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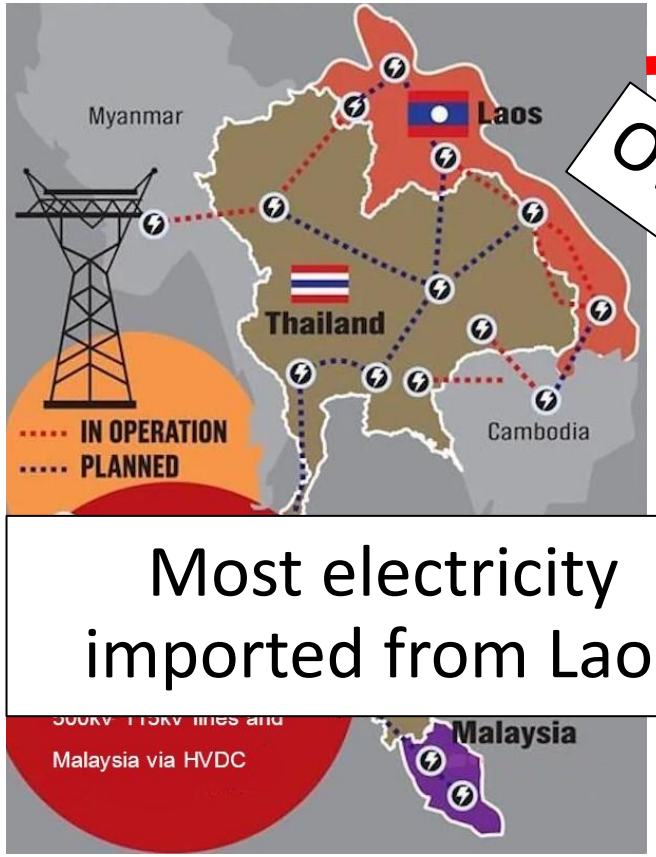
An Overview of Green Hydrogen Production and Energy Storage Facilities, the Lam Takhong Wind Hydrogen Power Plant

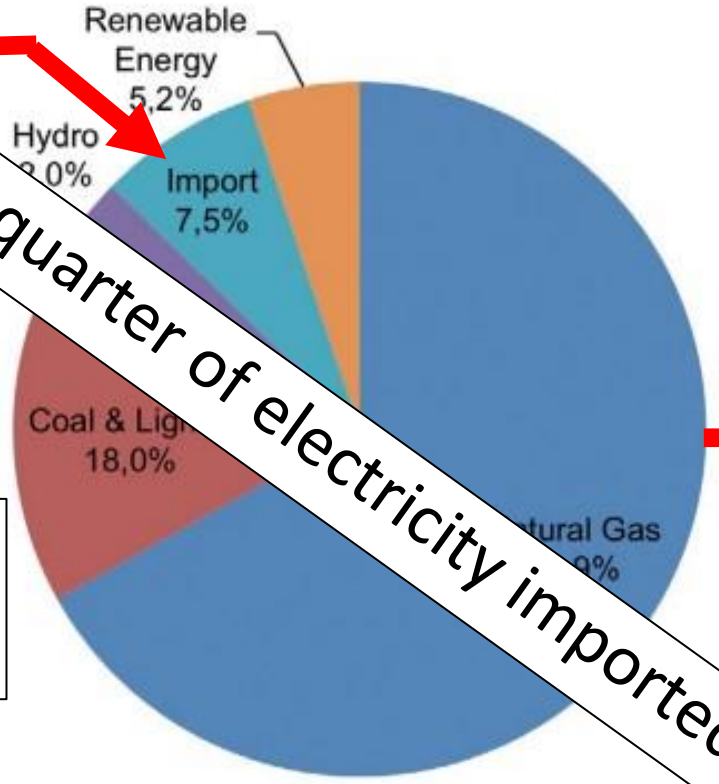
By Yosapol Rathamarit

Electricity Generating Authority of Thailand

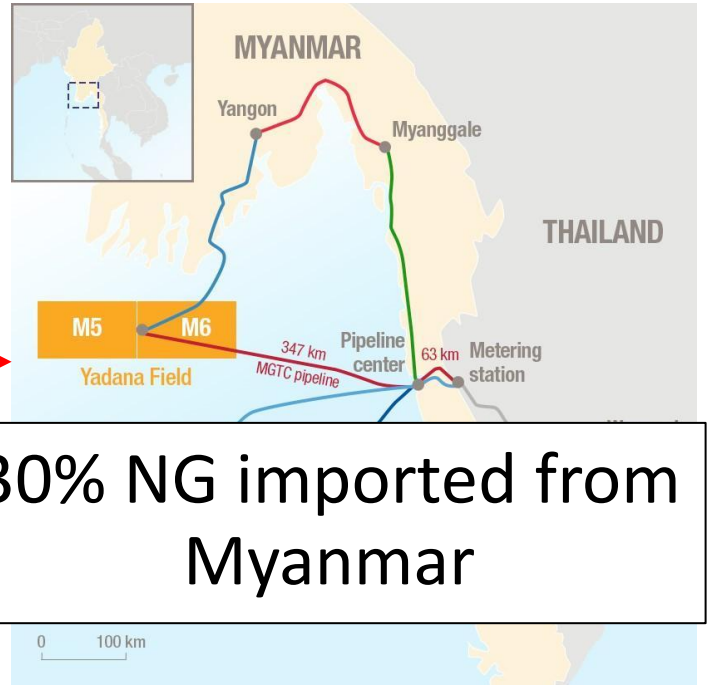
Thailand's search for new energy



Most electricity imported from Laos



Over quarter of electricity imported



30% NG imported from Myanmar

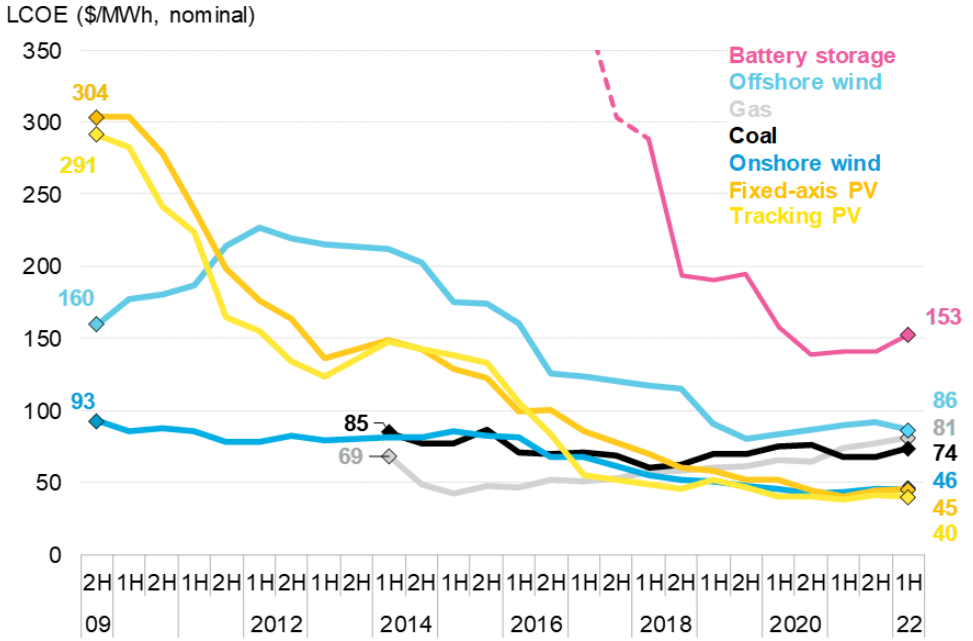
Thailand's Energy Mix in 2015

Source: Energy Policy and Planning Office, Ministry of Energy

Thailand's search for new energy

Strong protest against coal, only one replacement ccoal power plant built since 2016

Figure 1: Global levelized cost of electricity benchmarks, 2009-2022

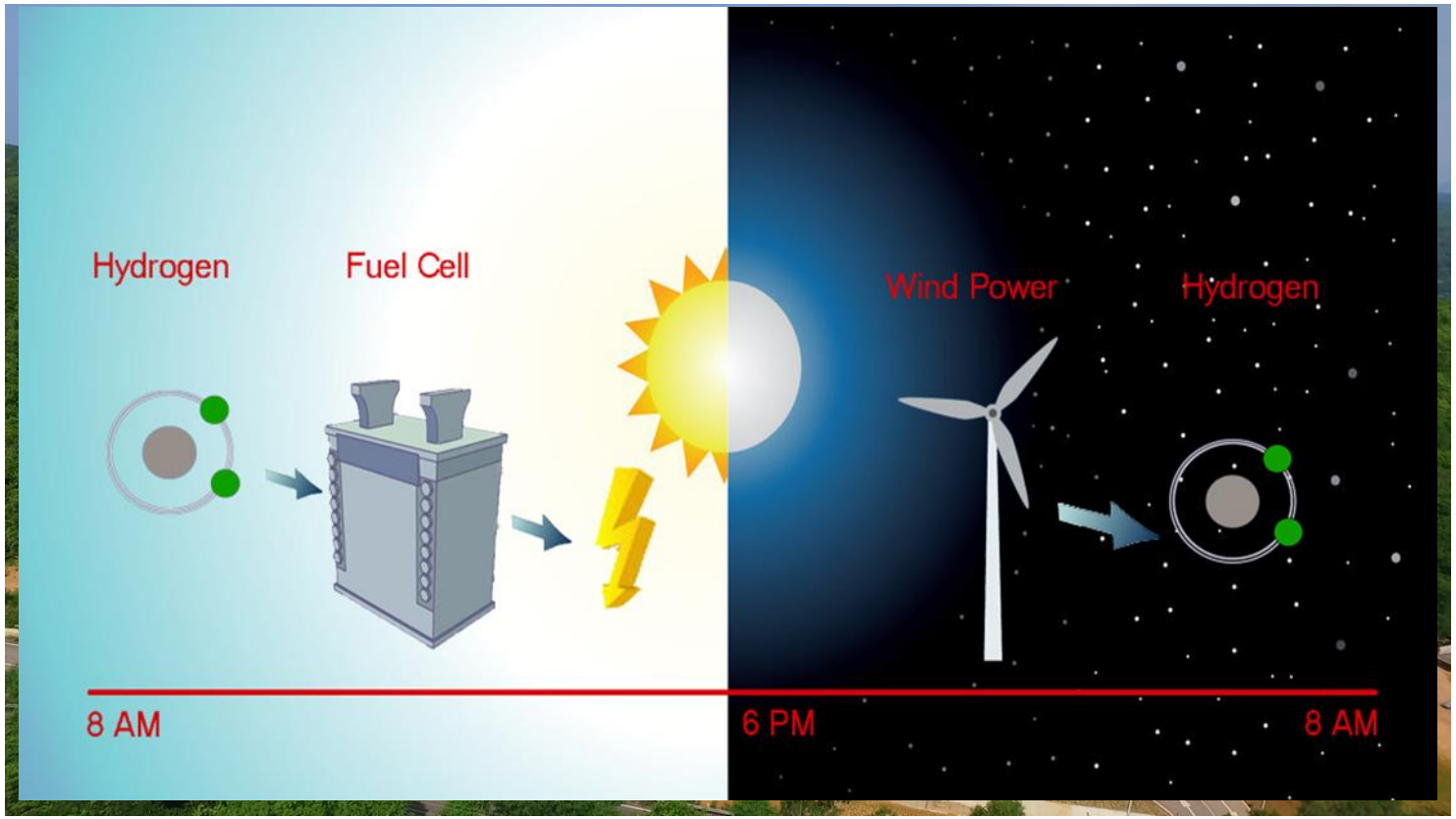


Source: BloombergNEF. Note: The global benchmark for PV, wind and storage is a country-weighted average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-ion battery storage system with four-hour duration running at a daily cycle and includes charging costs.

Significant reduction in prices per MW of renewables, but storage is necessary to mitigate transients

Green Hydrogen Case Study: EGAT Lam Takhong wind hydrogen hybrid

- Green Hydrogen from wind energy, 12x2 MW wind turbines, by electrolysis
- First grid scale green hydrogen production and wind hydrogen hybrid plant in Southeast Asia
- Electricity from hydrogen feeds EGAT learning center, first sync in 2018



EGAT Lam Takhong Electricity Flows

Excess Electricity

12 x 2MW Wind Turbines

Main Plant Switchgear

Switchyard

Transmission Lines

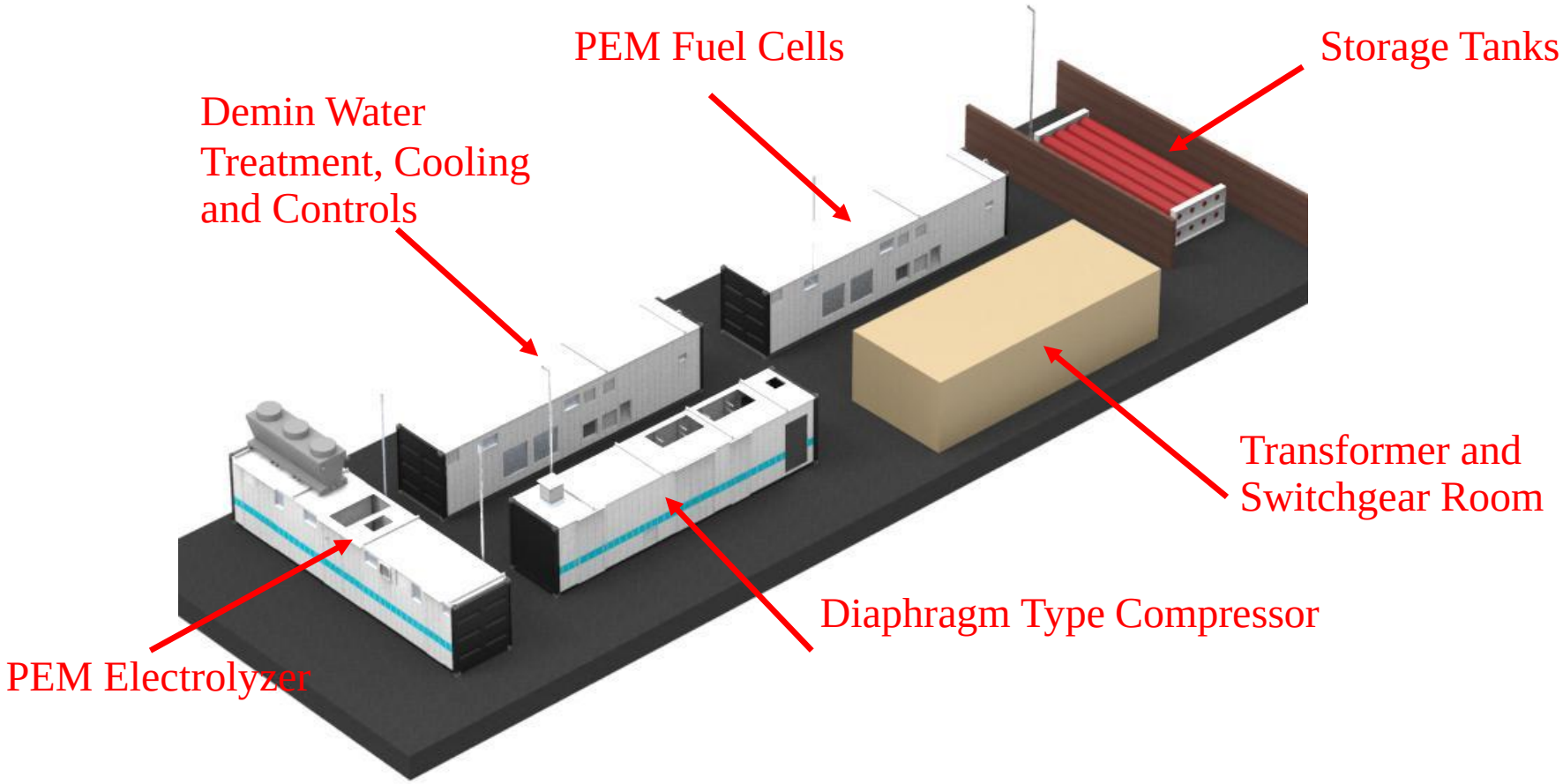
Hydrogen Production varies with wind energy

Hydrogen Energy Storage Ssystem

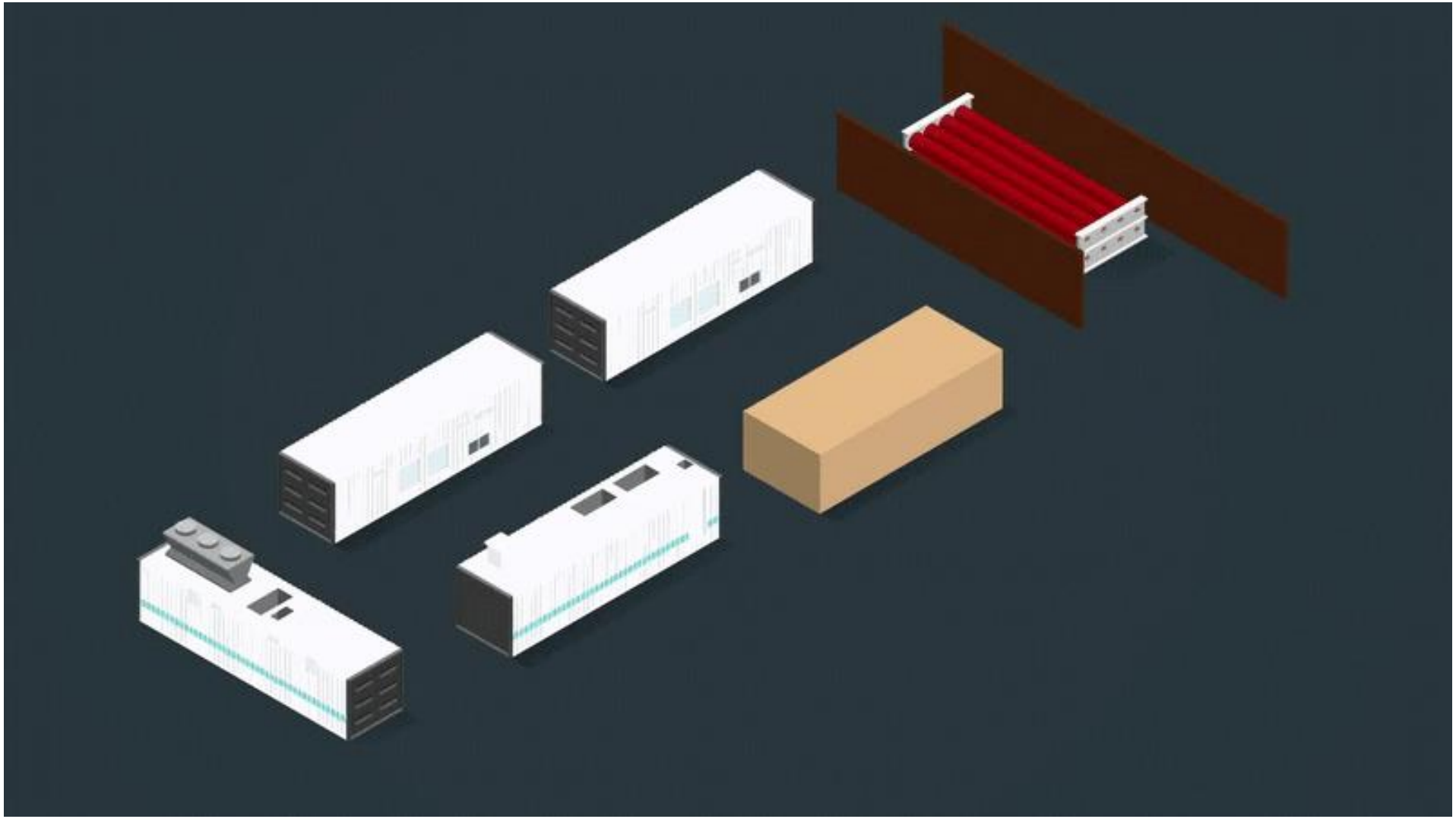
EGAT Lamtakhong Renewable Energy Park

38 kW Solar Panels

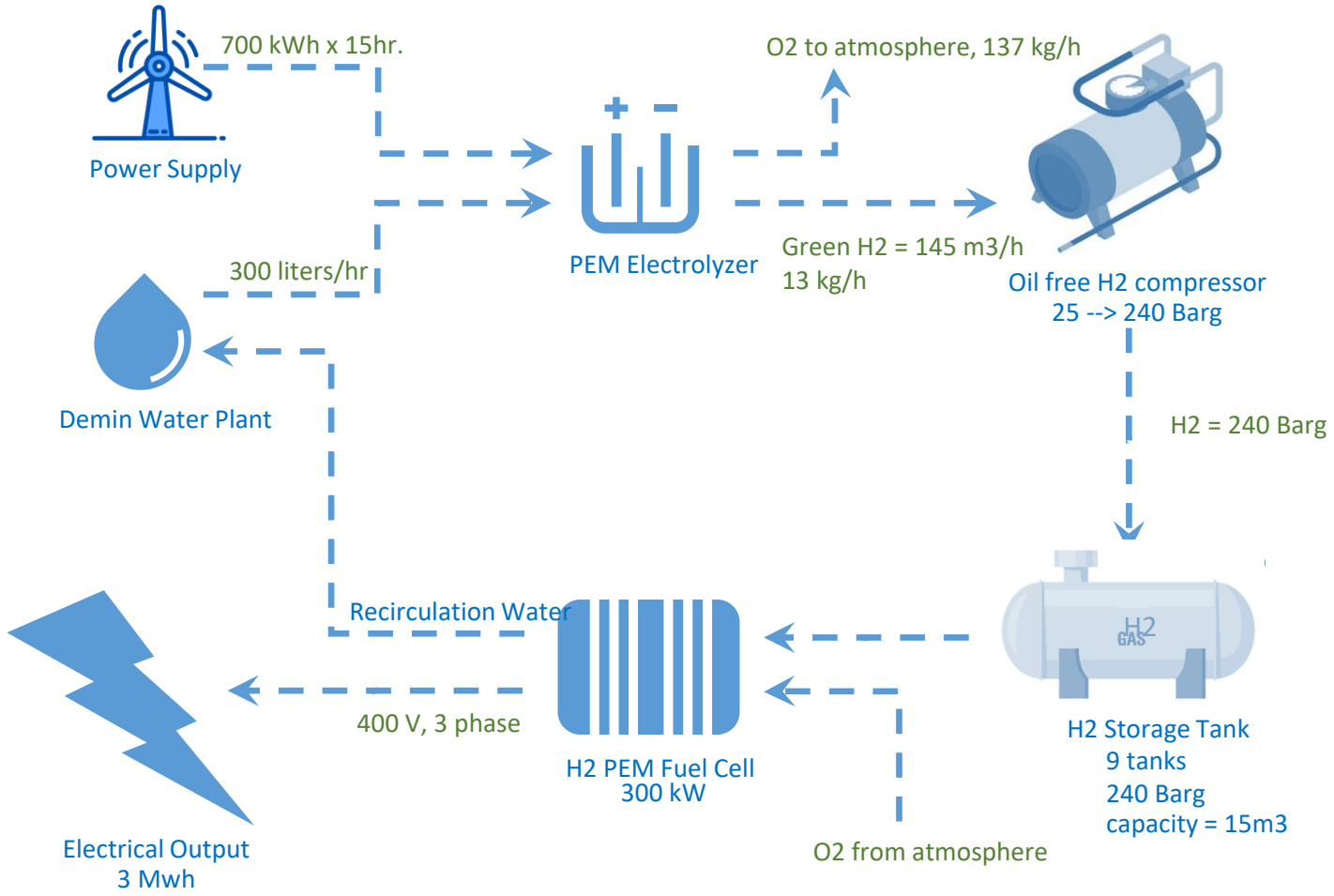
Components of the Hydrogen Energy Storage System Lam Takhong



Operation of the Lam Takhong Hydrogen Energy Storage System



Design Parameters of Lam Takhong Hydrogen Energy Storage System

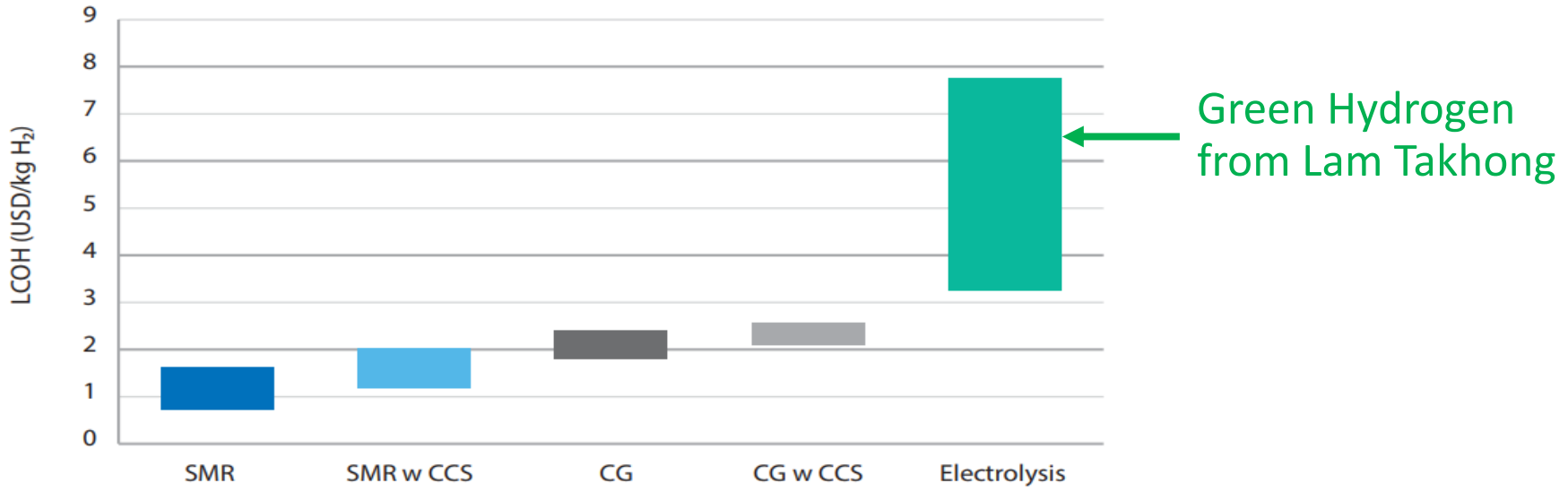


Efficiency of Energy Storage is 31-42%

Green Hydrogen from Lam Takhong

- 1 kg of green hydrogen uses 41.73 kwh of electricity (highest efficiency)
- LCOE of electricity from Lam Takhong wind turbines is 3.1 baht
- 1 kg of green hydrogen LCOE 129.6 baht (3.4 USD) in electricity costs
- With electrolyzer equipment costs, 1 kg of green hydrogen costs 238.6 baht ~ 6.27 USD

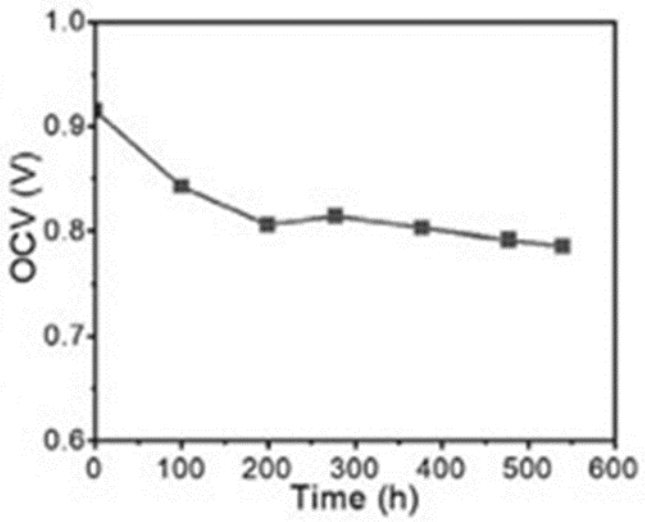
Figure 10.3: Current levelised cost of hydrogen productions for different technologies

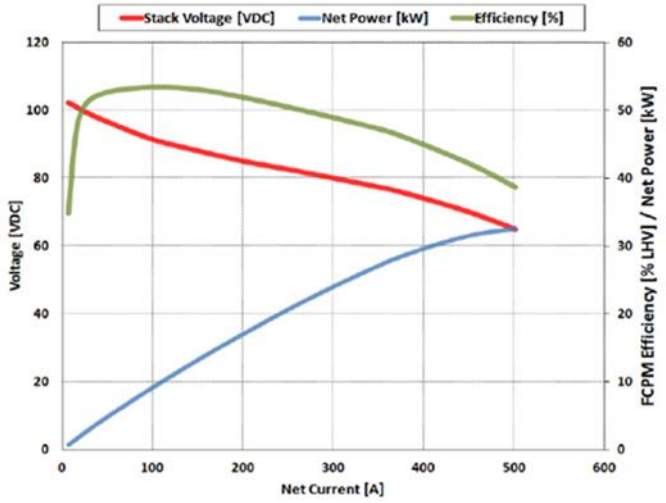


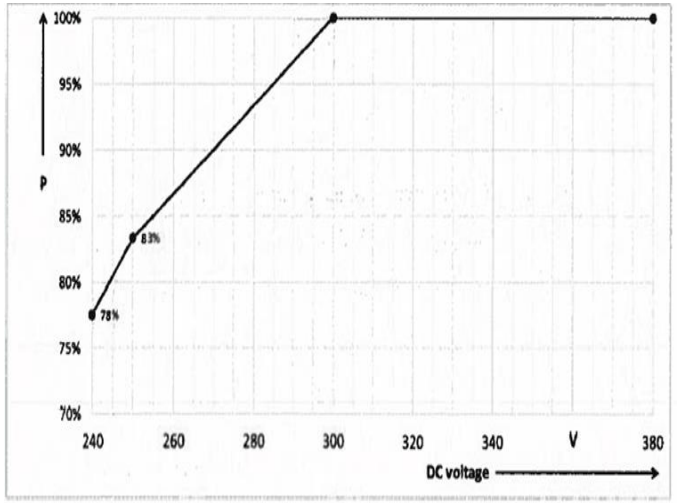
IEA 2019

Hydrogen as Energy Storage: Lam Takhong Experience

- Usage of hydrogen, limited by issues with fuel cell
- Lesson 1: chemical generation limited by property curves
  - Break in deterioration
  - I-V-load curves
  - High currents strain electrical components, inverter/converter







Hydrogen as Energy Storage: Lam Takhong Experience

- **Lesson 2: System is simple but every part is critical**

Recirculation pu
fail no alarm but
power

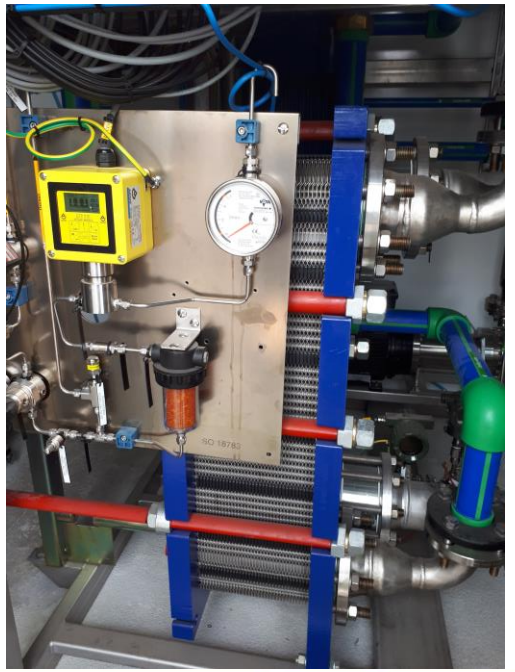
High Water is an Alarm, but flooding fouls FC

Water Recovery Tank

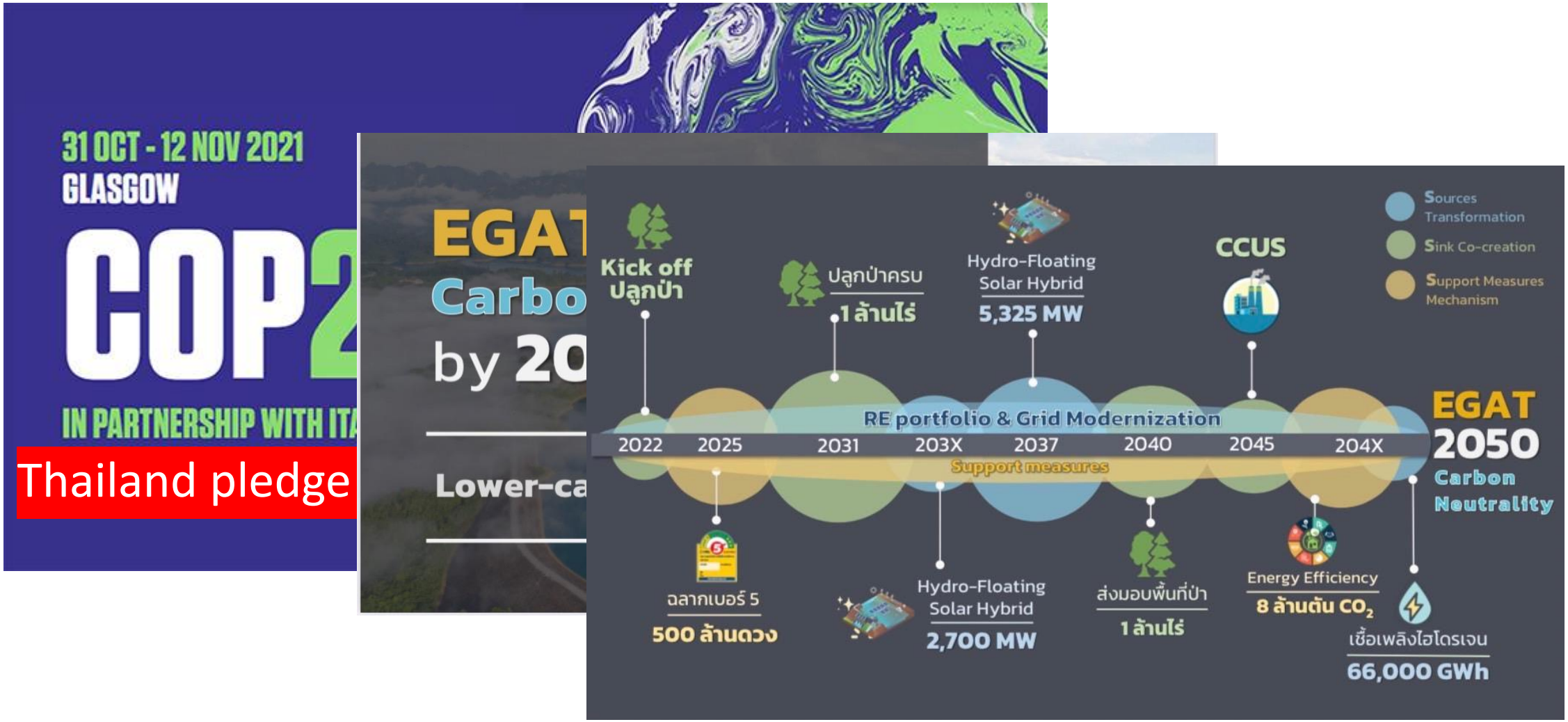
Three way cooling water control valve

Hydrogen as Energy Storage: Lam Takhong Experience

- Lesson 3: Hydrogen stored for long time, but Electrolyzer membrane is permeable
  - Hydrogen safely stored without leaks over a year during wait for inverter converter fix
  - Long storage caused permeation of oxygen to hydrogen side, dangerous
  - Purging of Electrolyzer, O_2 in H_2, H_2 in O_2 sensors for safety



The Future of Hydrogen in Thailand



The Future of Hydrogen in Thailand

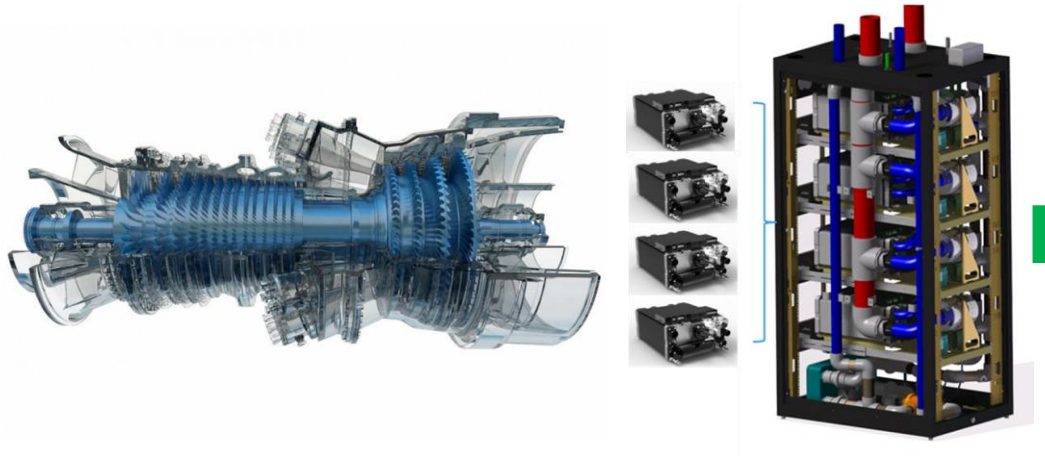
- **Future RE generation capacity set by Alternative Energy Development Plan overseen by regulator**
- **In 2037 new RE capacity is 18.7 GW, 38.1% of planned capacity in 2037**

Renewable Type	New Installed Capacity in 2037 from 2018 (MW)	Total Capacity in 2037 (MW)
Solar	9,290	12,139
Floating Solar	2,725	2725
Wind	1,485	2,989
Hydro	0	2,920
Biomass	3,500	5,790
Biogas	1,183	1,565
Waste	444	975
Total	18,696	29,411

EGAT will be hybrid floating solar, hydro, BESS power plant

The Future of Hydrogen in Thailand

Lower Electricity Cost, Excess Electricity, New Technologies = Low Cost Green Hydrogen



Reliable, High Eff. Electricity Generation= Lower Investment for Storage and Electrolysis

The Future of Hydrogen in Thailand

Mixing of Hydrogen with Natural Gas up to 20%

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Thank You

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