# Green H2: Overview of International Market

## New Energy Business, Siemens Energy

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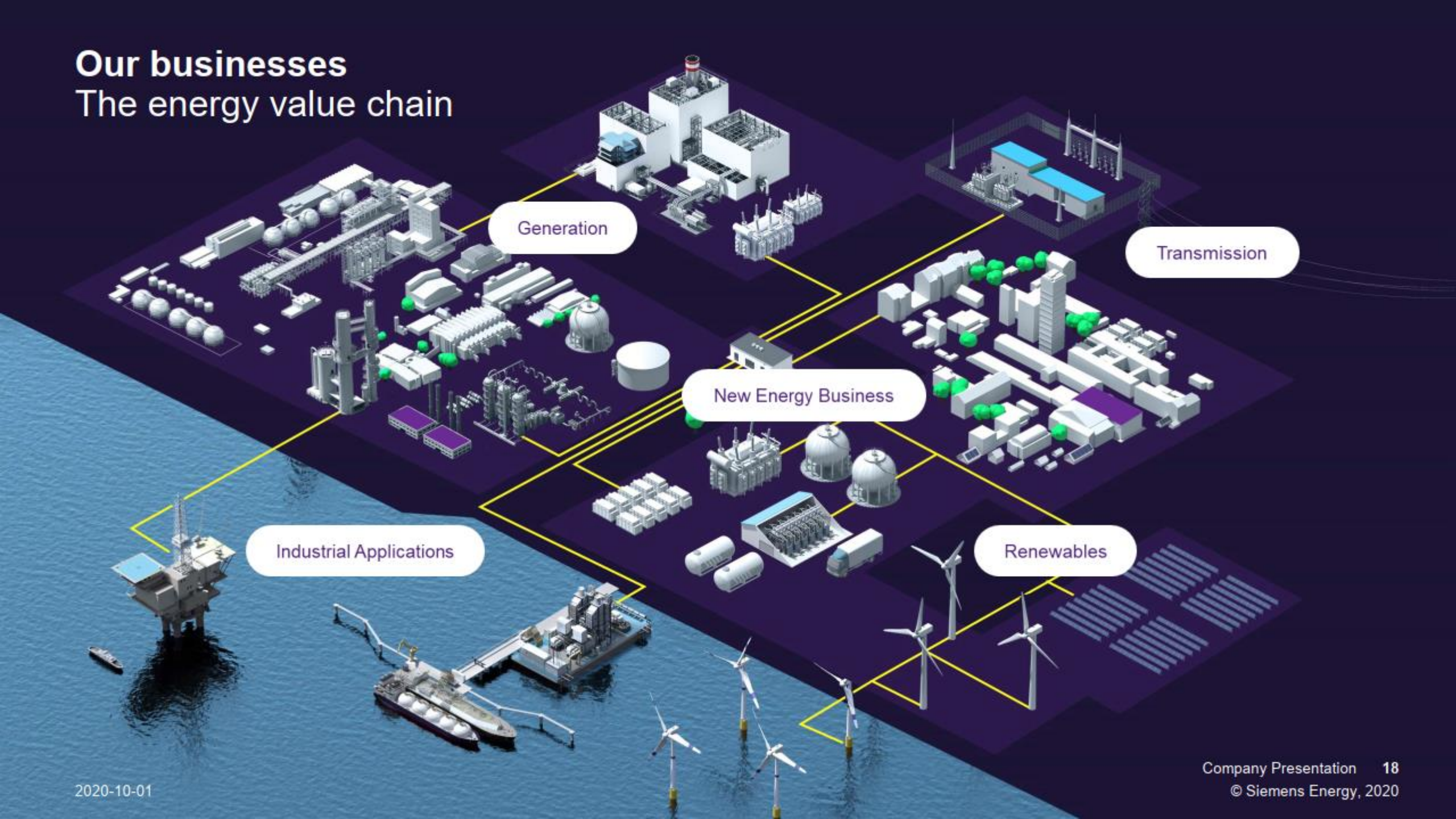
February, 2021

# Our businesses
## The energy value chain



# We believe in the fundamentals of the market which is expected to grow to from MW to GW ranges

## $H_2$ electrolyzer market potential: Market drivers and potential developments

### Key market drivers

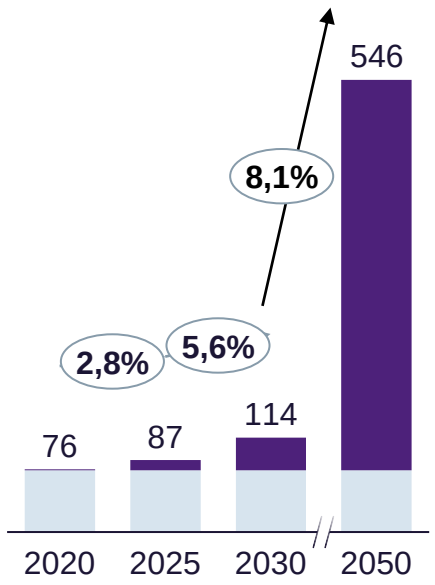
**Regulatory support** to promote $H_2$ and other renewable based energy forms, e.g., synthetic fuel

**Decarbonization self commitment** of **players** and their **customers**

**Economic push** due to e.g., reduction of **renewable prices**, **CAPEX** and increase in **$CO_2$** or **CNG price**

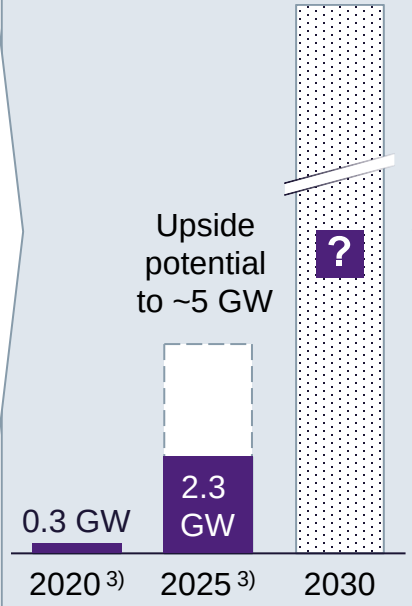
### Global $H_2$ market in Mt

**Growth mainly driven by blue and green hydrogen**




### Green $H_2$ electrolyzer market potential in GW (assumption based)

**Market uncertainty**
- Size of the market
- Time of market take-off




| Exemplary top down use cases [1] (incl. underlying assumption) | Installed electrolyzer capacity required |
|---|---|
| **Mobility** | |
| **$H_2$ direct use** | |
| • $H_2$ supply for up to 100k fuel cell heavy trucks | **20 GW** |
| **E-fuels** | |
| • 1% substitution of rail & road transport fuel in EU | **15 GW** |
| • 2% substitution of fuel for aviation | **17 GW** [2] |
| **Industry** | |
| • 50% $H_2$ based decarbonization of 30% of key players with self commitment in steel industry | **6 GW** [3] |
| **Energy** | |
| • 3% substitution of natural gas (e.g., blending in gas distribution grid) | **47 GW** [2] |

CNG: Compressed natural gas; 1) Use cases not necessarily to be seen simultaneously 2) North America + EU 3) Based on market reports and regulatory support for hydrogen in Europe
4) Thyssen Krupp Europe, POSCO, Salzgitter, Arcelor Mittal Europe, Tata Steel, voestalpine, SSAB
Source: NEB Next², GP top down $H_2$ market potential estimation, IEA report, market reports: Hydrogen Council (2017), IHS Autonomy & Rivalry (2019) FMI (2019), GIA (2016), Certifhy (2015)

# Silyzer portfolio scales up by factor 10 every 4 – 5 years driven by market demand and co-developed with our customers

## Silyzer portfolio roadmap

0.1 MW → 1 MW → 10 MW → 100 MW → 1,000 MW

### 2011

**Silyzer 100**
Lab scale demo
~20 kOH[1],
~30 t of $H_2$

### 2015

**Silyzer 200**
~130 kOH[1]
~1700 t of $H_2$

World's largest Power-to-Gas plants with PEM electrolyzers in 2015 and 2017 built by Siemens Energy!

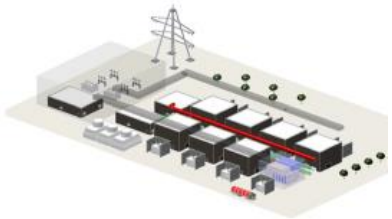
### 2018

**Silyzer 300**

Biggest PEM cell in the world built by Siemens Energy!

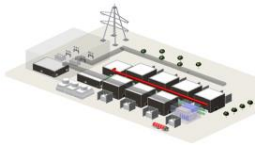
### 2023+

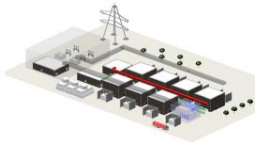
**Next generation**
Under development

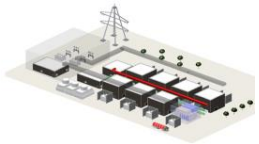


### 2028+

First investigations in cooperation with chemical industry







**1** 1000 accumulated Operating Hours; Data OH & tons as of Oct 2020

# The modular design of Silyzer 300 can be easily scaled to your demands

SIEMENS energy

**Module** | **Module array** | **n+1** | **Customized solution** | **Plant**

Between 12 and 24 modules

Scale up to the necessary demand

Control system | Water refinement | Transformer | Rectifier | LV supply

**! Modular concept to cover wide production rate**


=H1NHE11WP101
O2/Deionat
RL Modul 1


# H2FUTURE
## A European Flagship project for generation and use of green hydrogen

**6 MW**

Power demand based on Silyzer 300

**1,200 $Nm^3$**

of green hydrogen per hour

### Project

- Partner: VERBUND (coordination), voestalpine, Austrian Power Grid (APG), TNO, K1-MET
- Country: Austria
- Installed: 2019
- Product: Silyzer 300

### Use cases

- Hydrogen for the steel making process
- Supply grid services

### Challenge

- Potential for “breakthrough” steelmaking technologies which replace carbon by green hydrogen as basis for further upscaling to industrial dimensions
- Installation and integration into an existing coke oven gas pipeline at the steel plant
- High electrolysis system efficiency of 80%

### Solutions

- Operation of a 12-module array Silyzer 300
- Highly dynamic power consumption – enabling grid services
- State-of-the-art process control technology based on SIMATIC PCS 7

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 735503. This Joint Undertaking receives support from the European Union’s Horizon 2020 research and innovative programme and Hydrogen Europe and NERGHY

# Power to Methanol production in one of the best wind power sites in the world

# Haru Oni Pilot Project

## Worldwide first integrated plant for the production of climate-neutral e-fuel from wind and water

**750.000 liters**

of e-methanol per year from 2022
(130.000 liters of e-gasoline)

**>55 mio liters**

e-fuel per year
planned from 2024

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

February 2021

### Project

- Customer: HIF (Highly Innovative Fuels)
- Off-taker: Porsche AG
- Country: Chile, Patagonia
- Installation: 2021
- Product: Power-to-methanol solution based on Silyzer 200

### Use cases

E-Fuel for Porsche cars

Potential for adding Kerosene or Diesel production in future phases

Methanol for ship motors

### Opportunity

- Huge wind energy potential in Magallanes
- Existing industry and port infrastructure

→ Perfect conditions to export green energy from Chile to the world

### Solutions

- Production of e-gasoline and e-methanol at one of the best spots worldwide for wind energy
- Co-developer Siemens Energy realizing the system integration from wind energy to e-fuel production
- International Partners like Porsche and AME