



thyssenkrupp

engineering. tomorrow. together.

Power to Gas and Power to X

24th July 2018 | Smart Energy Asturias | Lukas Lueke

thyssenkrupp Uhde Chlorine Engineers



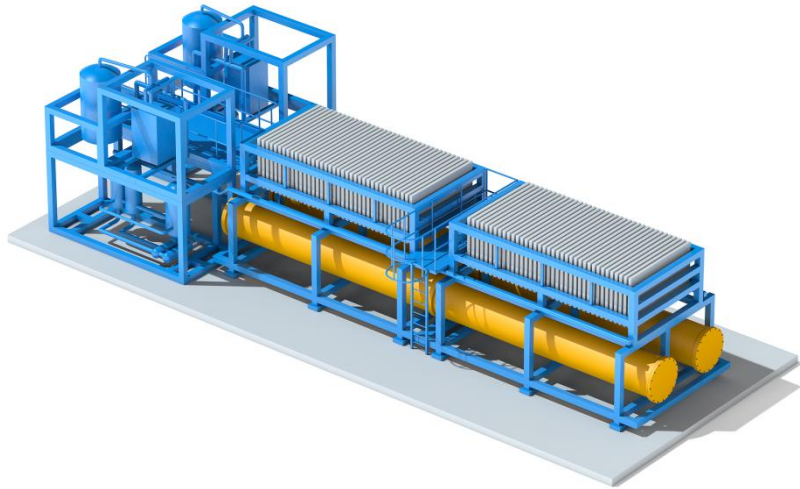
Water Electrolysis

key technology for sustainable hydrogen value chains

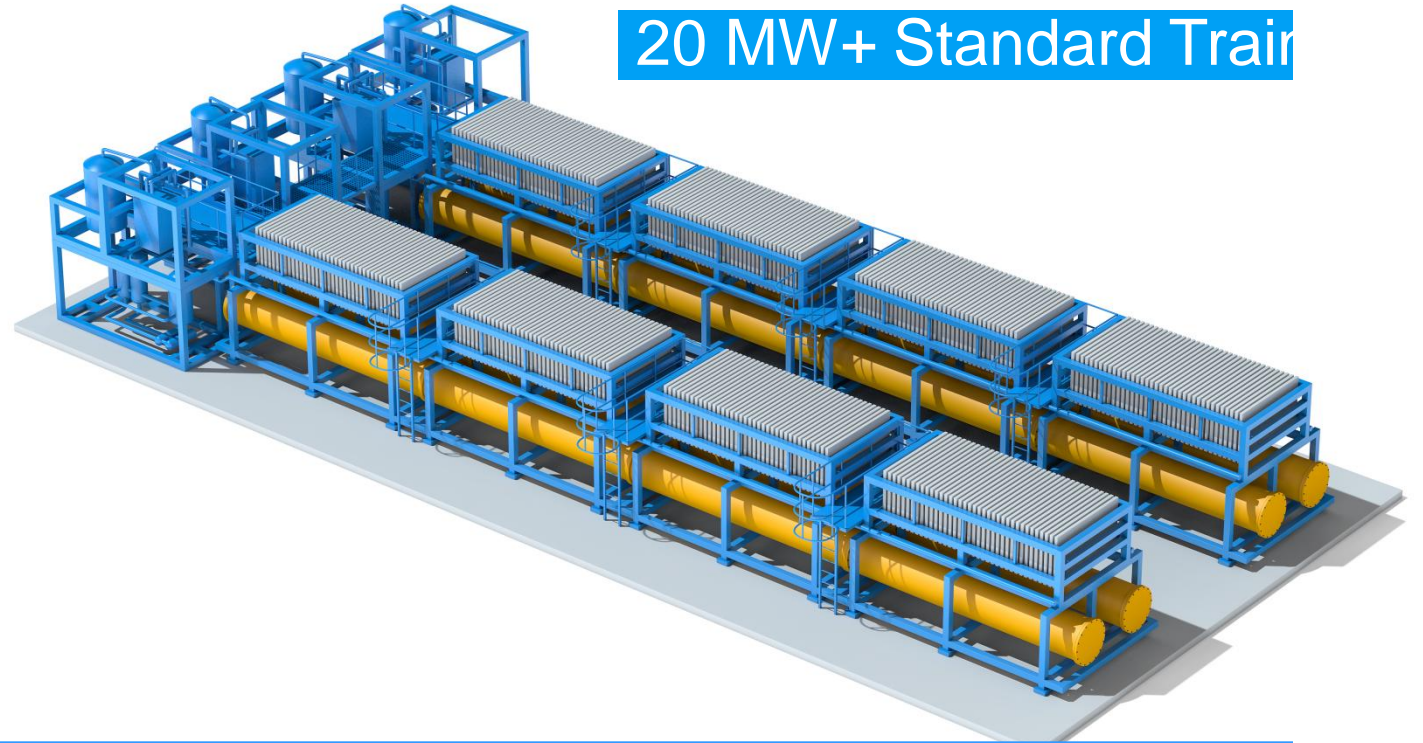


Our design philosophy: highly modular and standardized on prefabricated skids

5 MW Standard Module

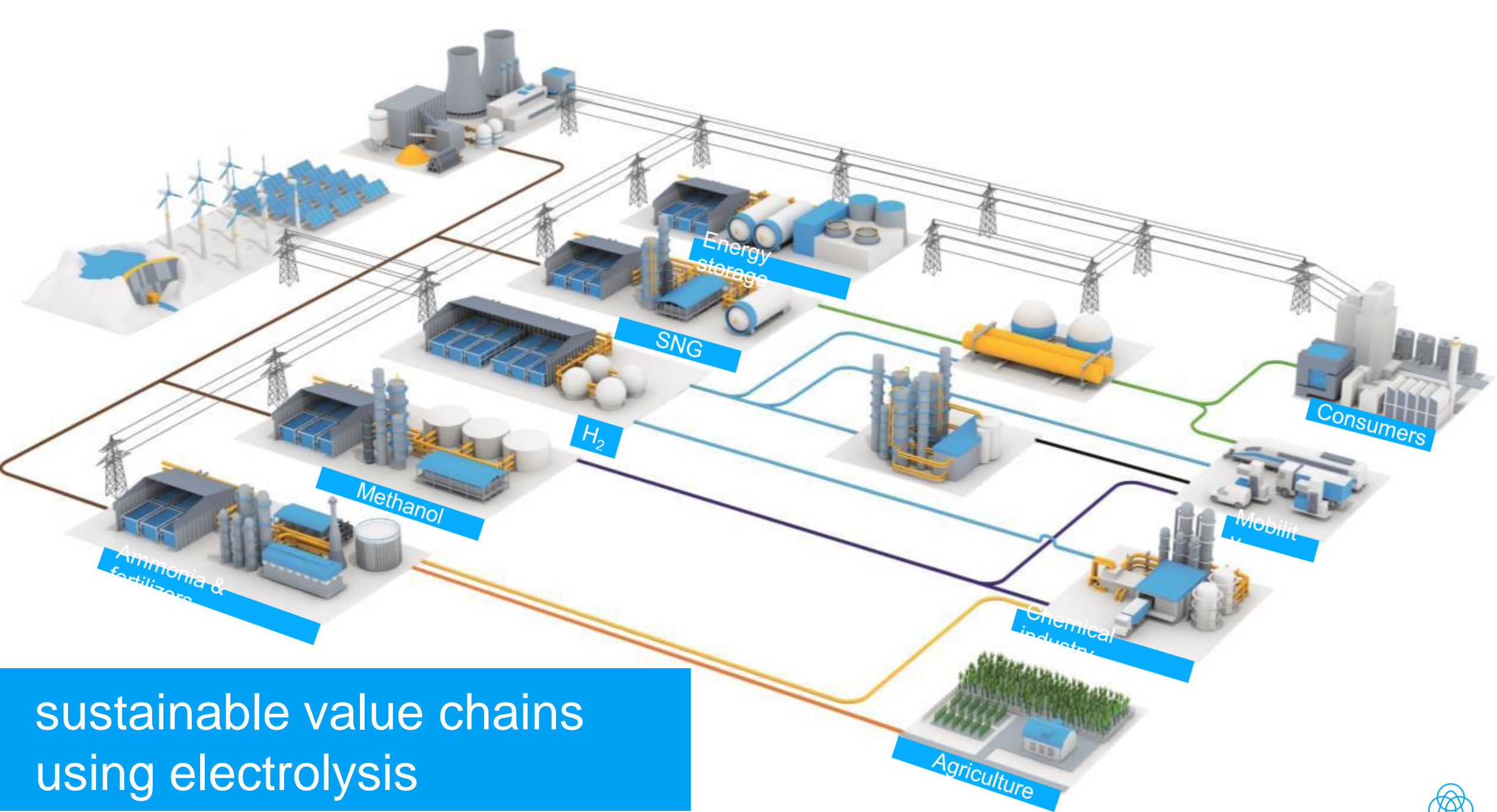


20 MW+ Standard Train



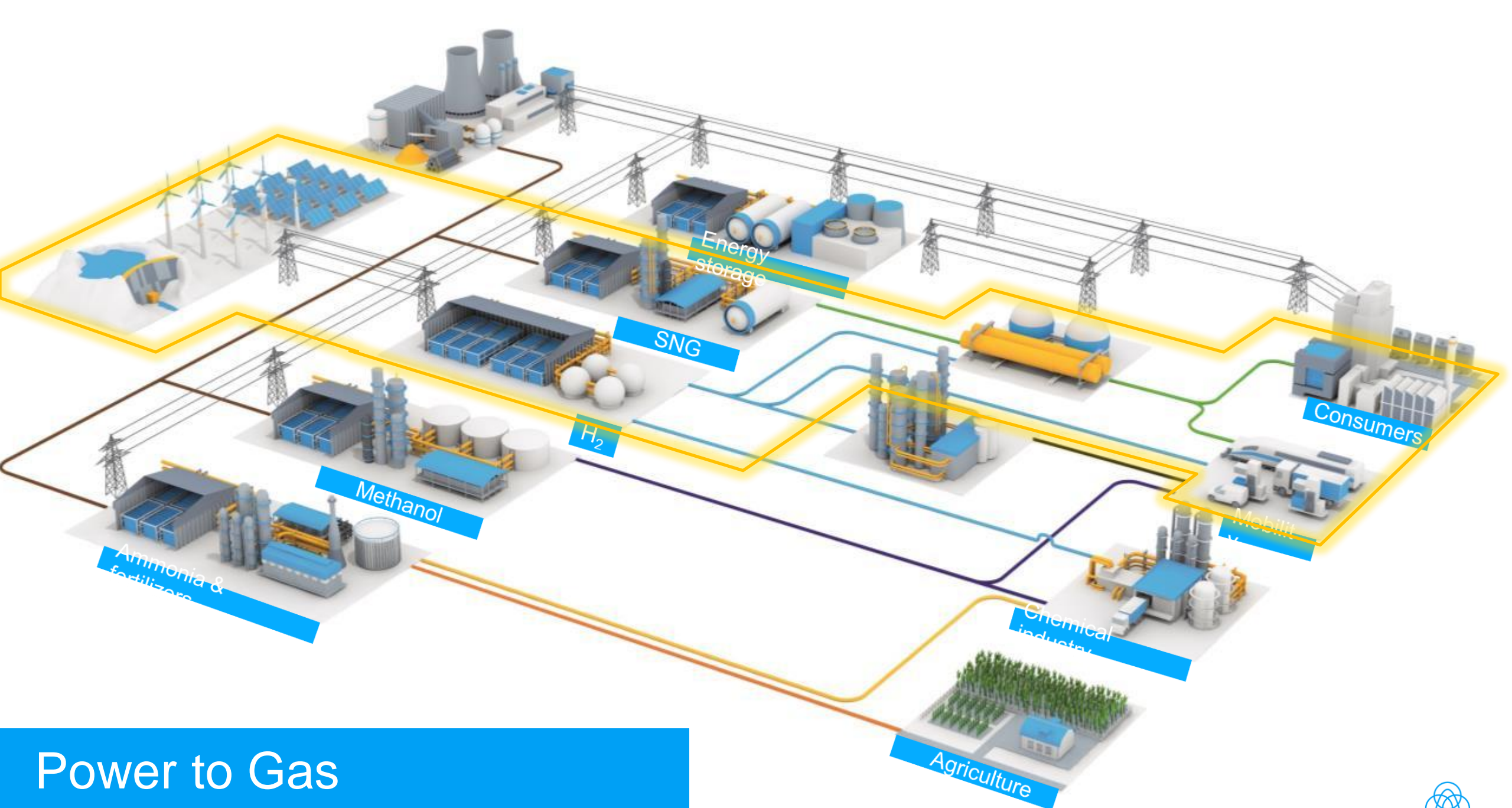
- Standardized, skid mounted electrolysis modules for cost efficient deployment at site.
- Area required for a 100 MW electrolysis plant is about 3000 m².
- Optional downstream processing equipment: compression, oxygen removal and drying





sustainable value chains
using electrolysis

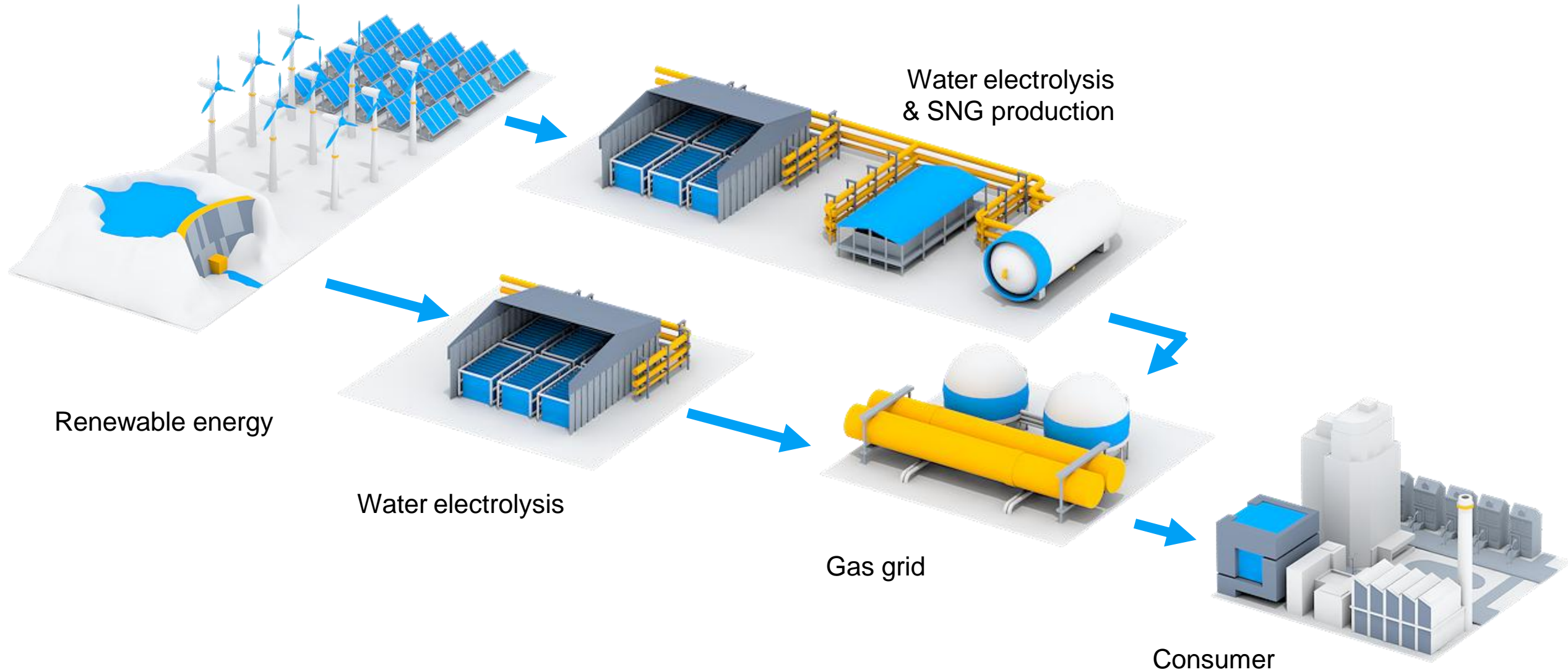




Power to Gas



Power to Gas



Power to Gas Projects in Germany



Germany	
E.ON - Falkenhagen 2 MW 2013 - 5 M€ e-on HYDROGENICS SWISSGAS	ENERTRAG - Prenzlau 500 kW 2012 - 21M€ ENERTRAG TOTAL VATTENFALL b-tu DB Energy Services AG NOW
E.ON - Hamburg 1 MW 2014 - 13,5 M€ e-on HYDROGENICS SolviCore	Thuga 360 kW 2013 thuga ITM POWER
RWE - CERAM HYD 100 kW 2013 RWE CERAM HYD	CO2RRECT 100 kW 2012 18 M€ RWE SIEMENS
Audi « e-gas » 6,3 MW 2013 entre 20 et 30 M€ Audi ETOGAS Fraunhofer EWE SW	RH2 - WKA 1 MW 2013 9,72 M€* HYDROGENICS
Energiepark Mainz 6 MW 2014 ~17 M€ Linde SIEMENS	H2BER Wind gas Hassfurt SHELL (10MW)

*pour la partie Hydrogène uniquement. Le projet est doté de 220 M€ pour la construction d'une ferme éolienne de grande envergure

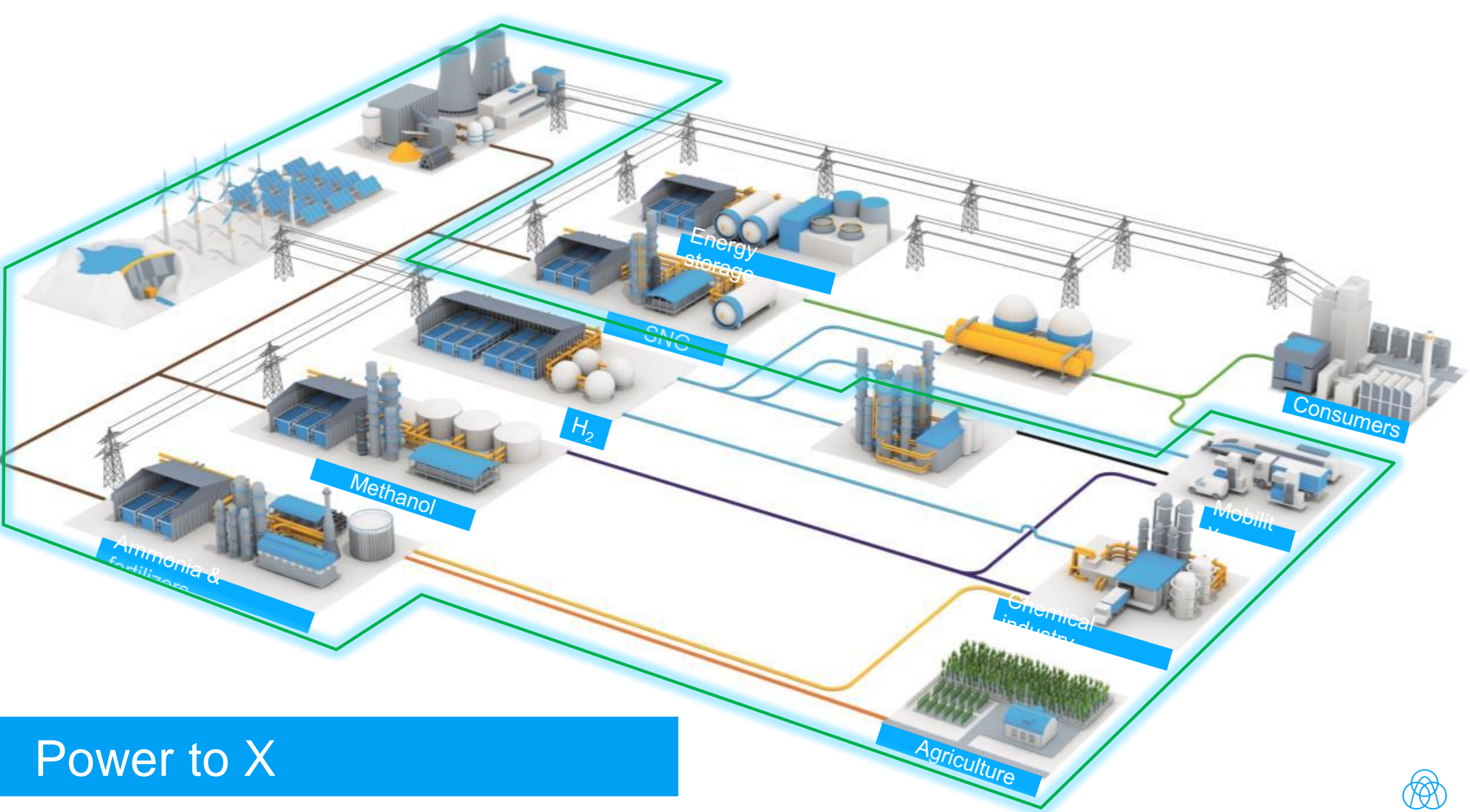
Source : Analyse Sia Partners





Site Falkenhagen / Germany





Power to X



Renewable ammonia

2 worldwide leading processes

1 holistic solution

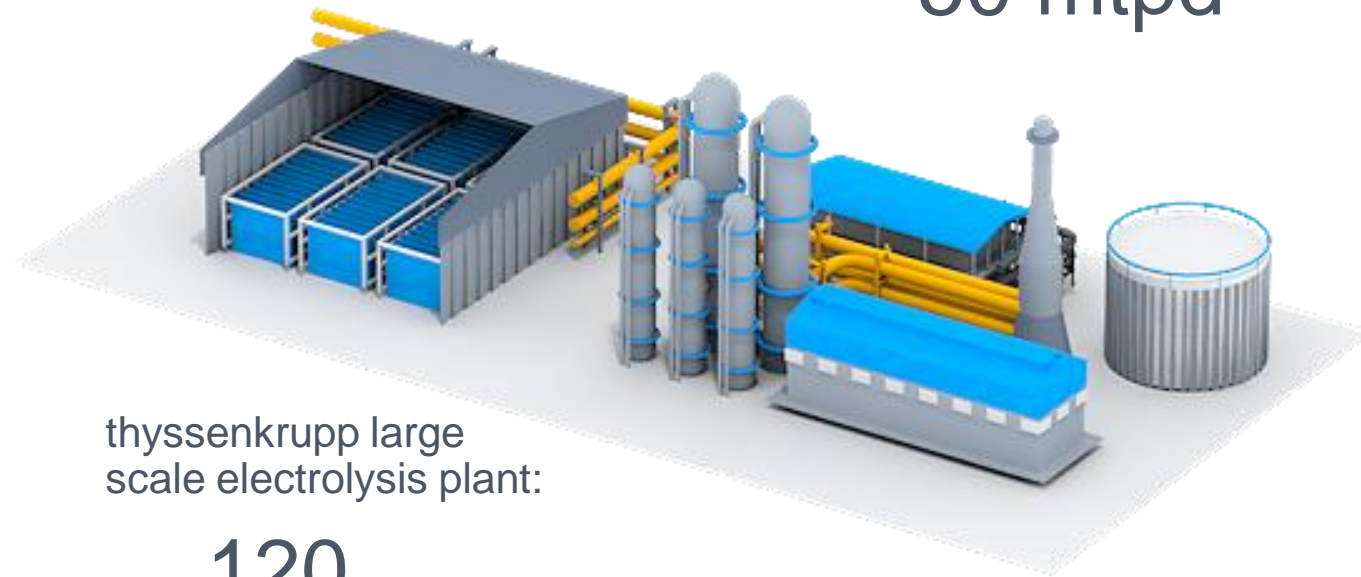
0 CO₂ emissions*

thyssenkrupp electrolysis plant:

20 MW

thyssenkrupp smallest scale ammonia plant:

50 mtpd



thyssenkrupp large scale electrolysis plant:

120 MW

thyssenkrupp small scale ammonia plant:

300 mtpd

*depending on E-power source



Availability of renewable energy is key

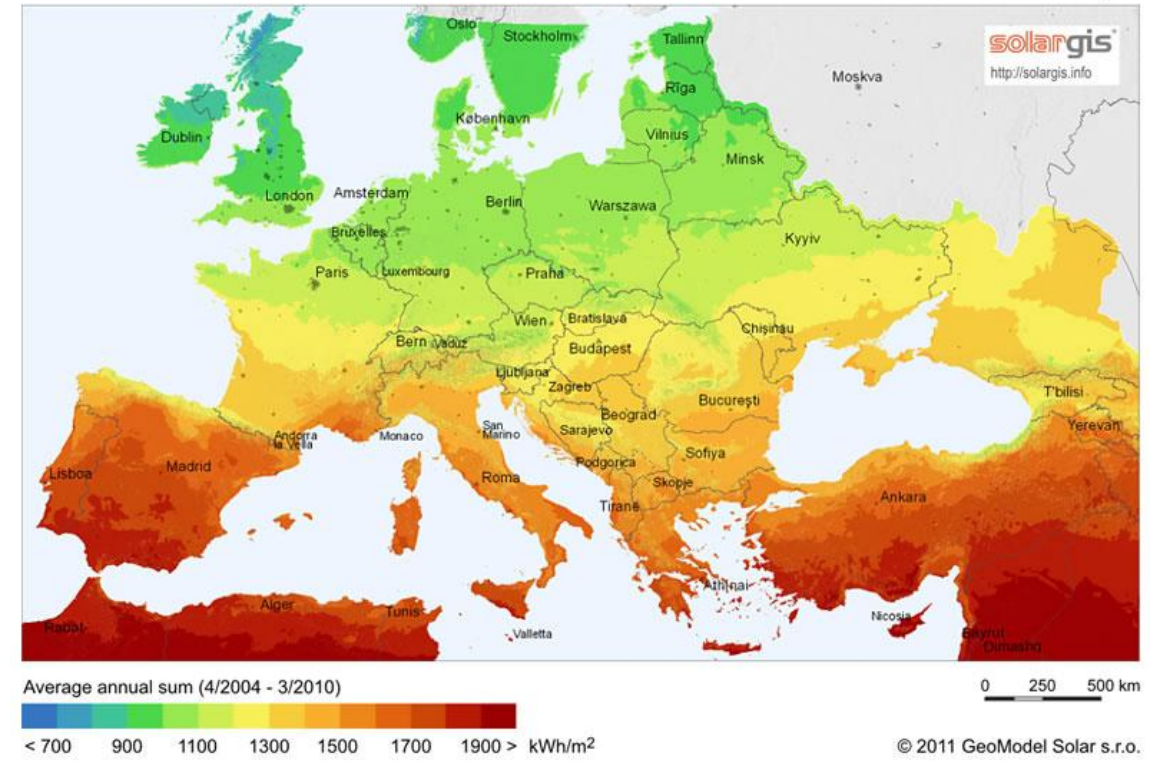
WIND MAP OF SPAIN
Annual Mean Speed at 80 m high



Source; http://atlaseolico.idae.es/inc/get_map.php?pdf=e-spd80_es

Global horizontal irradiation

Europe

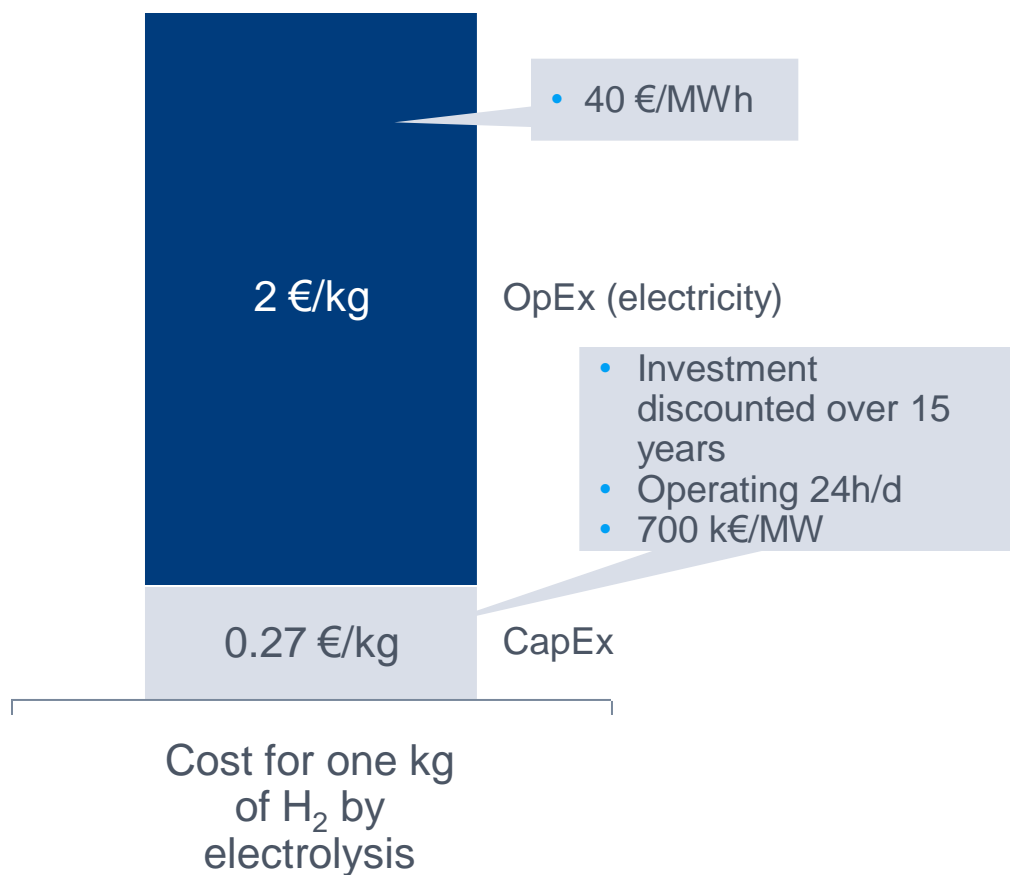


Source;
<http://www.greenrhinoenergy.com/solar/radiation/empiricalevidence.php>

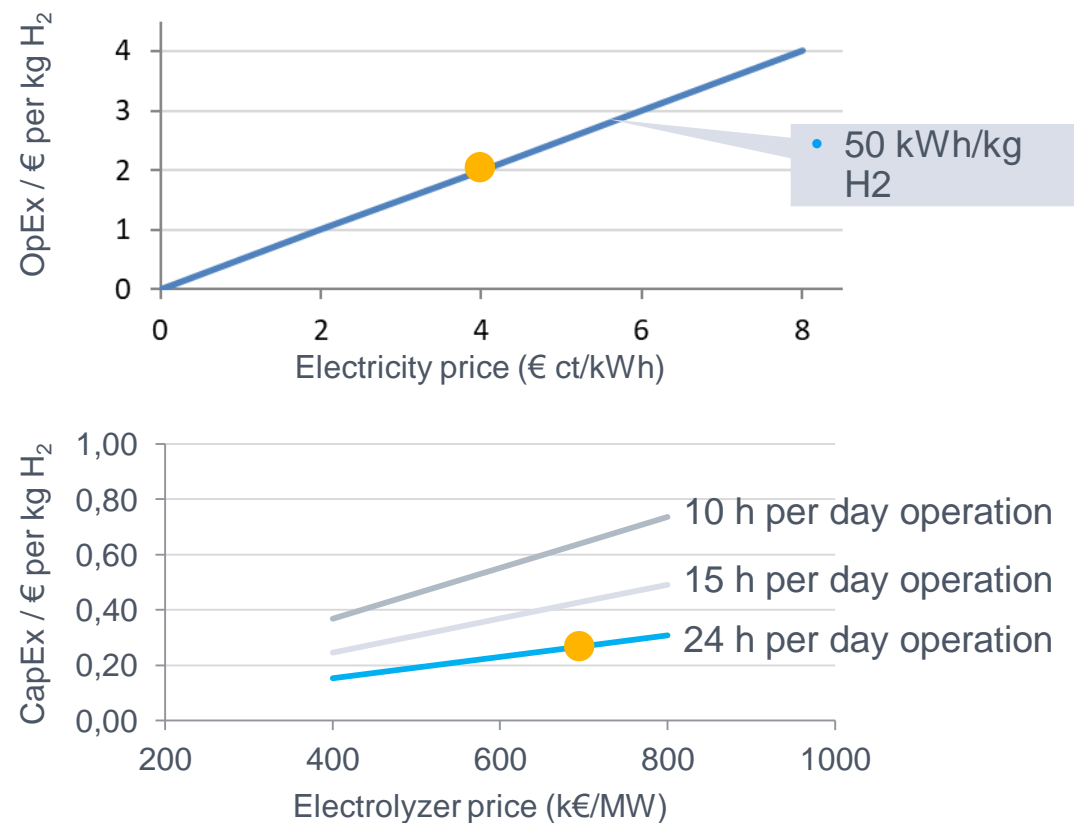


Cost for electricity strongly affects business case – example case H₂ production

Cost overview



Sensitivity analysis



The Future: Offshore solutions?



The renewable energy age is unstoppable...

... energy storage and carbon conversion are key

A photograph of four wind turbines in a field of green crops, likely rapeseed, during a sunset. The sun is low on the horizon, creating a warm orange and yellow glow. The turbines are silhouetted against the bright sky. The field in the foreground is filled with green plants with small yellow flowers.

thyssenkrupp provides solutions for
integrating

and leveraging renewables and recycling
carbon