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Hydrogen - Local and Global Perspectives in the Context of the Energy Transition

NET 2019 - Gabriele Schmiedel - Hydrogen Solutions

Six instant ways to reduce your CO_2 footprint

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+1 ct/kWh Green power

Greenpeace Energy compared to conventional power contract[1]

+2 ct/kWh Green gas

Greenpeace Energy compared to conventional gas[2]

- 96% CO_2 by using an BEV

Compared to a motor vehicle from Hamburg – Nuremberg[5]

+10 ct/100km Green flight

to compensate CO_2-emissions caused by your specific flight[3]

+up to 70 ct/ Green parcel

to compensate CO_2-emissions caused by transport of your parcel worldwide[4]

- 99% CO_2 by using the train

Compared to a motor vehicle from Hamburg – Nuremberg[5]

Source:[1] Compared to average standard power contract for 2500 kWh and a basis price of ~ 9,00 €/Month [2] Compared to average fossil NG contract for 7500 kWh and a basis price of ~ 9,90 €/Month [3] atmosfair.de [4]DHL http://bit.ly/2Jwad4W [5] DieBahn http://bit.ly/2q3Q1jO

The market is being heavily disrupted but a strong growth is certain

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+78%

Global electricity generation growth until 2040[1]

40%

CO_2 emissions from the energy sector[2]

< 2

ct/kWh,
lowest solar prices ever[3]

Source: [1]IHS Markit 2018, [2] World Energy Balances 2018, [3]thenational http://bit.ly/2r8Y7Z3

“Sector Coupling” is the key lever for decarbonization of all end-user sectors

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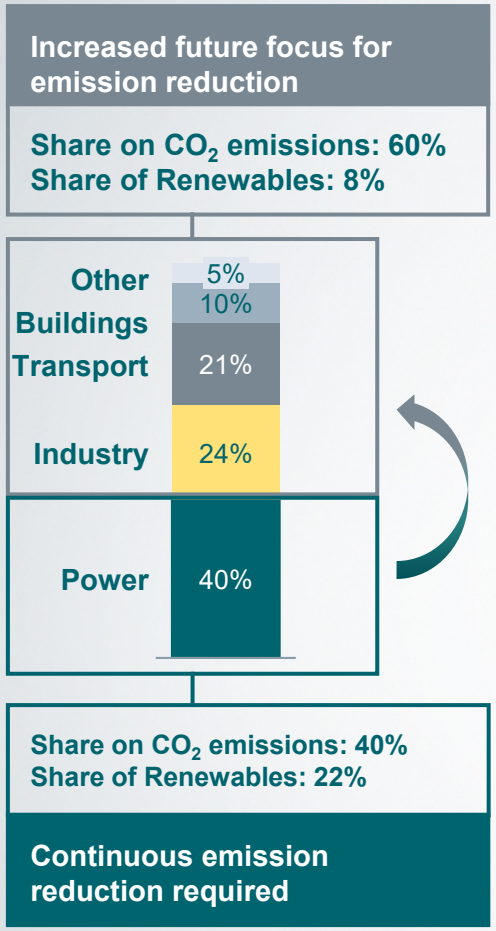
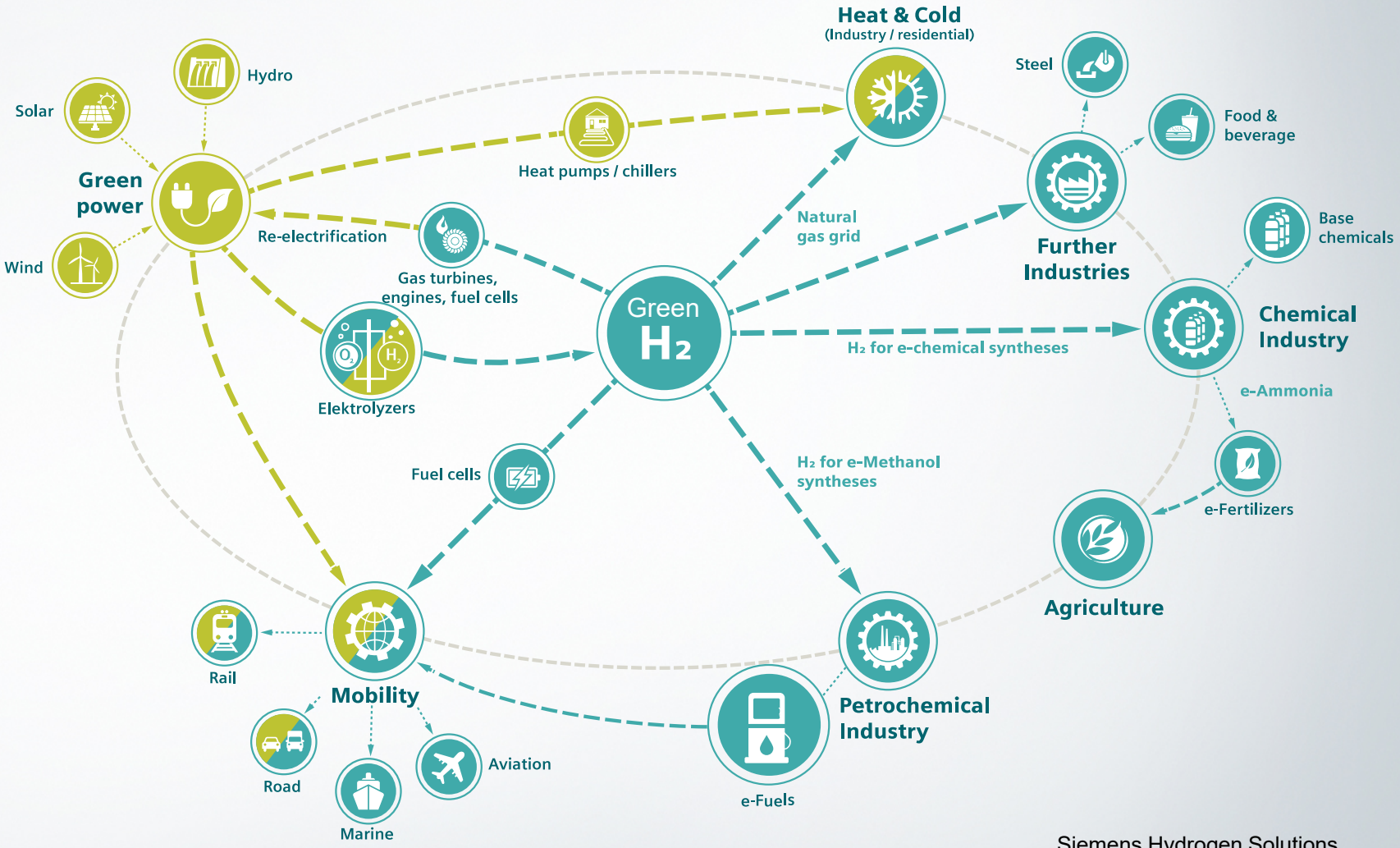
Shares in global CO_2 emissions by sectors



Sector Coupling

Source: World Energy Balances 2018

Sector Coupling – Links and Interactions



Hydrogen from renewables enables large scale long term storage and sector coupling

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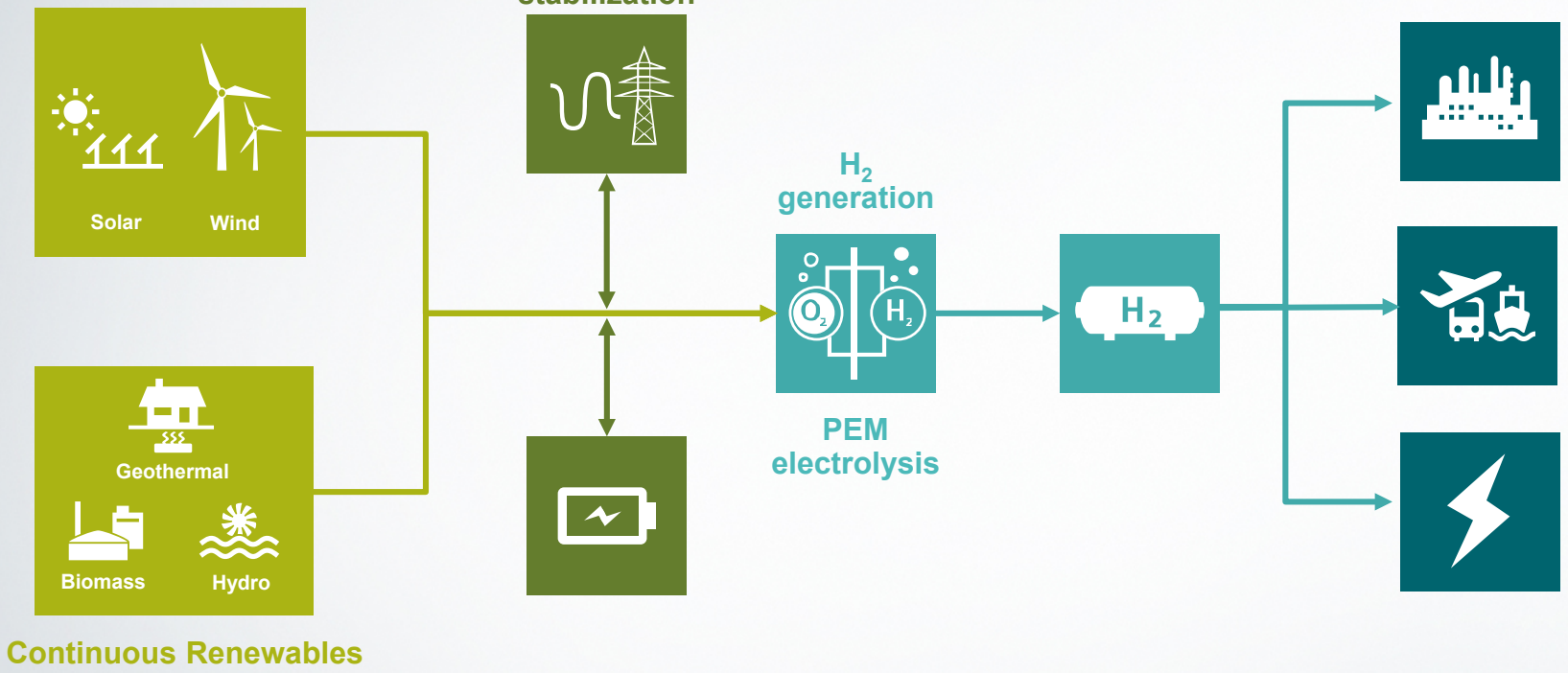
Renewable electricity generation | Grid Integration | Conversion / Storage | Applications



Exports for different applications

Industry
Hydrogen for ammonia production, petroleum refinement, metal production, flat glass, etc.

Mobility
Hydrogen as alternative fuel or as feedstock for e-fuels

Energy
Hydrogen blending (gas grid)
Remote energy supply/Off-grid

Various countries demonstrate strong potential for Power-to-X production / exports …

Source: Frontier Economics

Many nations have developed an H_2 roadmap to increase pace in CO_2 reduction

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National H_2 Energy Roadmap

On objectives for production, delivery, storage, conversion, infrastructure etc.

Hydrogen Sweden

Hydrogen being included to a larger extent in political strategies, regulations and legal framework as well as in research programmes

Nationales Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie

Guarantees continuity for R&D and addresses the support of first products necessary for market activation

Energy Technology Revolution & Innovation Initiative

Blue Book on Infra-structure Development of Hydrogen & fuel cell technology innovation, including hydrogen production from multi sources (PEM, SOFC)

Brazilian H_2 Roadmap

Introduces the hydrogen technologies in the market through a series of infrastructure projects

ProH2

Establishes the base of hydrogen and fuel cells R&D and markets

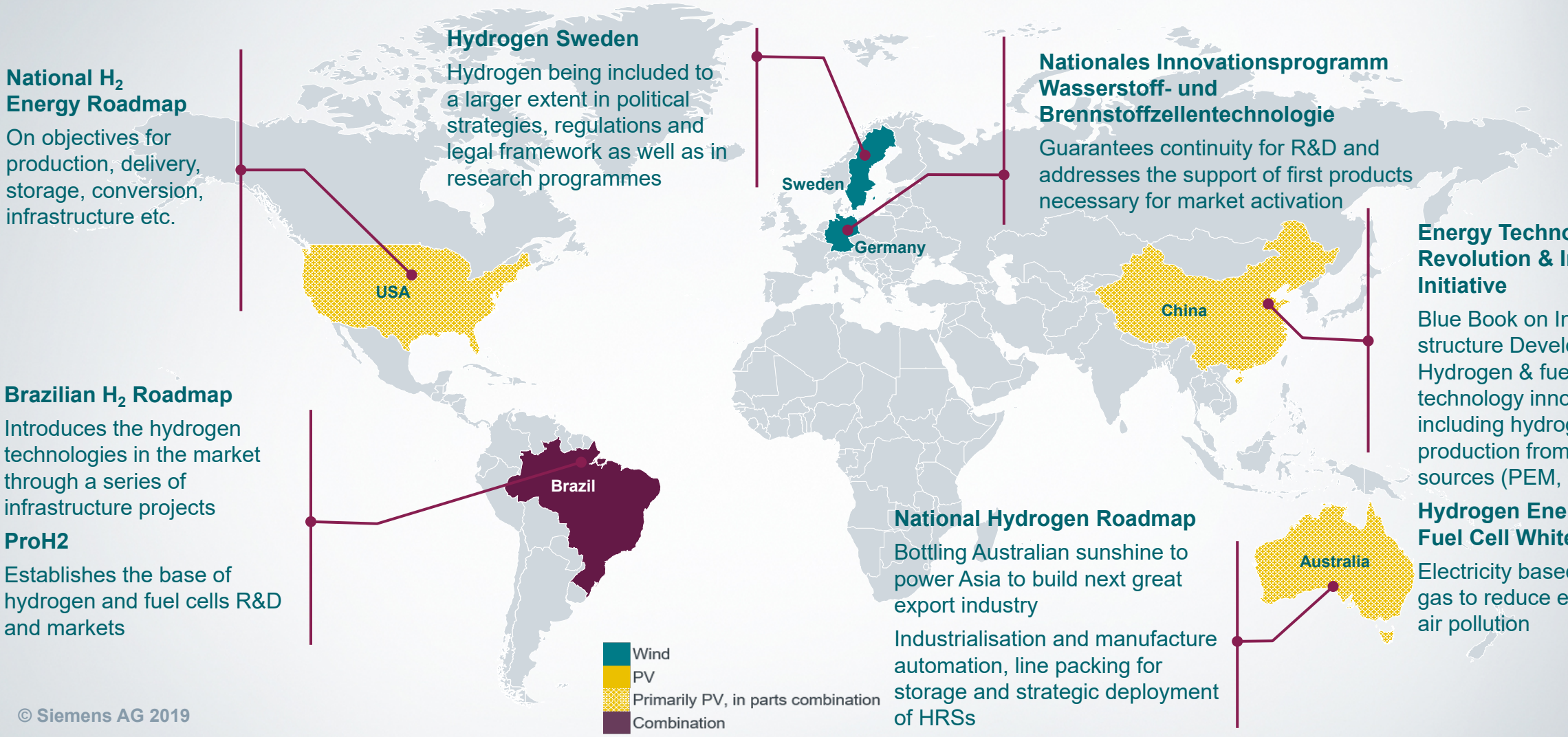
National Hydrogen Roadmap

Bottling Australian sunshine to power Asia to build next great export industry

Industrialisation and manufacture automation, line packing for storage and strategic deployment of HRSs

Hydrogen Energy and Fuel Cell White Paper

Electricity based on natural gas to reduce enormous air pollution



Patagonia, Chile: Producing synthetic methanol through electrolysis from wind power – Decarbonize European fuel

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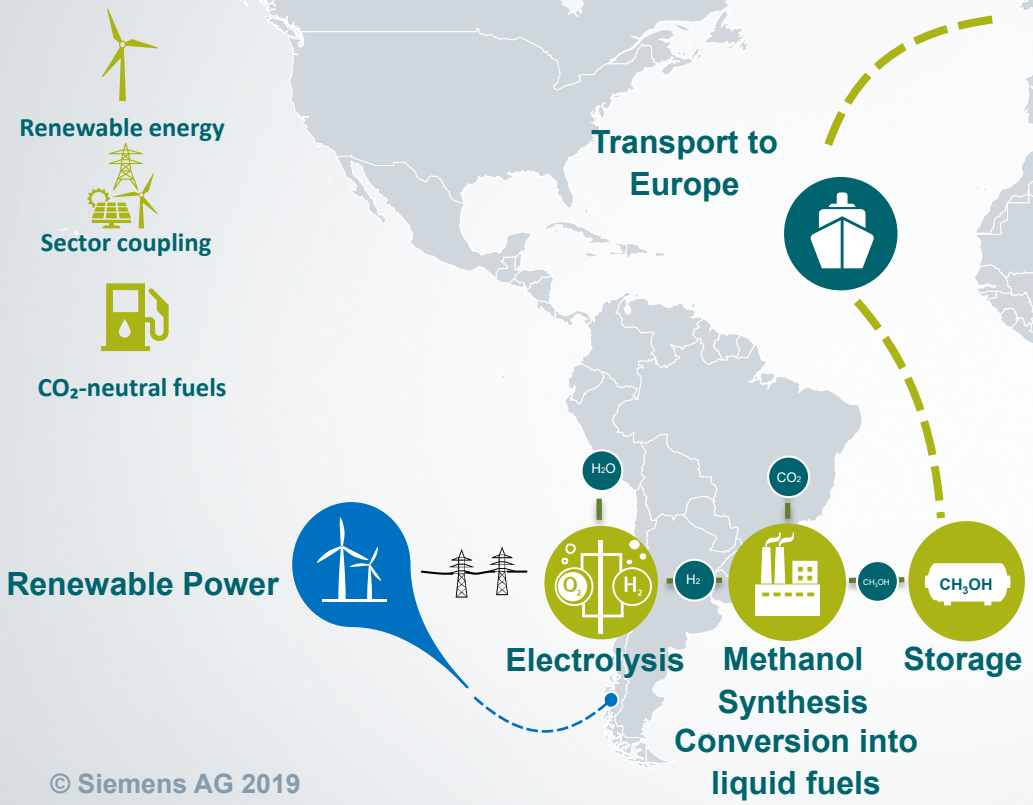
Case Study Patagonia: e-Methanol

Project Overview



Economic opportunities – Political challenges

- Generate hydrogen from renewable power at best wind location and convert to Methanol
- Use e-methanol as an alternative to Bio-Ethanol for blending of fossil fuel or as a feedstock for synthetic fuels or for add-ins like anti-knocking agents

Regulatory barriers

- Lack of level-playing field of e-fuels versus e-mobility
- Well-to-wheel vs. tank-to-wheel principles
- Recognition of imported e-fuels

Growth story Germany is based on Network Development Plan and exit of coal fired power generation

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2022

Exit of nuclear power generation & reduction of >12 GW of coal fired power generation (base: 2017)[1]

2030

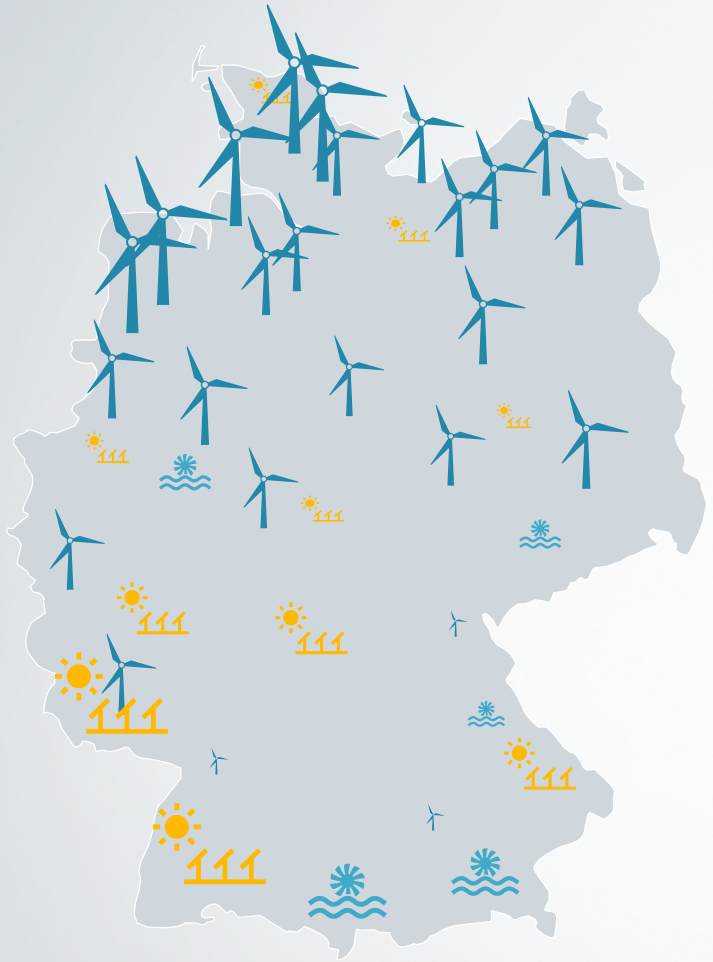
- 65 % share of renewables in total electricity consumption[2]
- >60 % Reduction of CO_2 emissions (base 1990)

2038

- Exit of coal fired PG[3]
- Installed capacity of[2] renewables >330 GW
- 3 GW Power-to-Gas

Source:[1]Bundesregierung http://bit.ly/2Nf2N8A, [2]IHS Autonomy Scenario, [3]Bundesregierung http://bit.ly/32gbeo4

The energy transition is facing logistical challenges. Supply and demand must be linked together



Source: Adapted http://bit.ly/2oJVxYE, http://bit.ly/2rcsDRY, http://bit.ly/2JO0Hu4

Supply: Renewables potential

Ideal conditions for **big wind parks** (offshore and onshore) **in the north**

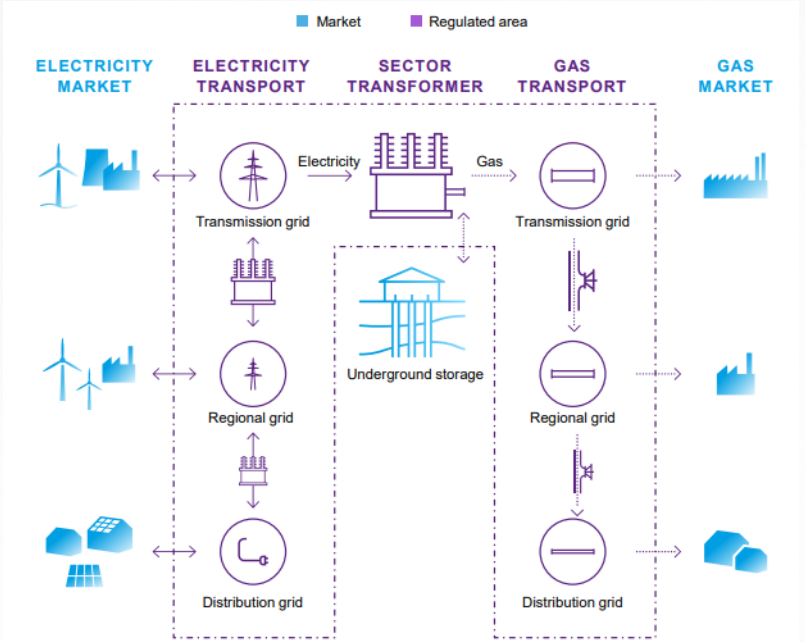
- Bigger **solar parks and hydro are located in the south / south west** of the country but with **much smaller capacity compared to wind**

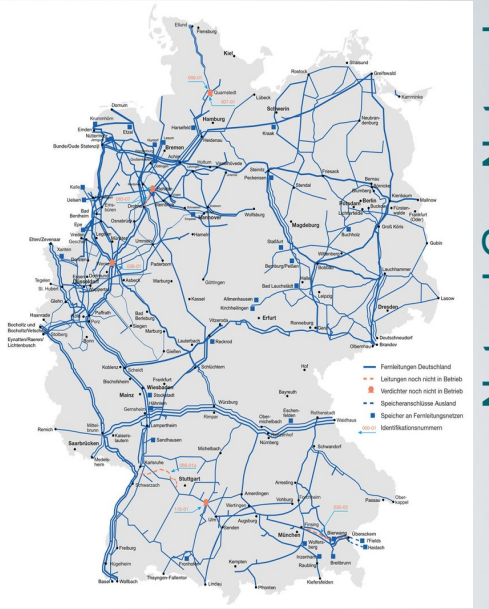
Demand: Population and Industries

- Bigger **industry and population** areas are located in the **south / south west** of the country
- Small wind, solar and hydro **can not cover the renewable demand** in this regions

Sector coupling at system level - Third party access must continue to be in place when the electricity and gas infrastructures are coupled at system level

Tranmission Network





Natural Gas Network

Coupling existing infrastructures of the German electricity and gas system with each other

- **Liberalized energy market** and the "**third party access**" is needed
- **The infrastructure is available to all market participants** on a non-discriminatory basis
- Remunerated for their transport services via **a regulated network charge**

Source: hybridge.net

Currently there are many distributed pilot projects for Power-to-Gas technologies with a total of 55 MW in Germany

Year	Project	Customer	Power demand	Product offering
2015	Energiepark Mainz	Municipality of Mainz	3.8 MW / 6 MW (peak)	Pilot Silyzer 200 
2016	Wind Gas Haßfurt	Municipality of Haßfurt Greenpeace Energy	1.25 MW	Silyzer 200 
2017	H&R	H&R Ölwerke	5 MW	Silyzer 200 

Source: DVGW 2017

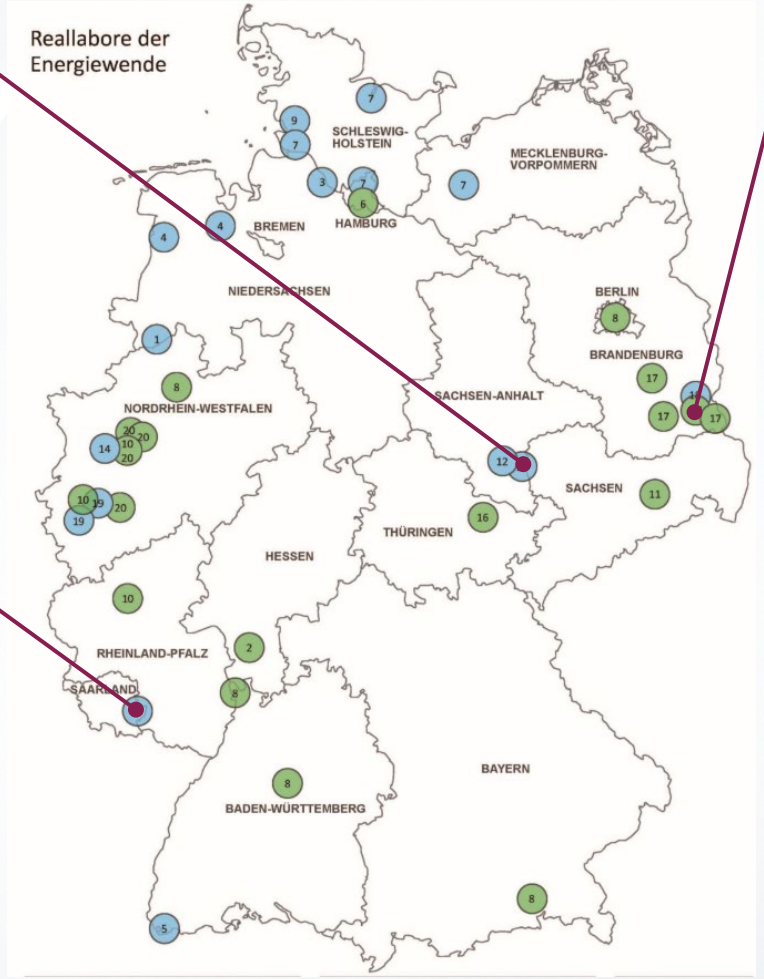
Winner of the ideas competition 'Reallabore der Energiewende'
Siemens participation mainly in areas of structural changes

GreenHydroChem

- 50 MW PEM Electrolyzer
- Overall expansion target of 100 MW
- Use case: Industry

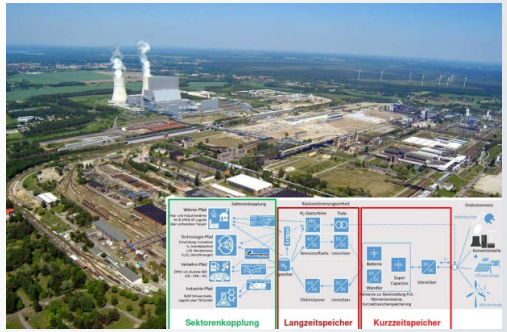
Hydro Hub Fenne

- 17.5 MW PEM Elektrolyzer
- Use case: Mobility and Industry



Referenzkraftwerk Lausitz

- 10 MW PEM Elektrolyzer
- + 500 MWh H_2 storage, 2 MW fuel cell, 7.9 MW gas turbine , 2 MW super condenser and 2 MW Li-battery
- Use case: Mobility, Energy and Industry



Future of energy in Europe is about decarbonization through “Sector Coupling” and a new market design

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Cornerstones of a future energy system

Decarbonization of energy

Transforming the conventional generation capacity into low-carbon assets

Sector coupling

Leveraging renewables in power sector to decarbonize heat, mobility, industry

Power-to-X

Key technology for sector coupling and fuel for decarboni-zation of energy

Regulatory framework

Has to value CO_2 reduction and needs to be technology open – necessary now!

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