ADVENT

MicroGrid Applications using Liquid Fuel with Fuel Cells

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ACEF Asian Development Bank

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ADVENT FUEL CELL TECHNOLOGY "ANY FUEL. ANYWHERE."

ANY FUEL

HYDROGEN

- Fuel for most heavy-duty mobility & industrial markets

METHANOL

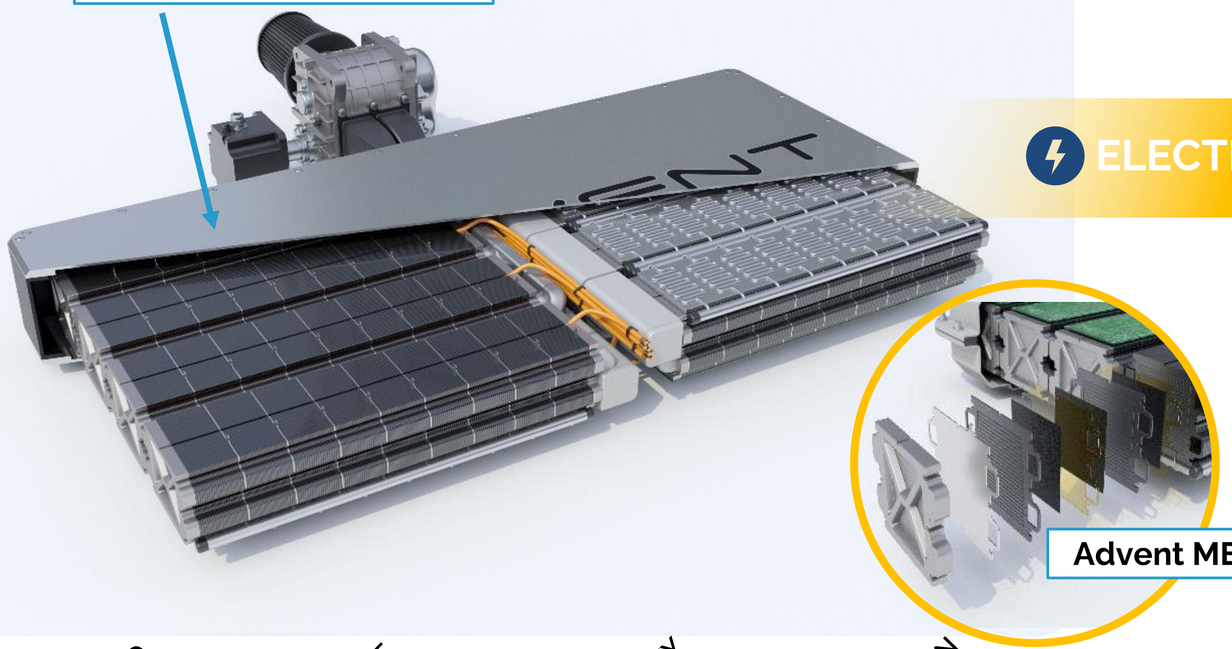
- Option for off-grid & portable
- Interim low-cost option for mobility

MARKET NOW

e-FUELS (H2 carriers)

- Low-cost hydrogen at minimal infrastructure cost
- e-Methanol, DME, LOHC

MARKET IN NEAR FUTURE



ANYWHERE

MARKETS

ELECTRICITY


Defense


Off-Grid


Heavy-Duty Automotive


Aviation


Combined Heat & Power


Marine

CRITICAL POWER GENERATION: H2/Methanol FUEL CELL SYSTEMS

01 PROVEN

- Advent has shipped and deployed close **to 1000 fuel cell units globally segments** within the telecom industry plus for utilities and other industry segments.
- Operate at extreme conditions up to 50c and -40C

02 DEPLOYABLE

- Clean technology for critical backup power, temporary or continuous power 24/7
- Optional Fuel cell cabinet: independent power system.

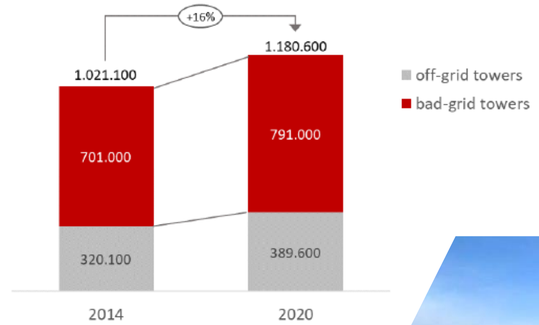
03 CLEAN ENERGY

- Multifuel Option (H2, Methanol, eFuels, NG)
- No particulate pollutants or unburned hydrocarbons.
- Less carbon dioxide than other, less efficient technologies.
- e-Fuels or bio-methanol, this creates a path to significant reductions of harmful emissions.

Business Case

Smart Communications deploys Advent Technologies fuel cells across its Philippine telco network

Total number of off-grid and bad-grid towers:



Source: GSMA, "Green Power for Mobile", Dec 2014.
Bad-grid: Less than 18 h of reliable grid access per day.

September 1, 2021
Acquisition of Fuel cell businesses SerEnergy & Fischer Eco Solutions.

- 100+ additional highly-skilled R&D, manufacturing and sales professionals
- HT-PEM focused with proven production capabilities in Denmark & Germany
- Acceleration with business in Asia and Northern Europe markets

Stationary Power Systems

We Replace Diesel Generators

with **Serene Fuel Cells**: Proven, Low-Cost, Green Solution

Ready to Use Today

METHANOL

Ready for the Future

HYDROGEN/eFUELS

POWER

- Mobile Operators
- Tower Companies
- Critical Infrastructure
- Energy Service Cos
- Construction
- Utilities
- Microgrids
- Government
- Defense
- Marine

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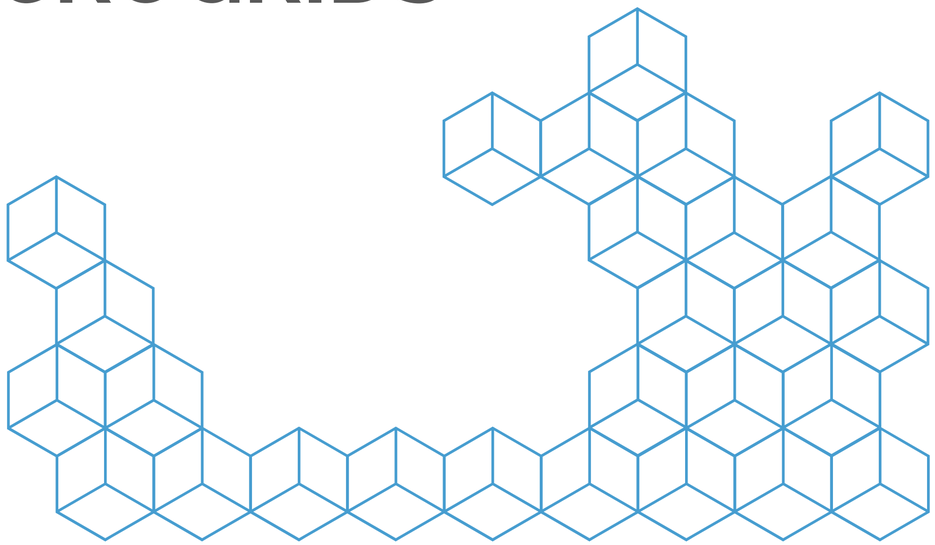
THE STORY OF THE MISSING LINK IN MICROGRIDS



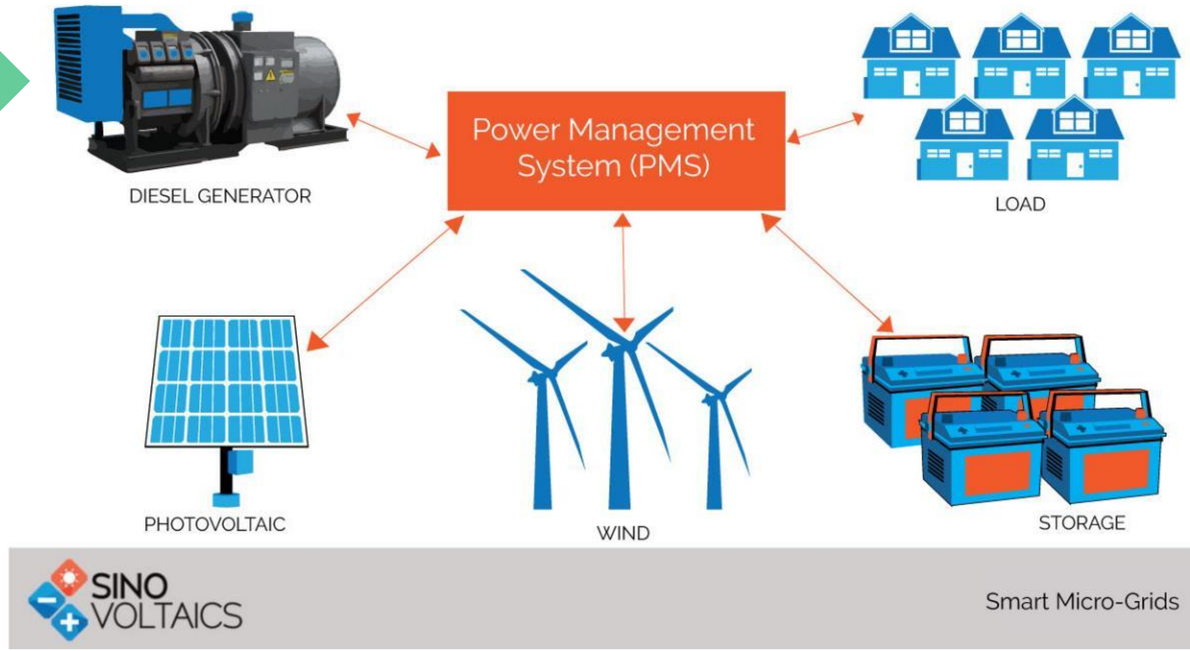
MICROGRIDS AND RENEWABLE ENERGY – THE CONUNDRUM

- Renewable Microgrids allow for shorter distribution networks will allow for less losses and less potential for failure

- Using Solar or Wind (if available) in Asia and possibly a little wind are great solutions, bridging with some batteries for a few hours …. But what about the evening load ? ?

- Batteries can take some of that load but aren't a solution for the whole evening and are not really that green

This Microgrid isn't Really Renewable



"What's wrong with this picture ??"

THERE IS ANOTHER FUEL THAT CAN REPLACE DIESEL

- Currently distribution of hydrogen is diffcult or not readily available
- Fuel cells that use an easily available liquid like methanol can be an interim solution to provide critical back up power
- Low weight and footprint compared to hydrogen storage in bundles of cylinders.

Renewable
Methanol

Comparison of energy content after convertion into electricity

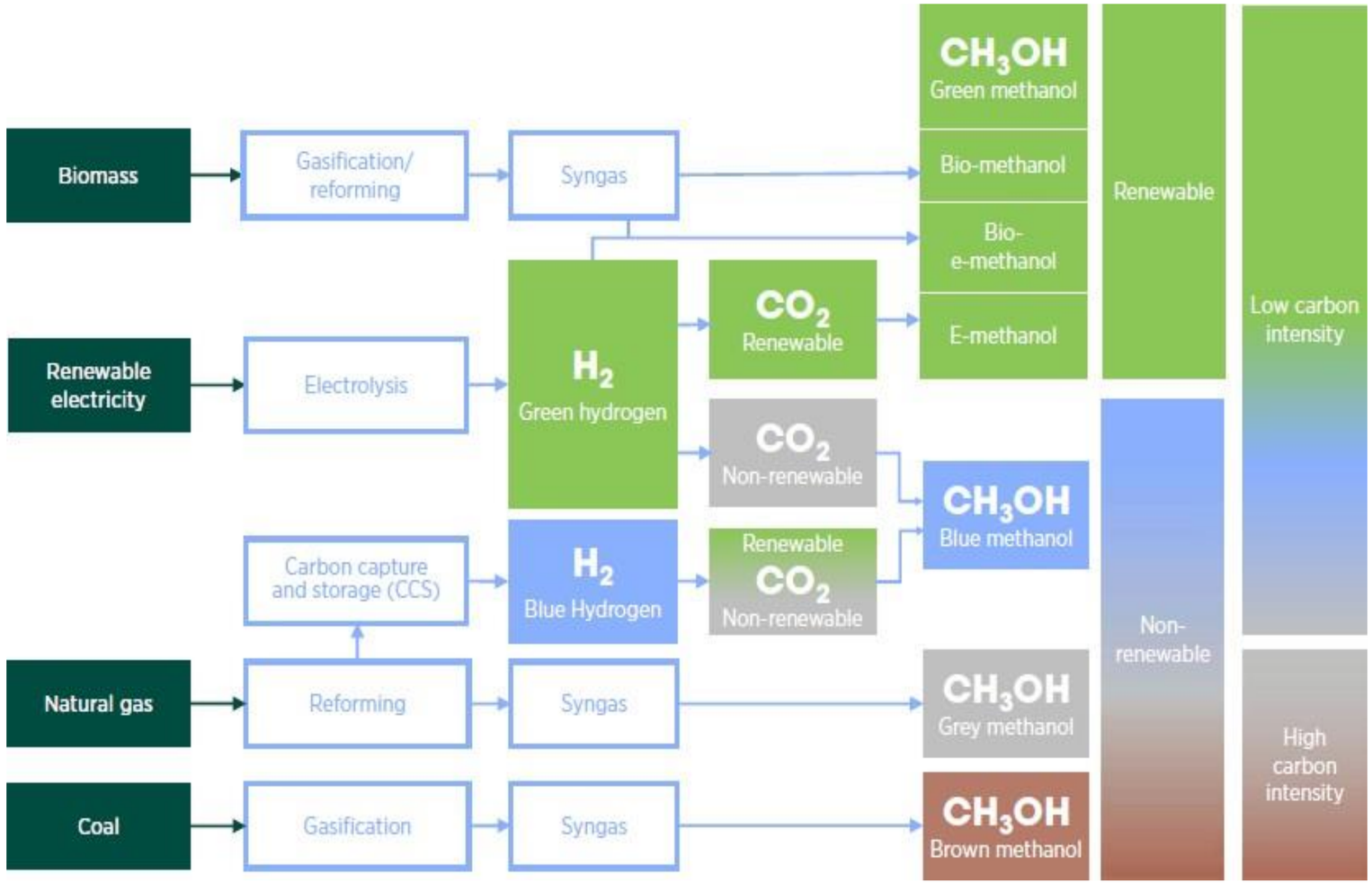
50 L compressed Hydrogen and Fuel cell $n_{eff.}$ = 50%	**44 MJ**
16 pcs. 840 Wh Lead-acid batteries, $n_{eff.}$ = 90%	**48 MJ**
7 L Methanol, reformer og fuel cell, $n_{eff.}$ = 40%	**45 MJ**

50 L H_2 @ 200 bar
+50 L og 63 kg

16 pcs. Lead-acid batteries
192 L og 461 kg

Methanol (CH_3OH)
7 L og 5,5 kg

METHANOL – THE FUEL OF THE FUTURE



- Interest in "green" methanol is growing due to its ability to be an extremely low-carbon fuel and chemical
- IRENA projected that by 2050, 250 MMT of e-methanol and 135 MMT of bio-methanol will be produced annually
- **As a liquid fuel, methanol's handling and utilization is not very different from conventional fuels, Its even Safer !!**

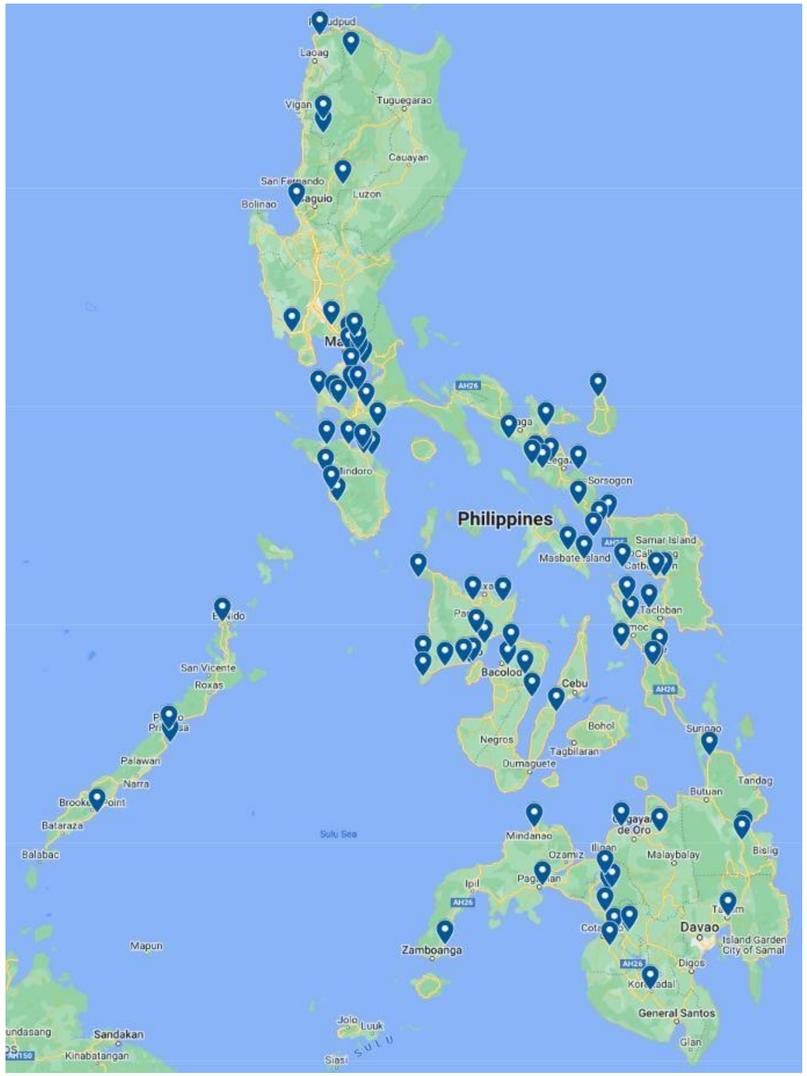
Note: Ammonia is 12,000 to 15,000 more toxic in water than Methanol

FUEL CELLS ALLOW FOR RESILIENCY AND RELIABILITY IN MICROGRIDS

- Fuel cells offer a viable alternative to diesel generators
- Offering a cost effective TCO of 2-6 years in most cases
- They are more reliable, need less maintenance, quite, don't vibrate and are Green
- With liquid fuel, is it also easily a replacement with existing generators

	Diesel Generator	Batteries	Fuel Cell
Maintenance	6-8 times per year	2-3 times per year	1 time per year
Resilience	Good	Intolerant	- 20°C to 50°C
Duration	Just add fuel	1-2 hours	Just add fuel
CO2 emissions	Highest emissions & pollutants	Grid-based (20% - 40%) reduction	80%-100% emissions reduction
Recycling	No recycling of system	Expensive and difficult to be recycled	Easily recycled
Noise	High over 100db	Negligible	Under 50db
Footprint	Large	Large	Small
Theft	High	High	Negligible

PHILIPPINES – HUNDREDS OF SITES IN OPERATION



- Our experience in the Philippines over 6 years (over 800 systems)
- Deploying back up systems to allow for reliable communication systems in that country

FUEL CELLS WITH LIQUID FUELS ARE EASILY PORTABLE

OTHER EXAMPLES THAT CAN BE USED IN THE FUTURE

CASE STUDY: FELDHEIM GERMANY

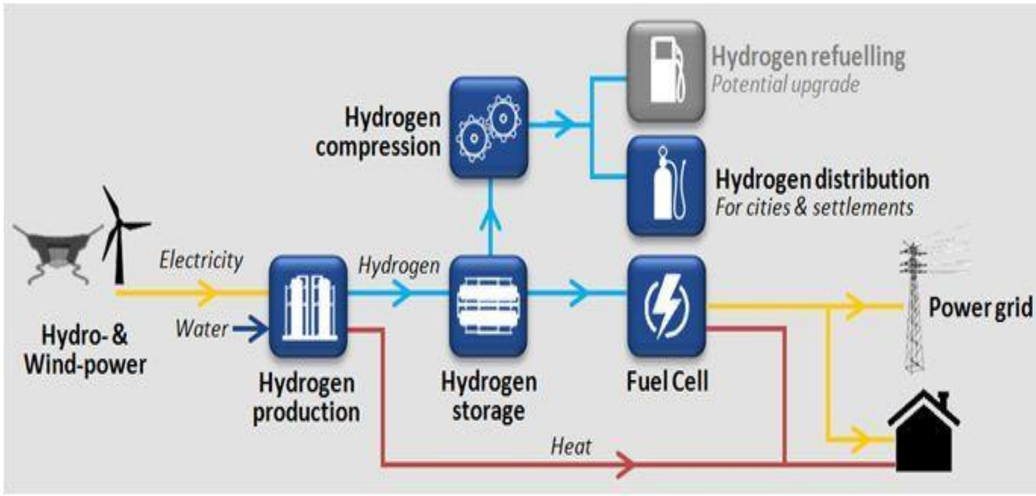
- With Germany's centre right initiative toward energy independence by 2035 !

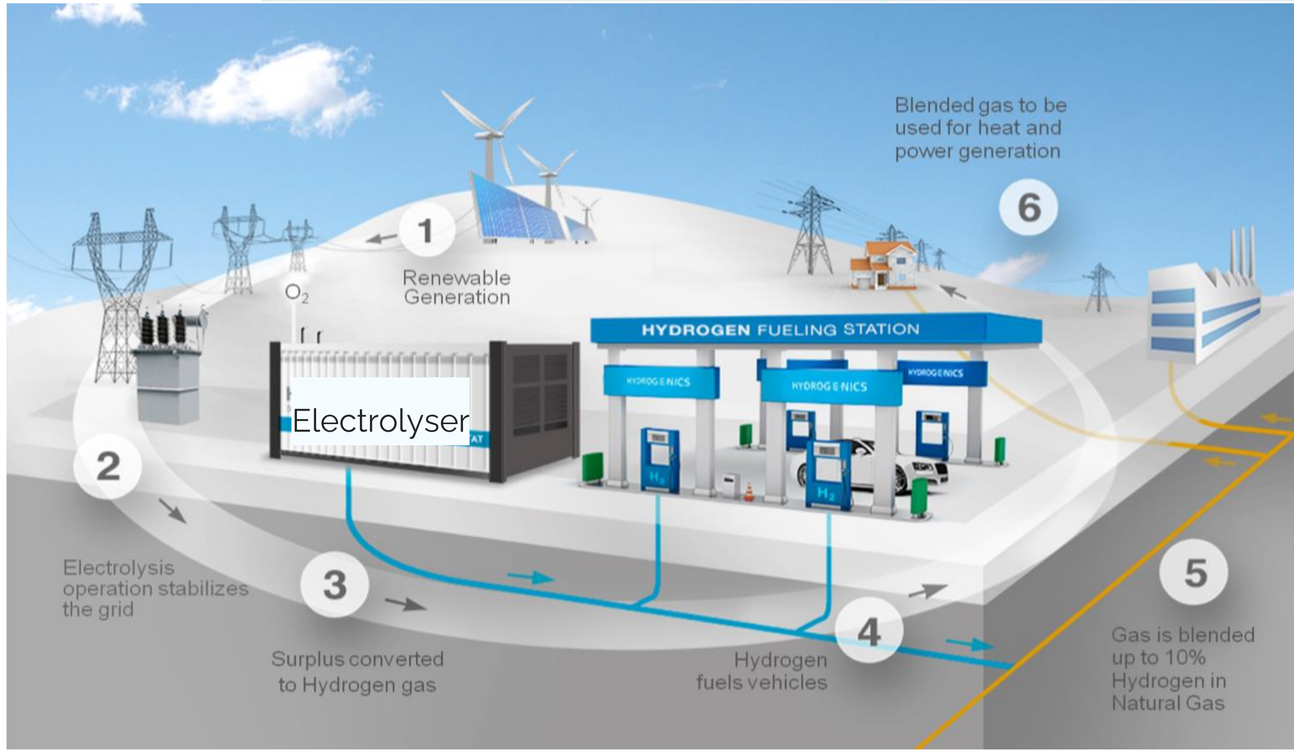
- 'Energiewende' or energy independence is being expedited with the Invasion of Ukraine

- Felheim Germany went one step further by building their own grid from :
  - Solar Farm
  - Wind Farm
  - Biogas plant
- Initial legal challenges but eventually the town became 100% off grid by
- Now exports 250 times the energy it uses and was 100% renewable since 2013
  - Initial connection fee of 3000 euro

FUTURE GRID : RENEWABLES & HYDROGEN

- Integrating renewables allow for not only local generation but also local supply of fuel
- Integrating local peak solar or wind can allow for local generation of hydrogen
- Hydrogen can fuel vehicles, used in fuel cells or can be used in local industrial processes





Thank you for your attention

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