A1

SIEMENS
Ingenuity for life

Hydrogen Sector coupling

A pathway to deep decarbonization

CERC Meeting, July 2019, India

Rajeev Rajdeva, Siemens Gas and Power

www.siemens.com/silyzer

Slide 1

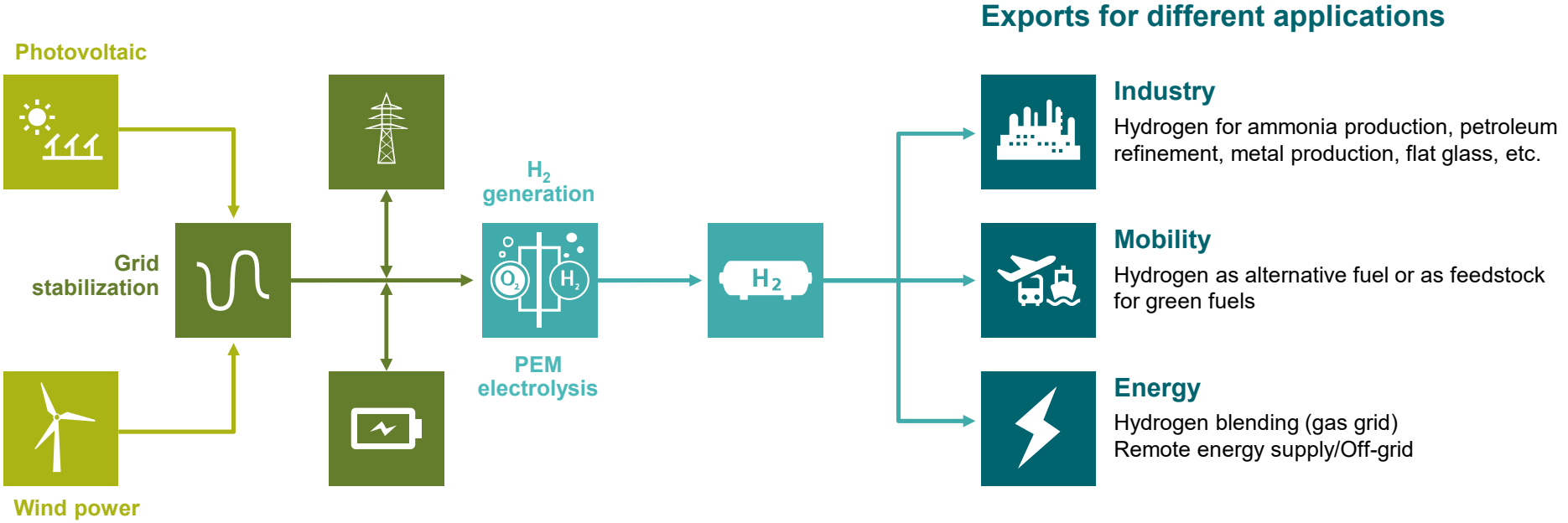
A1 Hier bitte das neue Titelbild mit Zug (wie HMI) verwenden

Author, 5/6/2019

Green hydrogen is a key lever for sector coupling addressing industry, mobility and re-electrification sectors

SIEMENS
Ingenuity for life

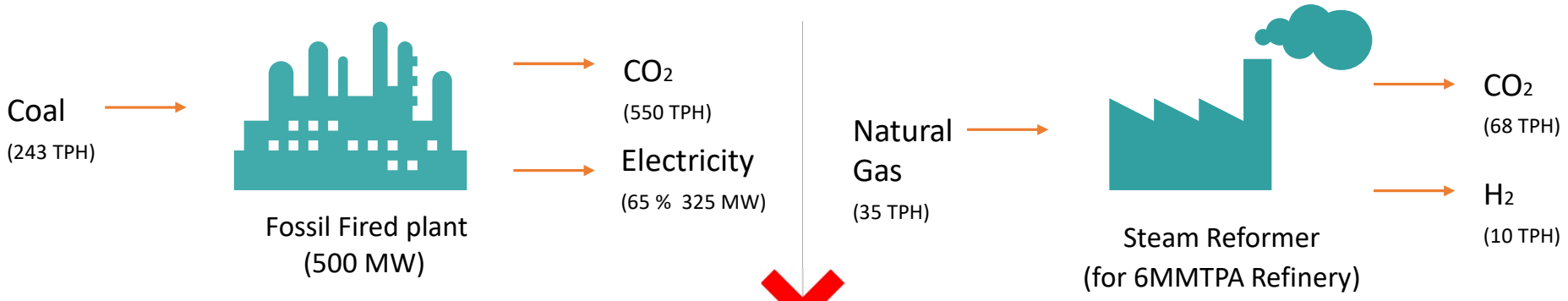
Volatile electricity generation | Grid integration | Conversion/ storage | Applications



Present Scenario

SIEMENS
Ingenuity for life

In present scenario, Power Generation and Refinery sector are coupled



Low PLF regime due to renewables at least 12 hours per day

Deteriorated Heat rate and higher Aux power consumption

Higher Carbon emissions at lower loads

Uses costly natural Gas adding to Forex deficits

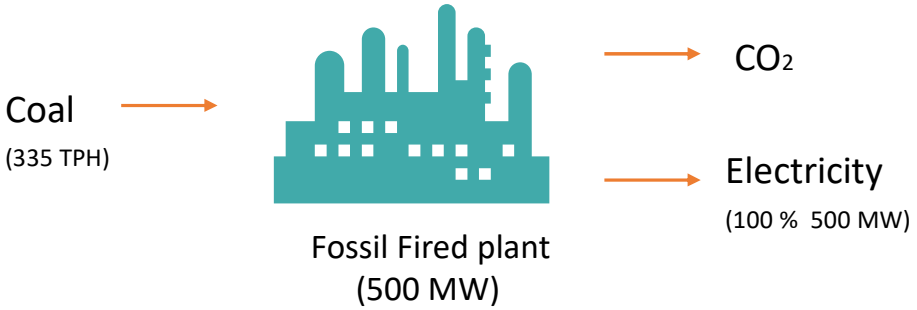
Natural Gas unavailable for Gas based power generation

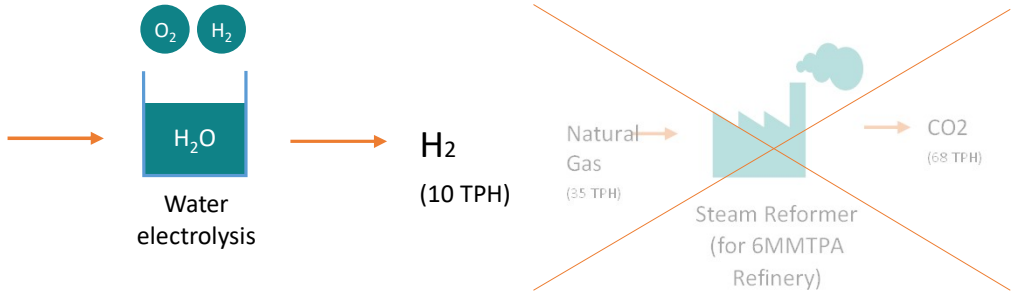
Carbon intensive process

Proposed Sector coupling

SIEMENS
Ingenuity for life

Proposed Scenario wherein Power Generation and Refinery Hydrogen Production process our sector coupled





24 Hours High PLF regime even with renewables

Improved Heat rate and lower Aux power consumption

Higher efficiency and lower per MW Carbon emissions

Natural Gas saved ~ 35TPH

266 MW of CCPP flexible power achievable with the saved NG

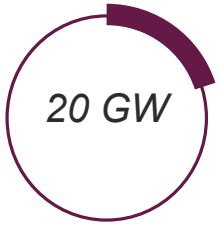
No Additional Carbon emissions

P2X as Grid Flexibilzation

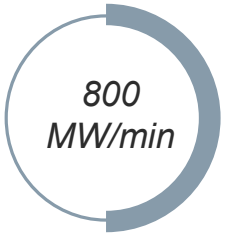
To analyze the impact of Sector Coupling , we consider all the 234 MMTPA installed refinery in India to utilize Electrolysis for their Hydrogen requirement.

Following are key calculated results of sector Coupling :

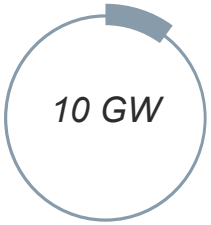
Total Hydrogen requirement by refinery.



Additional Latent demand induced in Grid to produce 100 % hydrogen through Electrolysis



Grid Load ramp achievable by increasing /decreasing load of electrolysers



Additional Power available by utilizing Natural Gas saved from SMR process

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

SIEMENS
Ingenuity for life

Silyzer portfolio roadmap

0,1 MW → 1 MW → 10 MW → 100 MW → 1000 MW

2011

Silyzer 100
Lab-scale demo
~4.500 op.h[1],
~150k Nm³ of H_2

2015

Silyzer 200
~86.500 op.h
~7.3 mio Nm³ of H_2

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

2018

Silyzer 300

Biggest PEM cell in the world built by Siemens!

2023+

Next generation
Under development

2030+

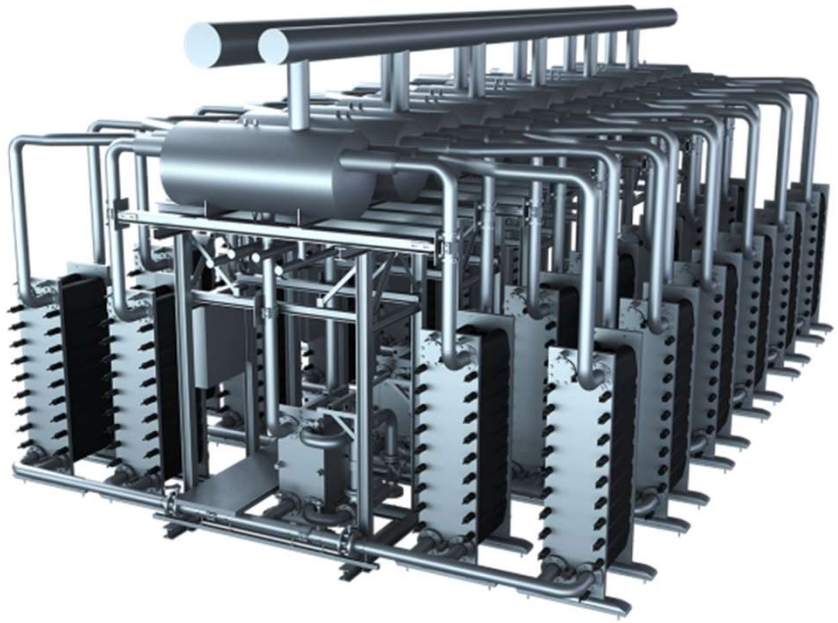
First investigations in cooperation with chemical industry

[1] op.h.: operating hours; Data op.h & Nm³ as of Jan. 2019

Silyzer 300 – the next paradigm in PEM electrolysis

SIEMENS
Ingenuity for life

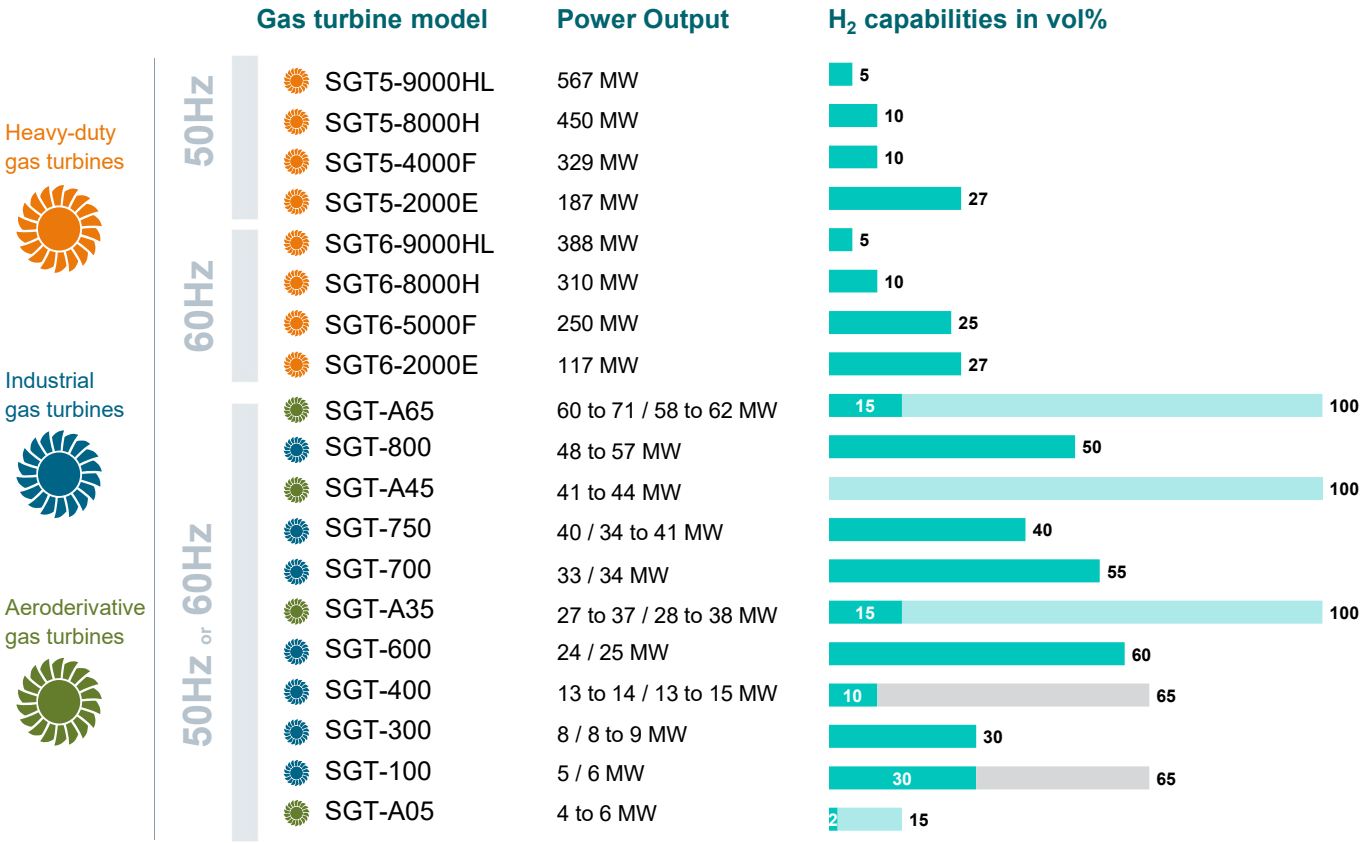
17.5 MW	Power demand per full Module Array (24 modules)
75 %	System efficiency (higher heating value)
24 modules	to build a full Module Array
340 kg	hydrogen per hour per full Module Array (24 modules)



Silyzer 300 – Module Array (24 modules)

In the short term, Hydrogen can already play a role to make fossil green

SIEMENS
Ingenuity for life



DLE burner
WLE burner
Diffusion burner with unabated NOx emissions

Values shown are indicative for new unit applications and depend on local conditions and requirements. Some operating restrictions / special hardware and package modifications may apply. Any project >25% requires dedicated engineering for package certification.

DLE: Dry Low Emission
WLE: Wet Low Emission

Energiepark Mainz
World's largest PEM electrolysis facility in 2015

SIEMENS
Ingenuity for life

3.75 MW

Power demand / 6.0 MW peak power (limited in time) based on three Silyzer 200

Facts & figures

- Customer: Energiepark Mainz (JV of Linde and Mainzer Stadtwerke)
- Country: Germany
- Installed: 2015
- Product: Silyzer 200

Use cases

Green hydrogen is fed into the local natural gas grid.

Delivery to surrounding industrial companies.

Hydrogen for regional filling stations.

Challenge

- Installation of world's first PEM electrolysis plant in the multiple megawatt range
- Provision of balancing energy
- High degree of automation

Solutions

- Installation of three Silyzer 200 with a maximum power consumption of 6 MW
- Highly dynamic power consumption
- State-of-the-art process control technology based on SIMATIC PCS 7
- Hydrogen processing, condensing, and storage (provided by Linde)