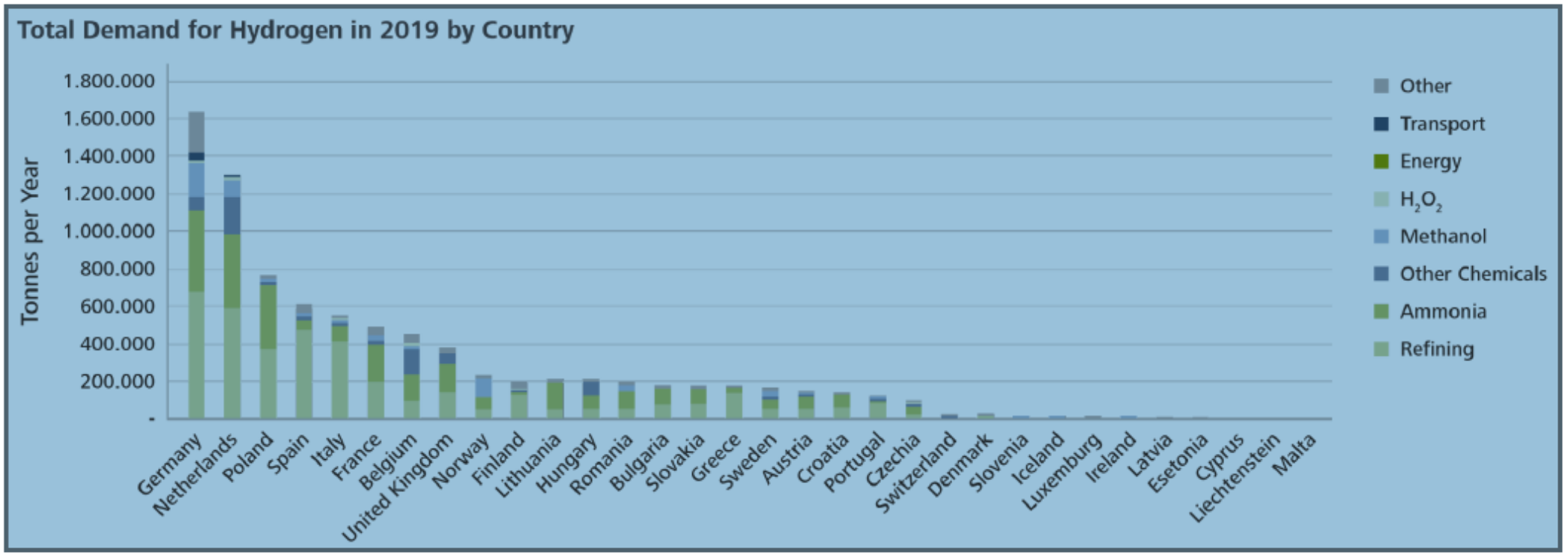
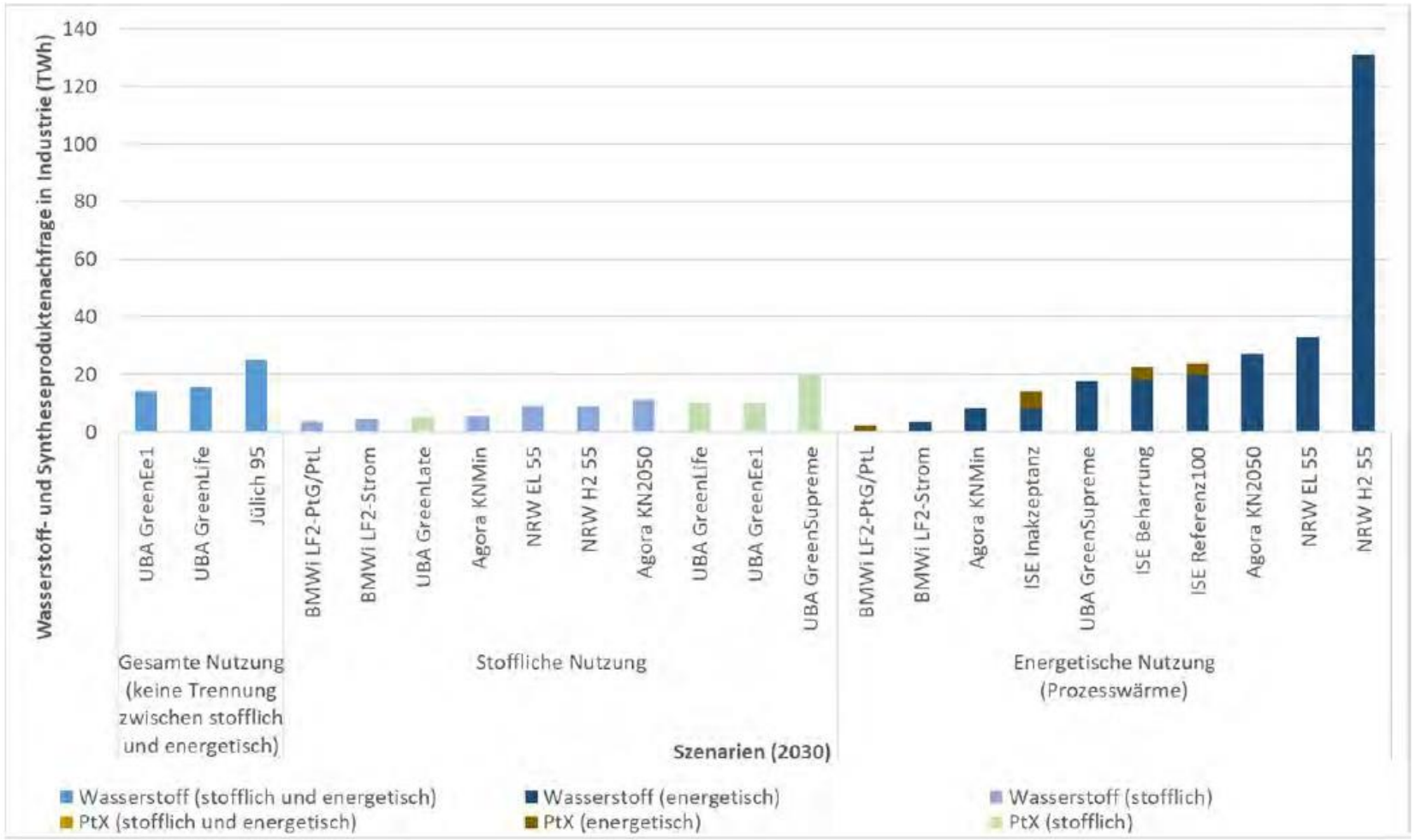
Hydrogen demand



Hydrogen Europe 2020 study

Hydrogen demand in industry 2030



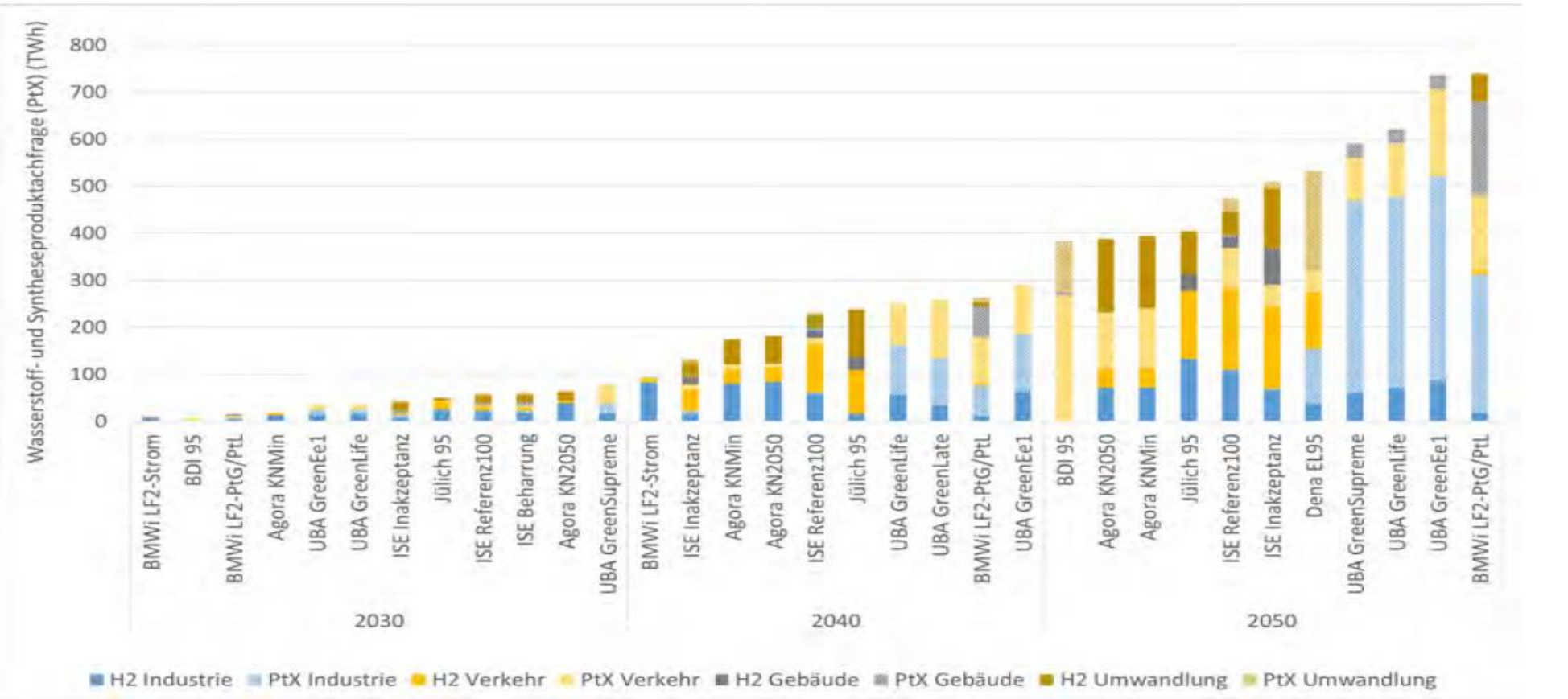
Hydrogen 2021 meta study

Fraunhofer Institute for Systems and Innovation Research ISI

Fraunhofer Institute for Solar Energy Systems ISE

Fraunhofer Research Institution for Energy Infrastructure and Geothermal Energy IEG

Hydrogen and synthesis product demands (PtX)



Hydrogen 2021 meta study

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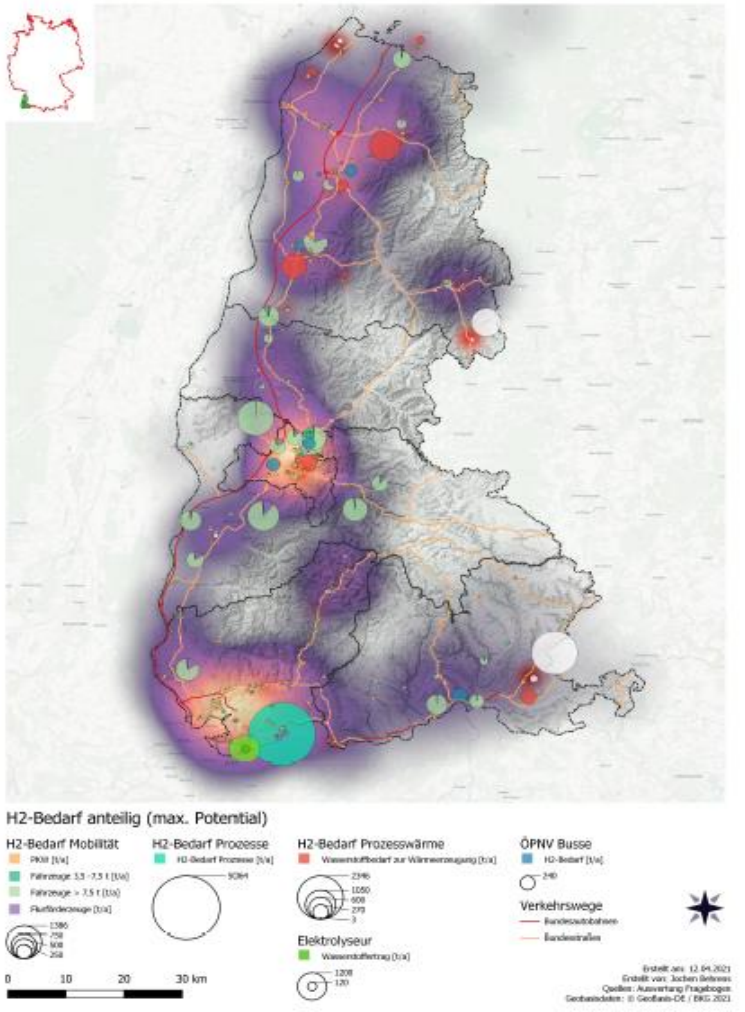
Hydrogen demand - Upper Rhine



Study H_2 - so Fraunhofer ISE Vogelstätter et al. 2022

218 000 t/y for Switzerland and France in the Upper Rhine when switching from natural gas to hydrogen

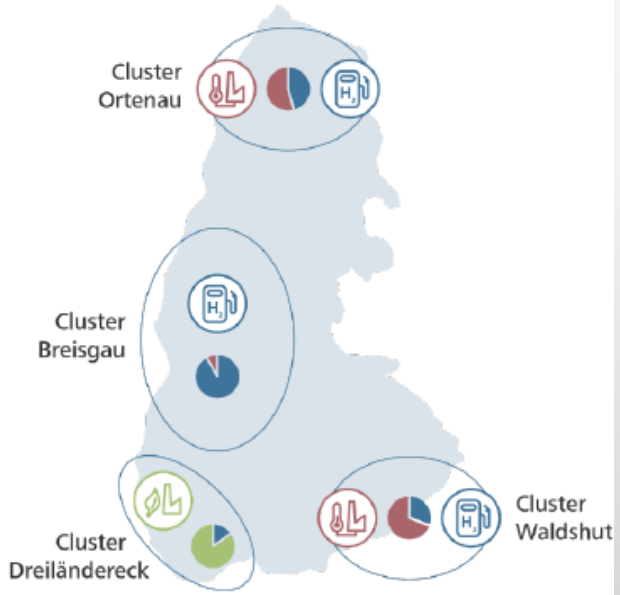
Upper Rhine Germany (today)
5064 t/y H2 Demand for processes
4269 t/y H2 for heat generation
Demand approx. 20 000t/y

Demand 'Chalampe cluster' approx. 60 000 t/y
Demand BASF approx. 10 000 t/y

Generating 100 000 t of CO_2 today

Hydrogen demand - Upper Rhine cluster

Cluster	Ortenau [t/a]	Breisgau [t/a]	Dreiländereck [t/a]	Waldshut [t/a]	Σ [t/a]
PKW	204	188	79	107	578
LnF	57	368	59	8	492
SnF	810	6.268	541	903	8.522
FFz	106	315	209	94	724
Busse	237	407	0	240	884
Mobilität	1.414	7.546	888	1.352	11.200
Prozesse	0	0.1	5.000	0.8	5.001
Prozesswärme	1.320	604	0	2.616	4.540
Summe	**2.734**	**8.150**	**5.888**	**3.969**	**20.741**



Study H_2 - so Fraunhofer ISE Vogelstätter et al. 2022

Hydrogen demand

Chemical industry

Glass industry

Metal and steel production

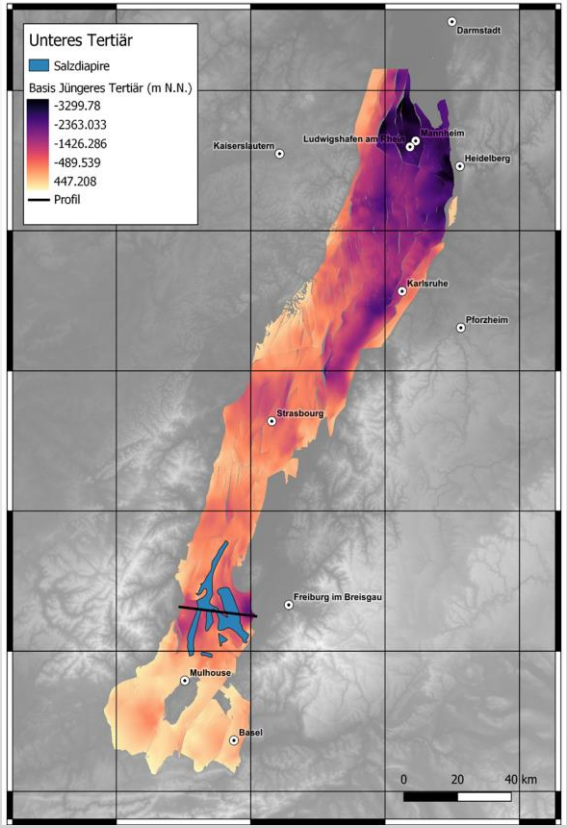
Anzahl der Unternehmen 2005

	Anzahl Unternehmen	Anteil Unternehmen mit weniger als 50 Beschäftigten
Elsass*	91.973	97,7%
Südpfalz	13.687	98,7%
Baden	105.734	98,1%
Nordwestschweiz	72.988	98,3%
Region Oberrhein	284.382	98,1%

** Betriebe*
Quelle: Statistische Ämter

Geological potential for H_2 storage

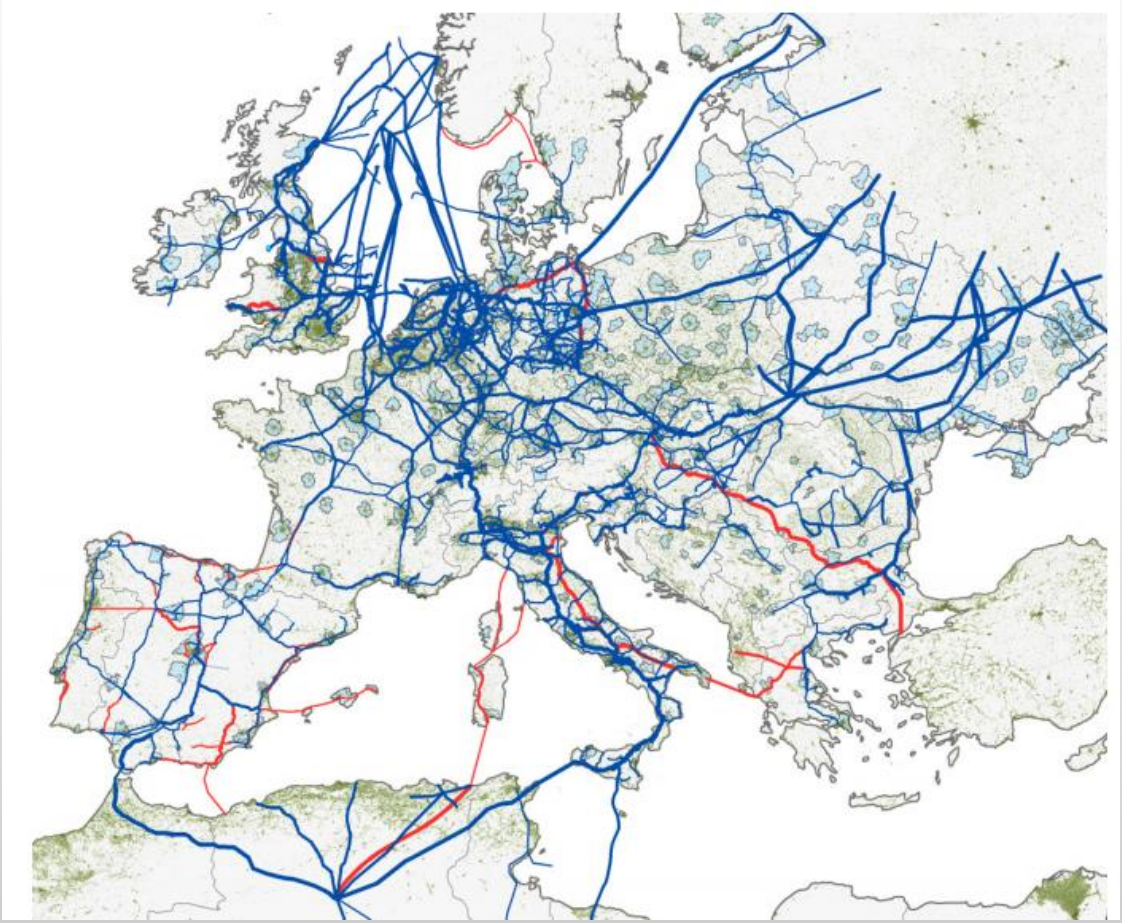
1. salt caverns in the salt diapirs of the southern ORG (Bad Krozinge-Colmar-Wittenheim).
2. salt caverns in the salt diapirs in the southern ORG (Wittelsheim-Staffelfelden).
3. pore storage facilities in Tertiary sandstones (marginal areas of the ORG, also in the northern OR (see existing gas storages)
4. pore storages in the permotriassic sandstones of the ORG



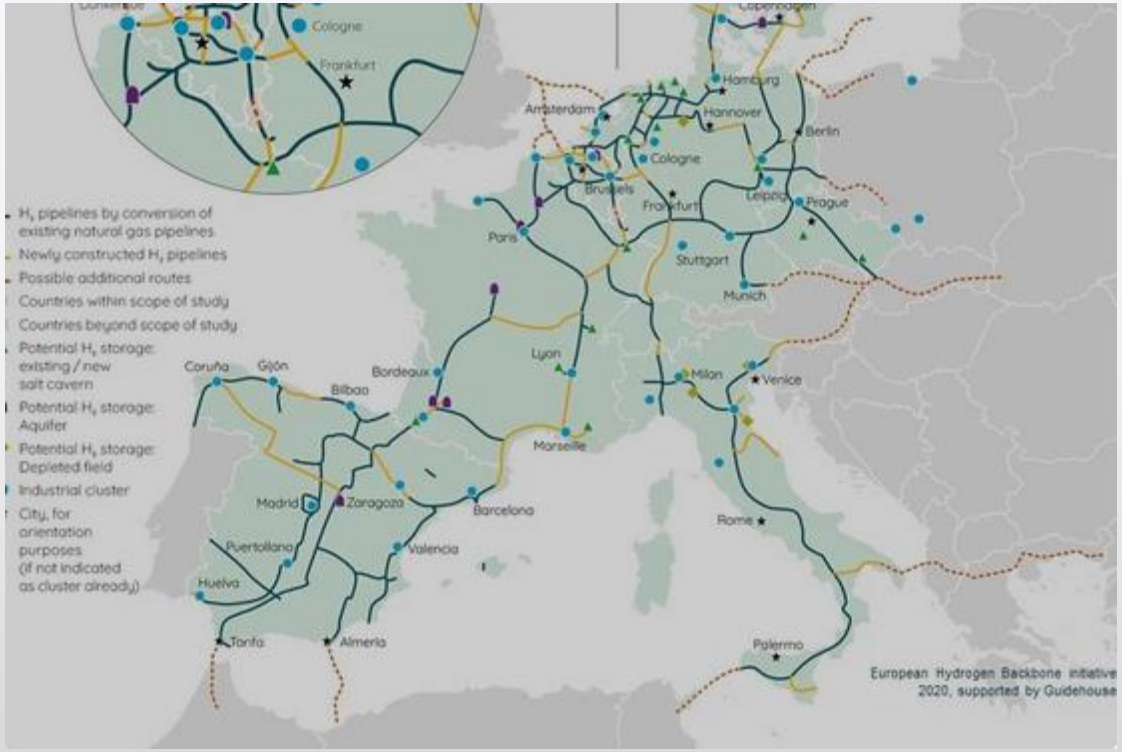
Geological storage capacity

11 TWh on the Upper Rhine.

Europes Transmission Gaspipes

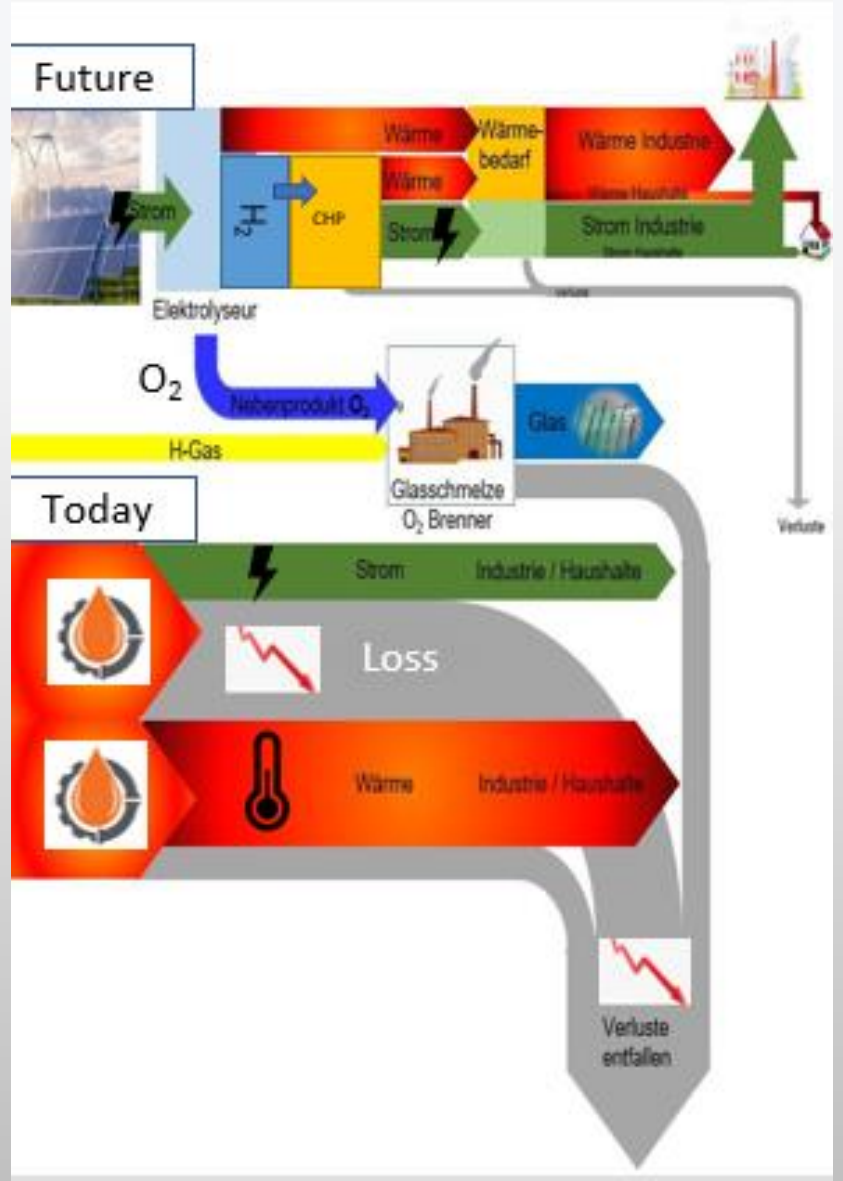


Energy post by Karel Beckmann 2015



- Regional production
- Transport North South/South North
- Transport in the gas distribution network (up to 20% possible)
- Big gas pipes can be used for transport but compression stations needed
- Structure of the hydrogen "backbone

Gas utilisation versus hydrogen cycle



Energy production:
Wind: Black Forest and Vosges
PV: gravel pond, noise protection, roofs, BM and Agri-PV
Geothermal energy: CHP near the surface (deep geothermal energy)
Biomass: agricultural, biowaste and (residual) wood
Hydropower: Rhine

Electrolysers: utilisation of waste heat and oxygen

Energy storage: caverns, pipe systems, container systems, battery storage systems

CHP for better demand adjustment

- Burner technologies
- Calibration technologies
- Gas distribution networks must be upgraded for hydrogen

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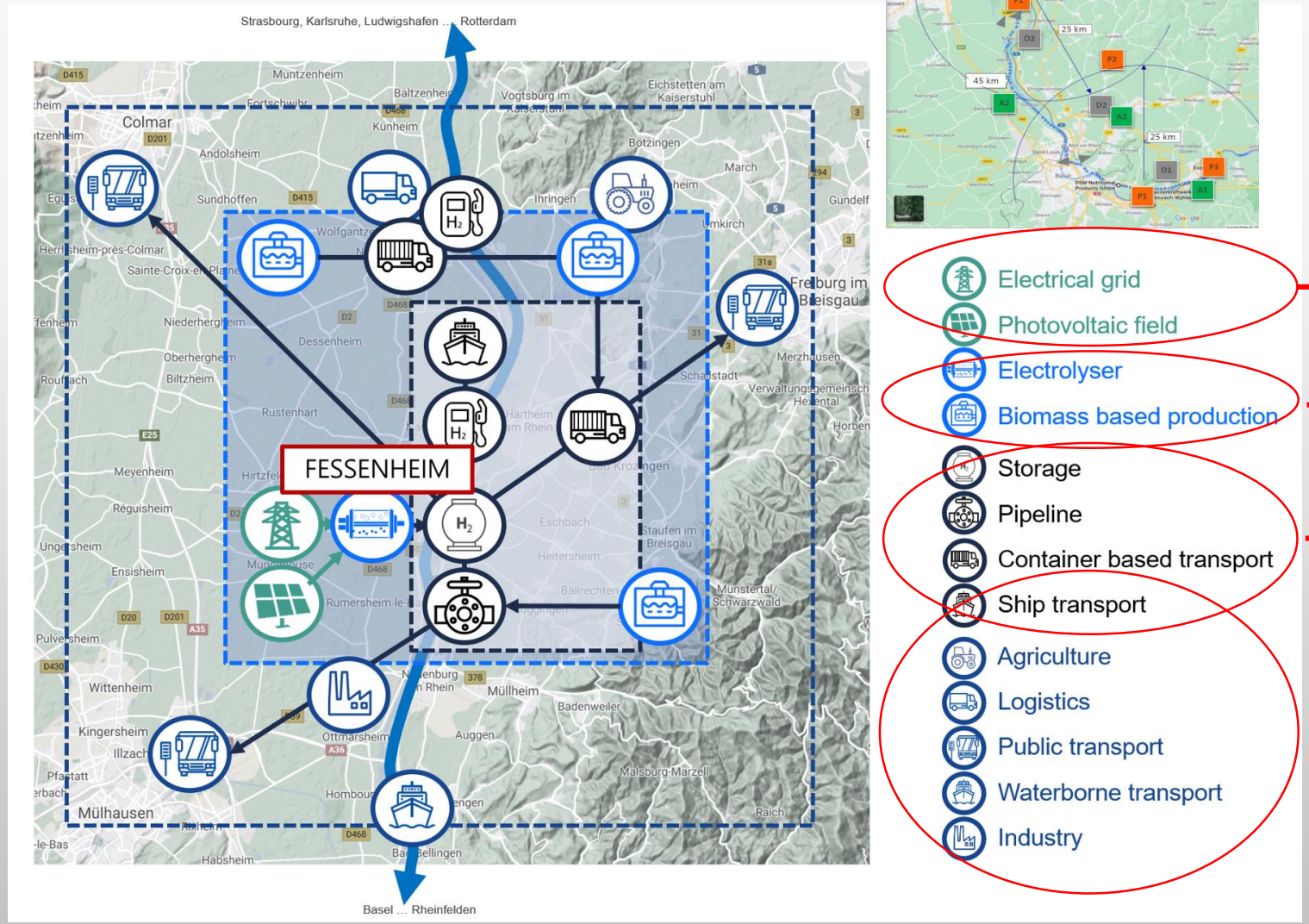
Hydrogen – Infrastructure



- Electrical grid
- Photovoltaic field
- Electrolyser
- Biomass based production
- Storage
- Pipeline
- Container based transport
- Ship transport
- Agriculture
- Logistics
- Public transport
- Waterborne transport
- Industry

1. Production
2. Storage
3. Transport
4. Applications

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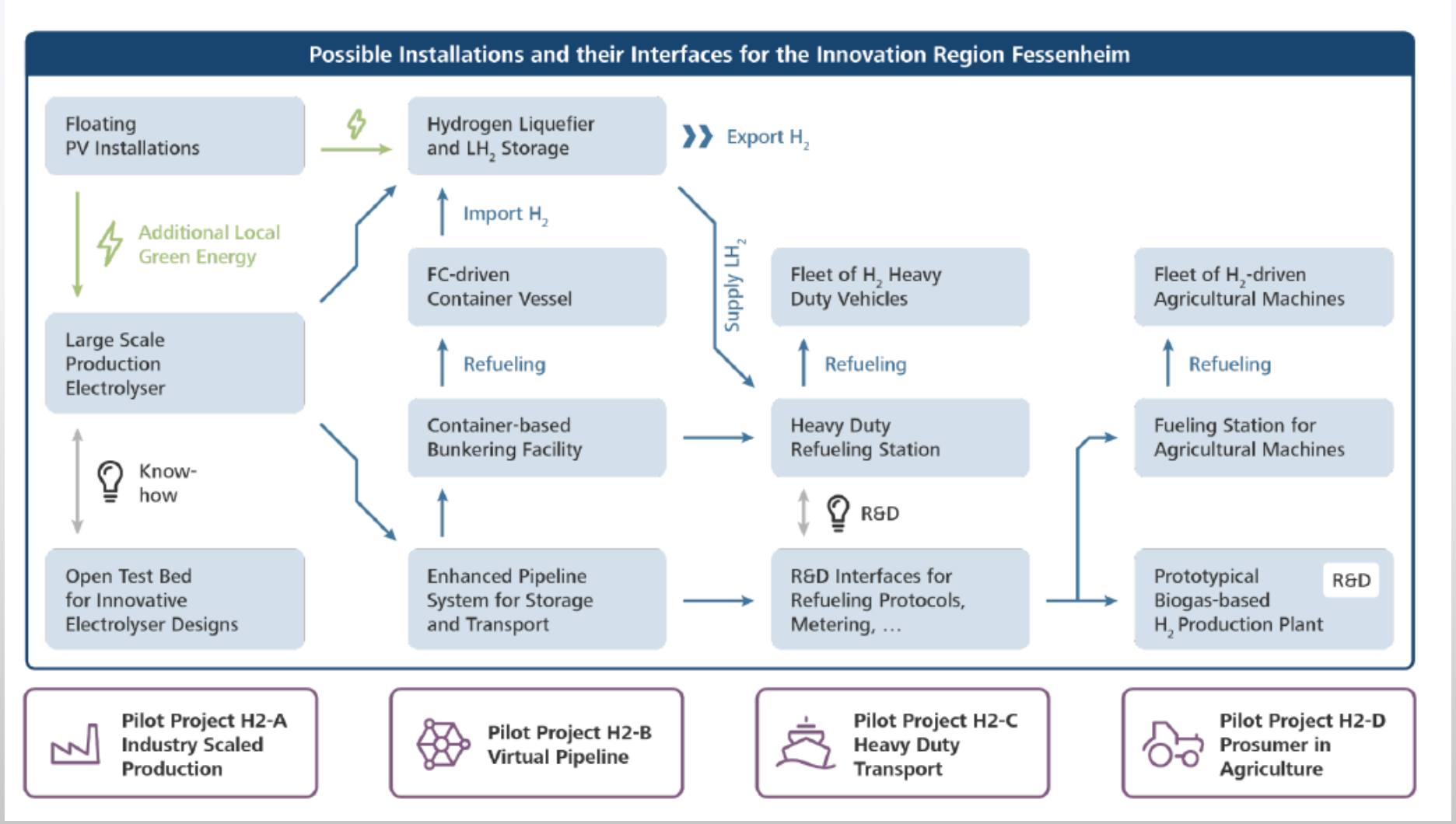
Green hydrogen - supply



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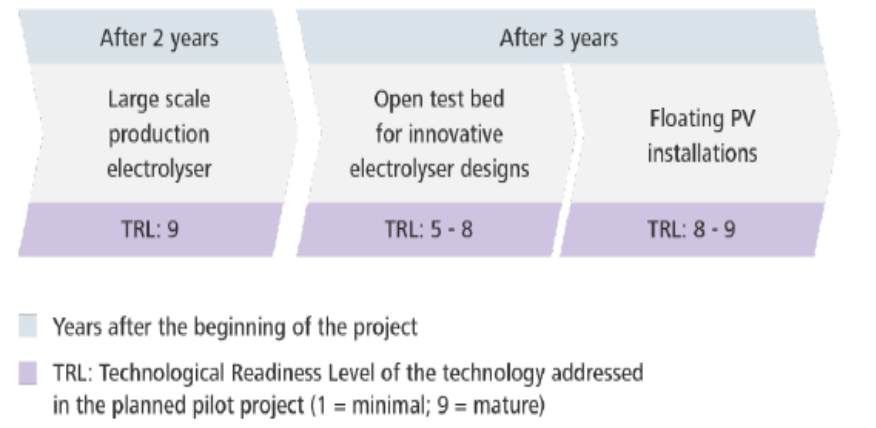
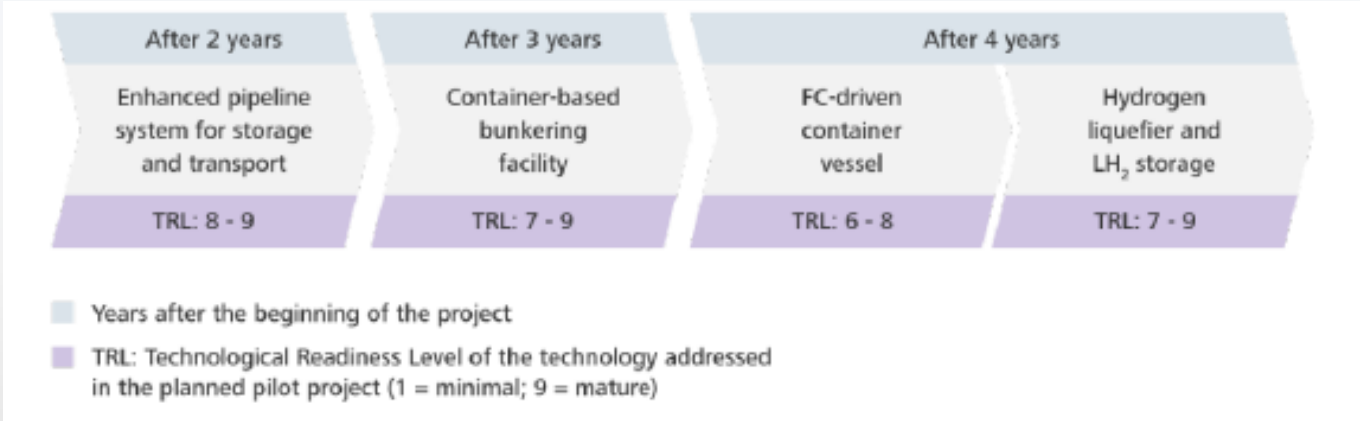
Green hydrogen – timeline for pilots

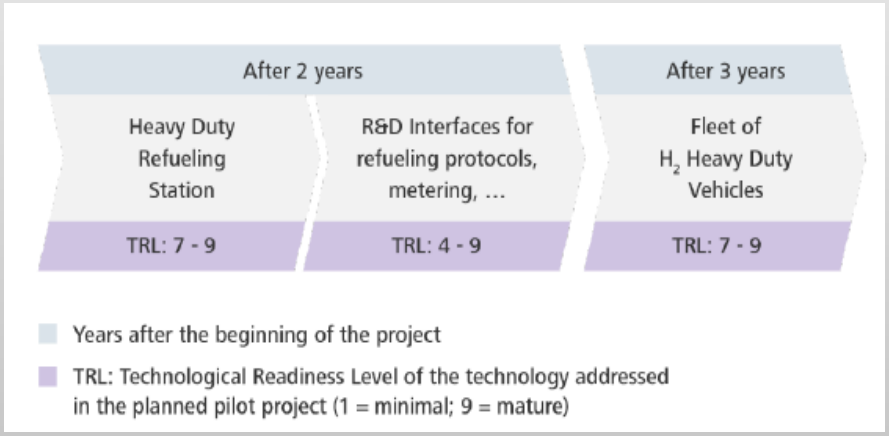
Pilot 1: Production



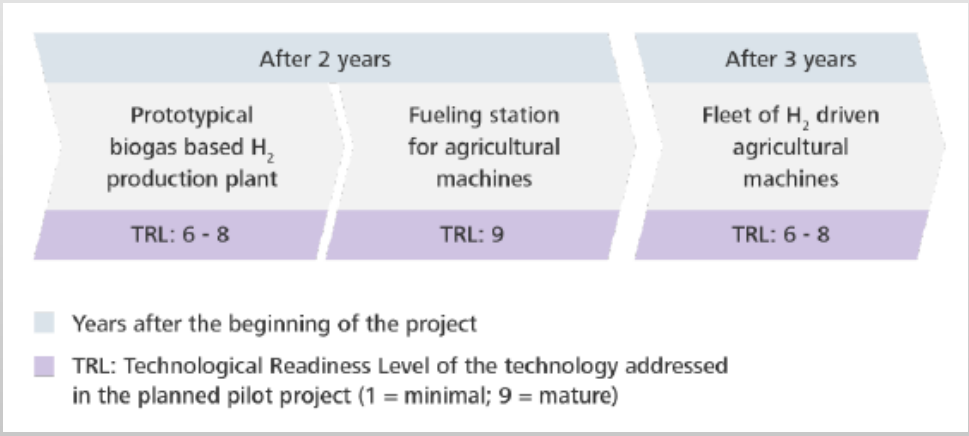
Pilot 2: Virtuel pipieline



Pilot 3: Heavy Traffic



Pilot 4: Biomass based hydrogen production



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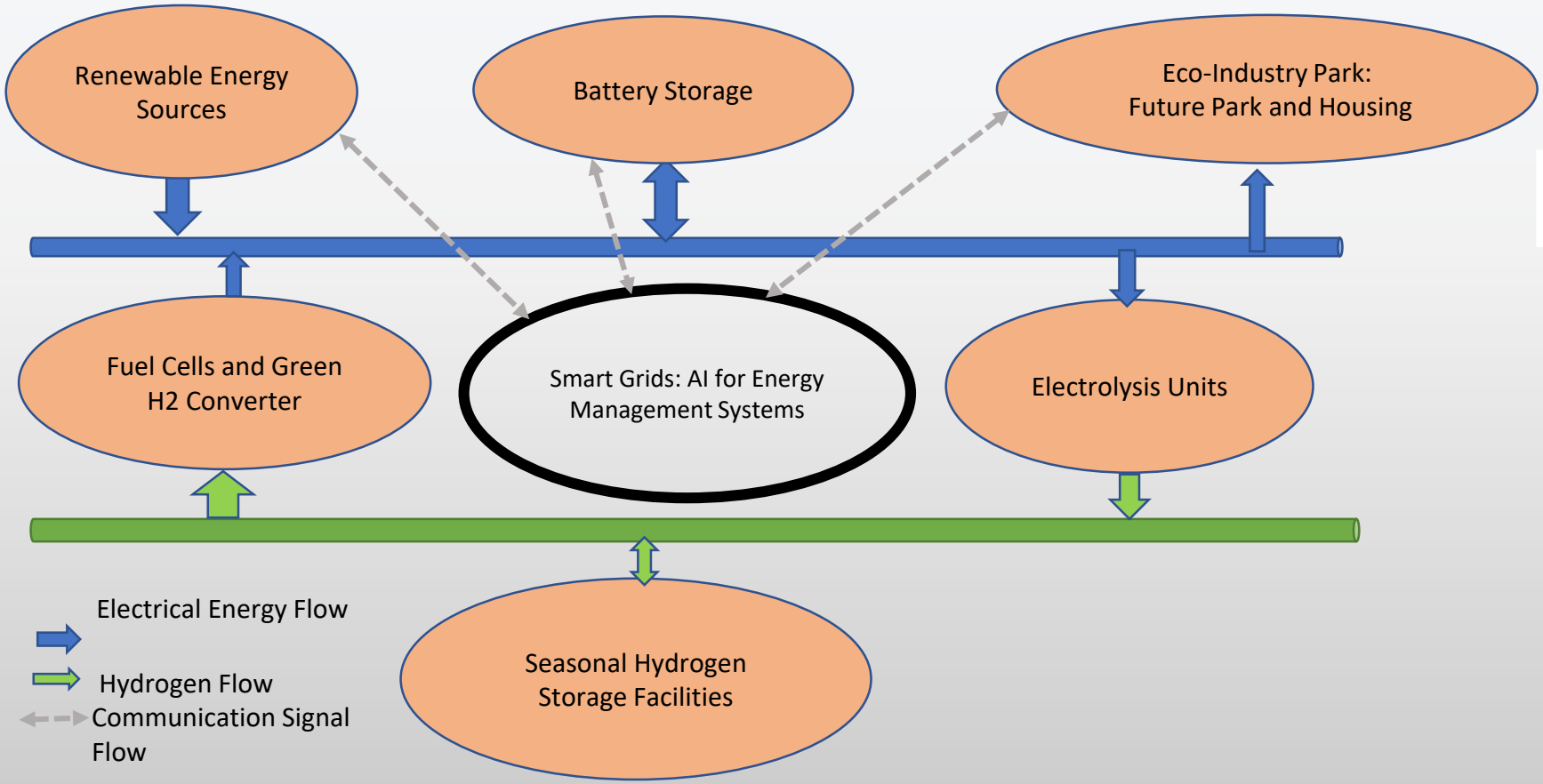
System Interdependence



Example

Pilot 1 Project H2_ "Large scale industry supply with green hydrogen

Aims:

- Identify together with industries the location and power supply
- Develop a testbed for electrolysers (H2 Gigafactory for electrolysers in Aspach-Michelbach)
- Testbed for grid integration of electrolyser
- Develop ideas for LH2 hydrogen transport connected to other opportunities in using the low temperature
- Develop design plan importing green energy via green ammonia could be another option.

Thyssen-Krupp

Thank you