

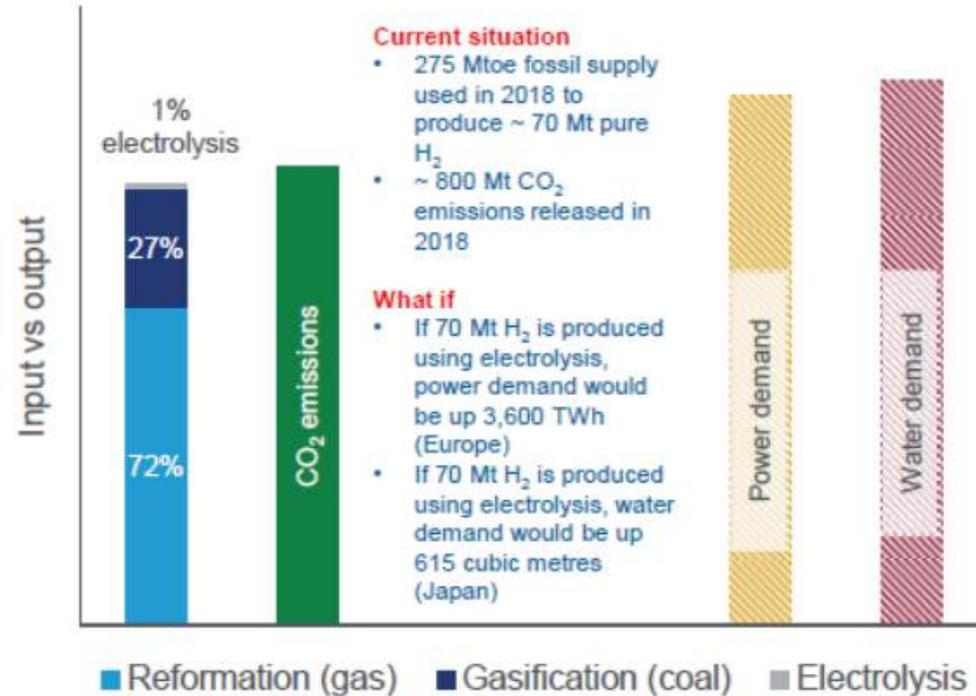
Wood Mackenzie



Hydrogen offers hope and can help meet decarbonisation goals

RE based hydrogen receiving attention and despite high costs, industry is hopeful that mass manufacturing of electrolyzers and standardisation will drive costs lower

Hydrogen production value chain 2018



H₂ production costs trends

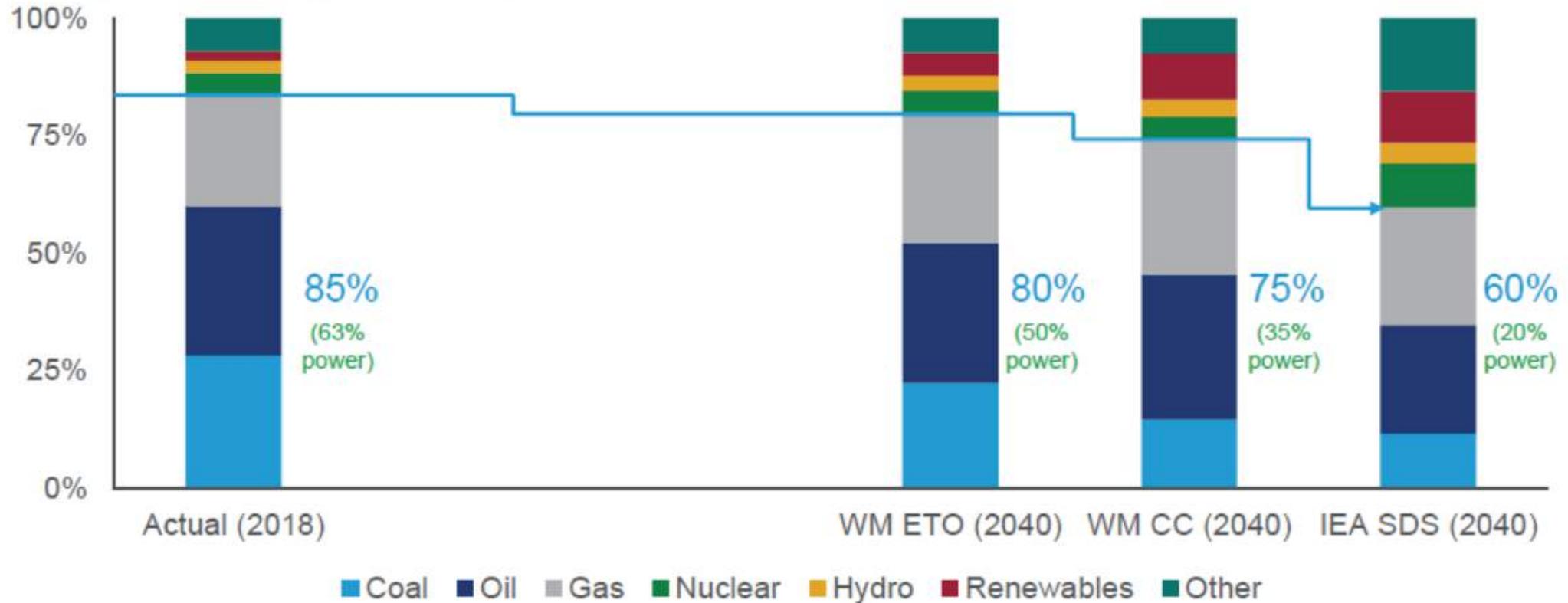
- Brown hydrogen is produced from coal or lignite while grey hydrogen comes from steam methane reformation. Blue hydrogen is produced when paired with CCS.
- Fossil-based hydrogen range US\$1-3 per kg depending on the location and the price of feedstock.
- Green hydrogen production costs vary US\$3-15 per kg depending on the price of electricity and load hours.
- We estimate green hydrogen electrolyser market to reach 100 MW installed capacity this year. Average size of electrolyser installed has grown to about 4 MW.



Hydrocarbons persist as the largest part of the energy supply mix

Even in more rapidly accelerating transition scenarios, there is still a role for hydrocarbons

Total primary energy demand by fuel mix



Bangkok Industrial Gas

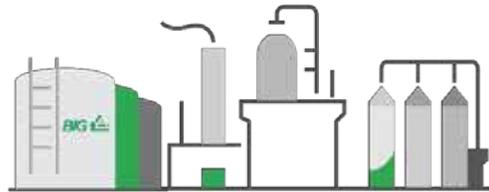
BIG Overview



A **Joint Venture** Affiliate



1st Supply since
1988

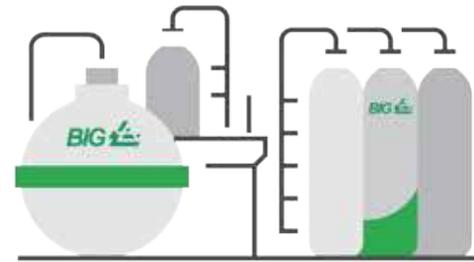


For Exclusively Serving
Map Ta Phut

Largest

Capacity & Market Share

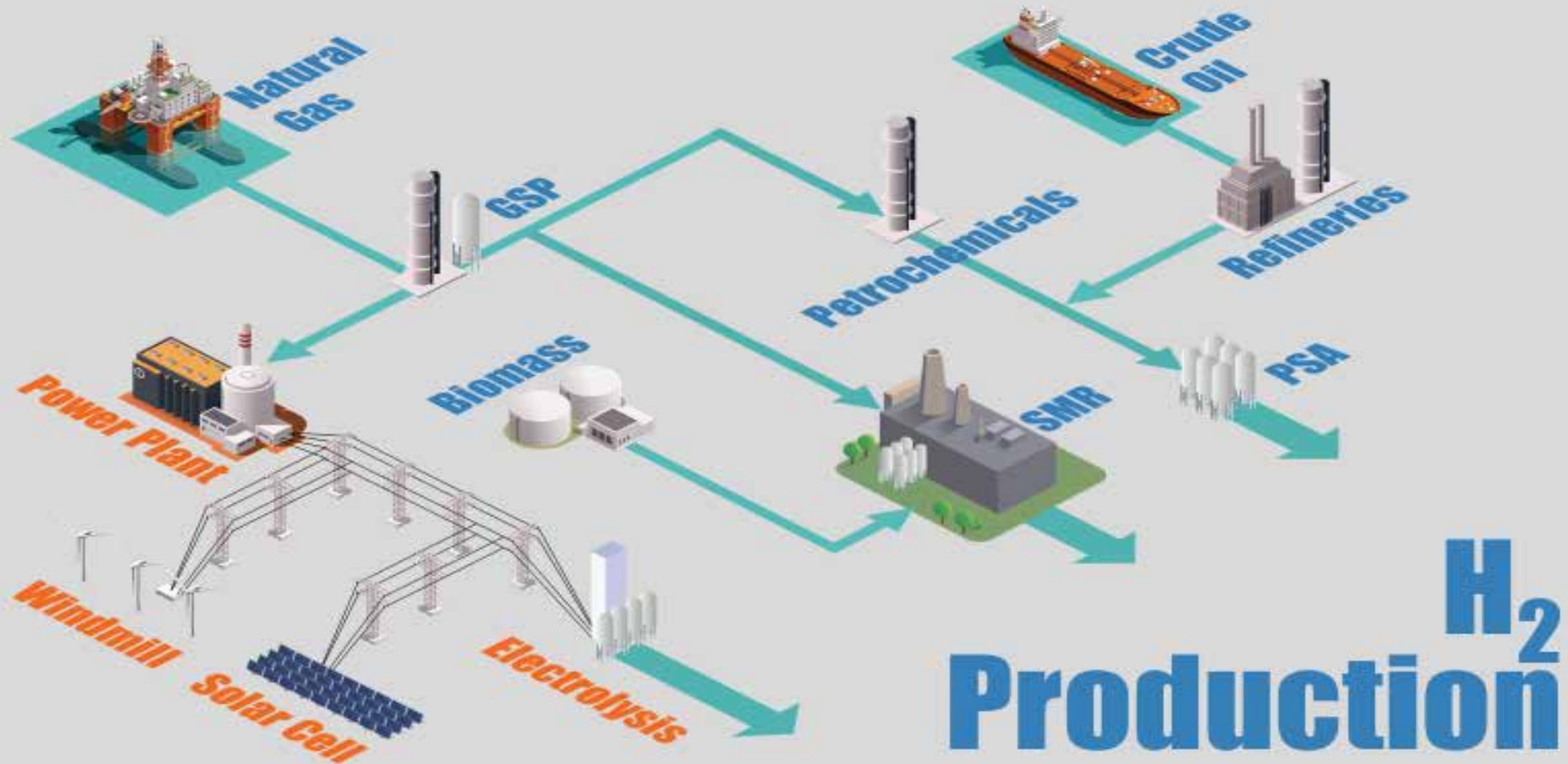
Capacity **4,800 TPD**
Market Share **45%**



5,843 MB

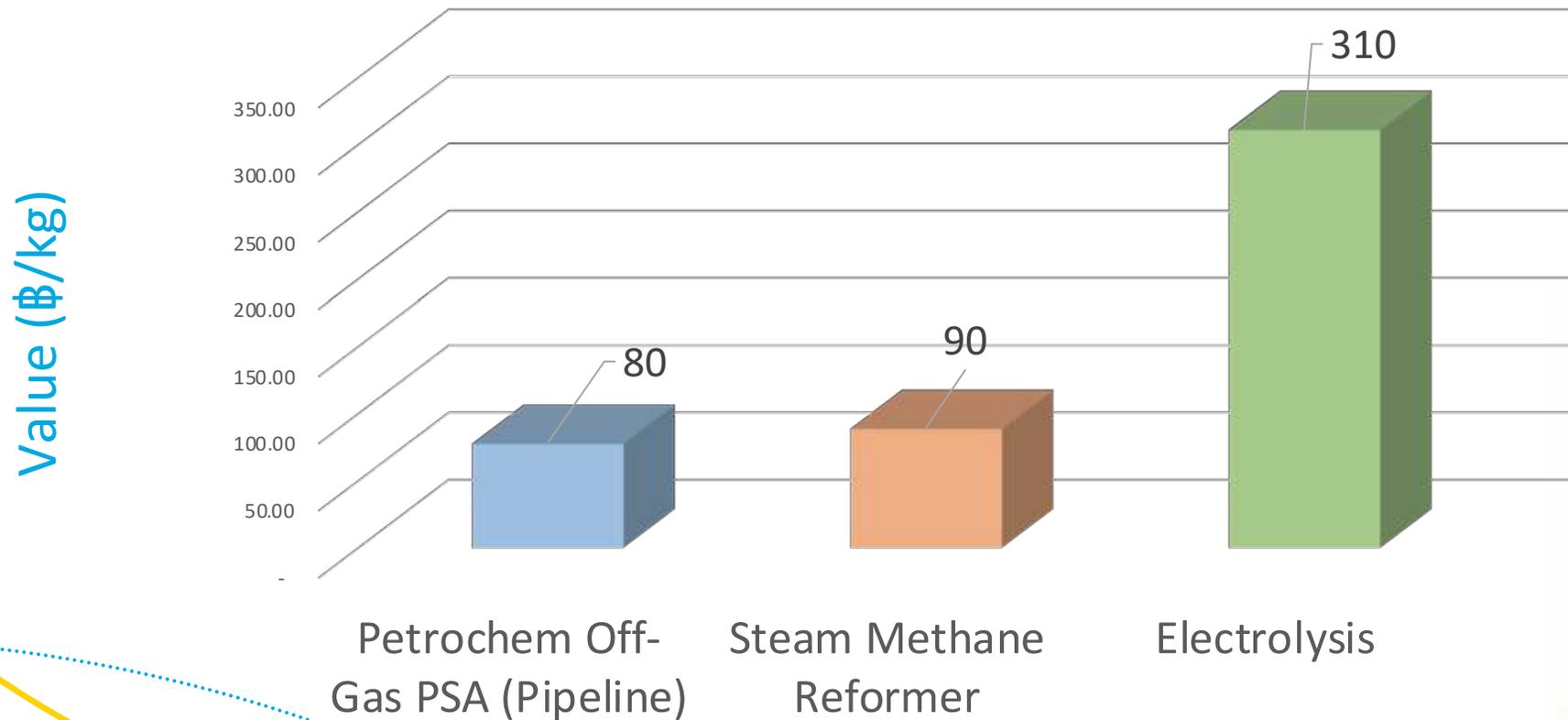
Revenues
2018





Hydrogen Economics

Economics of H2 Production Technology

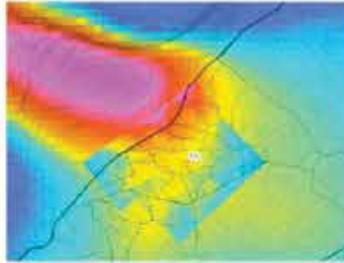


Total Eren

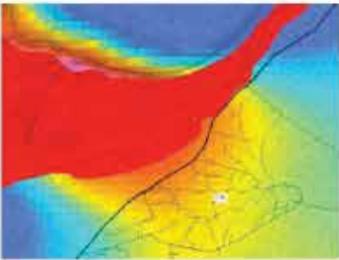
THAILAND ESTIMATED WIND POWER POTENTIAL

Key number
5 MW of Wind Power
 Potential (conservative
 estimate)

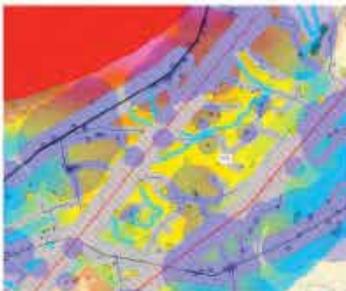
EXAMPLE



Wind resource looks great and quite large potential (400+MW?? ?)

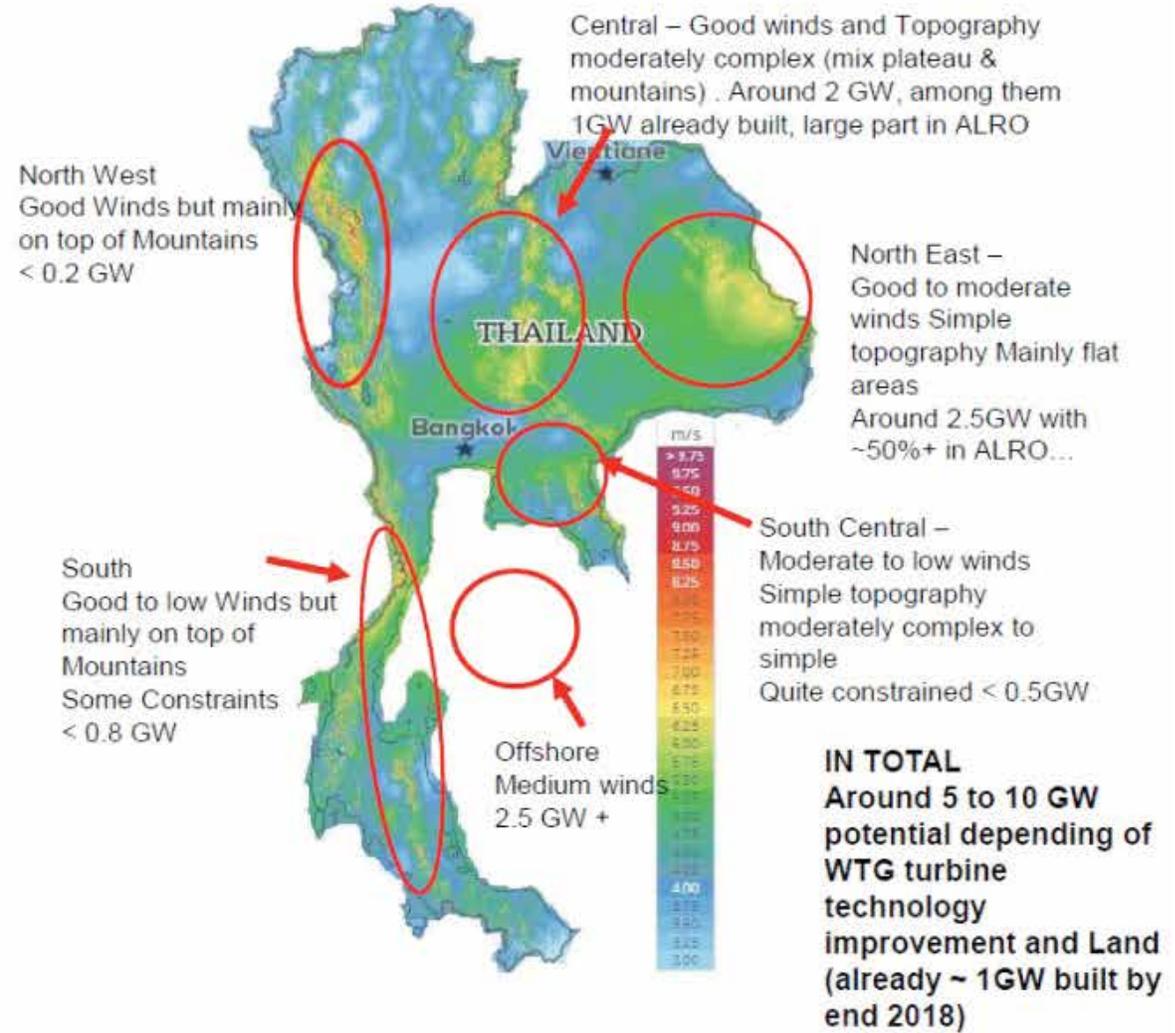


But Environmental / Legal constraints (red = NO GO)



And no go exclusion Road/RailWay/ HV & Village/house

To Finally get the REAL MW potential (90+ MW in lower winds...)



THAILAND

CAPACITY FACTORS & LCOE FOR ON SHORE WIND POWER IN THAILAND

Key numbers
Wind Farm CF 27% up:

LCOE THB 2.09 – 2.92 /kWh
[US\$ 0.065 to 0.09 /kWh]



| FIT THB/kWh | Capacity Factor | | | | | | |
|------------------|-----------------|---------|----------|---------|----------|---------|----------|
| | 10% IRR | 27% Low | 27% High | 30% Low | 30% High | 33% Low | 33% High |
| | 43.23 | 2.45 | 2.43 | 2.20 | 2.19 | 2.00 | 1.99 |
| | 53.20 | 2.91 | 2.91 | 2.62 | 2.62 | 2.38 | 2.38 |
| | 63.18 | 3.37 | 3.38 | 3.03 | 3.04 | 2.76 | 2.77 |
| CAPEX MTHB/MW | 12% IRR | 27% Low | 27% High | 30% Low | 30% High | 33% Low | 33% High |
| | 43.23 | 2.56 | 2.71 | 2.30 | 2.44 | 2.09 | 2.22 |
| | 53.20 | 3.05 | 3.25 | 2.74 | 2.93 | 2.49 | 2.66 |
| | 63.18 | 3.54 | 3.80 | 3.19 | 3.42 | 2.90 | 3.11 |
| | 15% IRR | 27% Low | 27% High | 30% Low | 30% High | 33% Low | 33% High |
| | 43.23 | 2.72 | 3.15 | 2.45 | 2.84 | 2.22 | 2.58 |
| | 53.20 | 3.25 | 3.80 | 2.92 | 3.42 | 2.66 | 3.11 |
| | 63.18 | 3.78 | 4.39 | 3.40 | 4.00 | 3.09 | 3.64 |

Note: current PPAs at 6.06 THB/kWh



GLOBAL

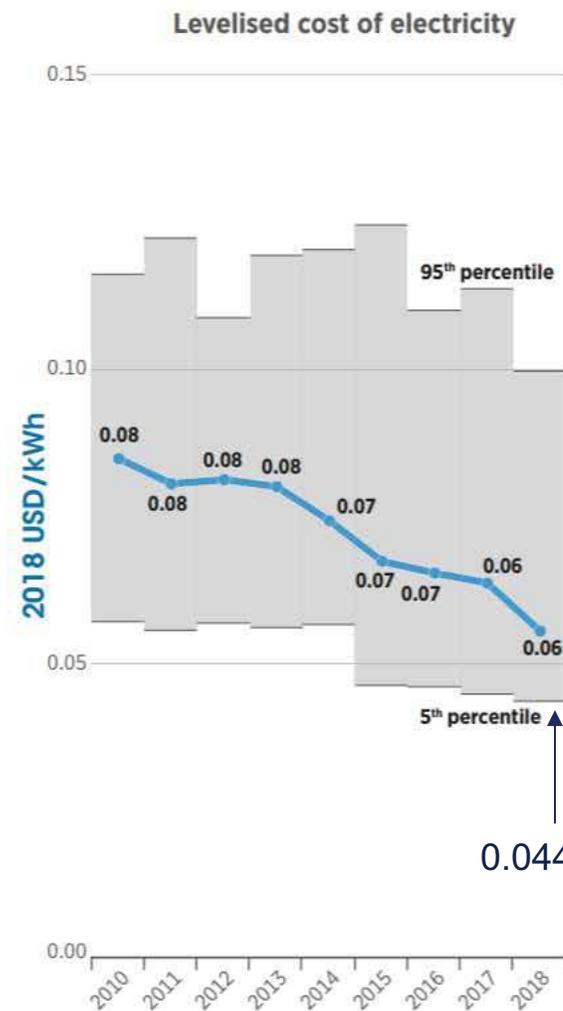
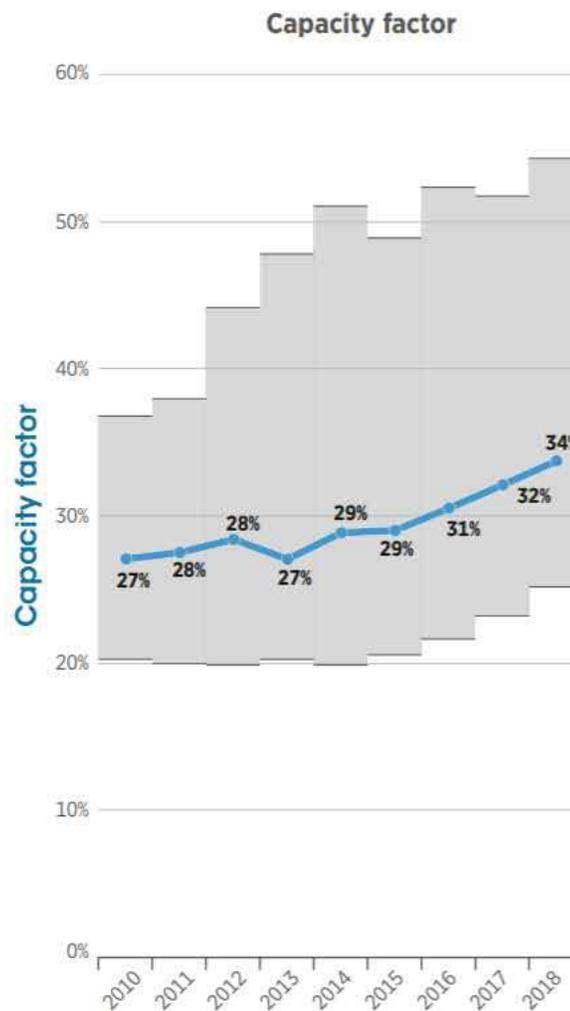
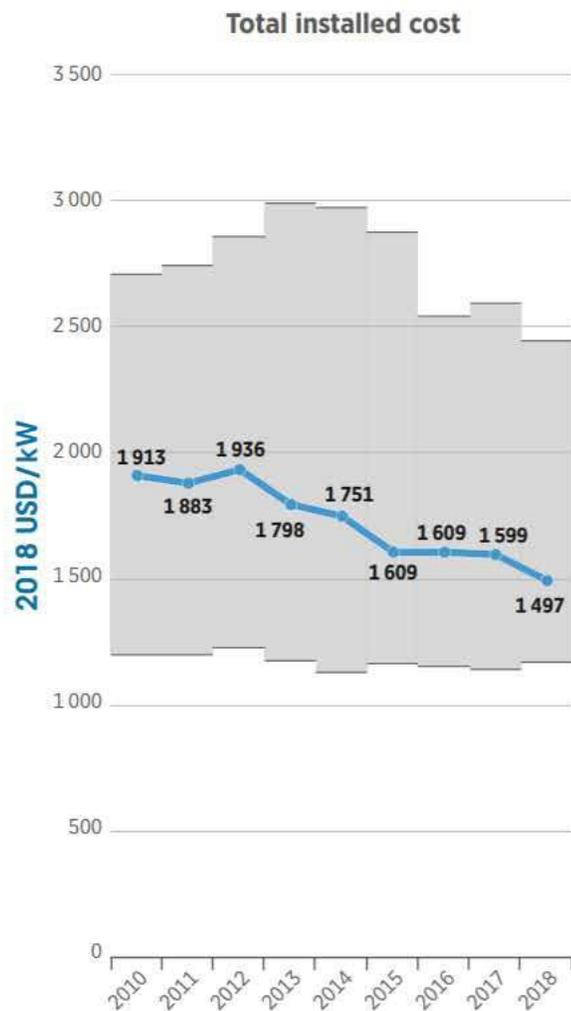
WEIGHTED AVERAGE TOTAL INSTALLED COSTS, CAPACITY FACTORS AND LCOE FOR ONSHORE WIND, 2010–2018

Key numbers:

Capex drop of 22%

CF increase of 26%

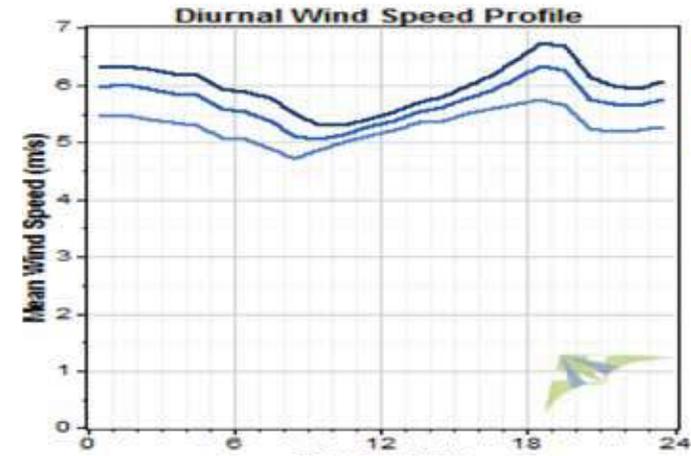
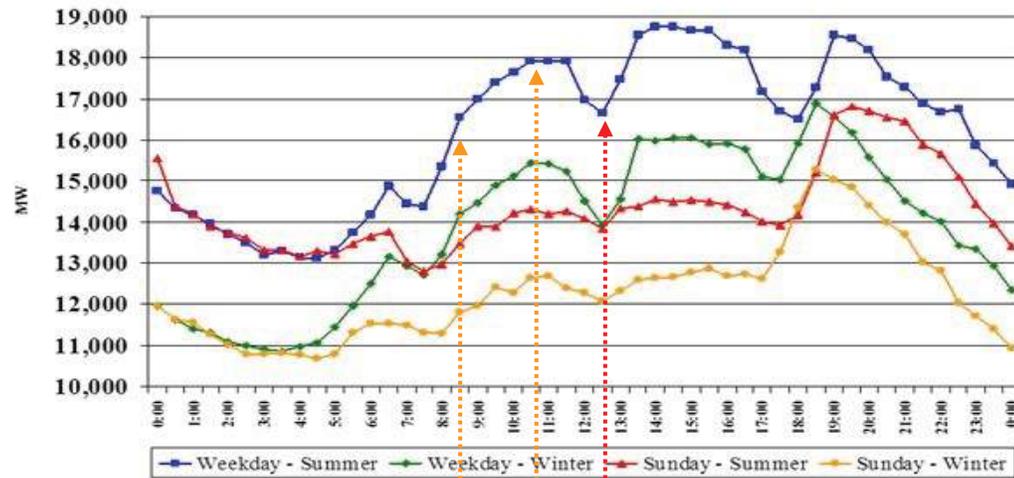
LCOE decrease of 30%



THAILAND

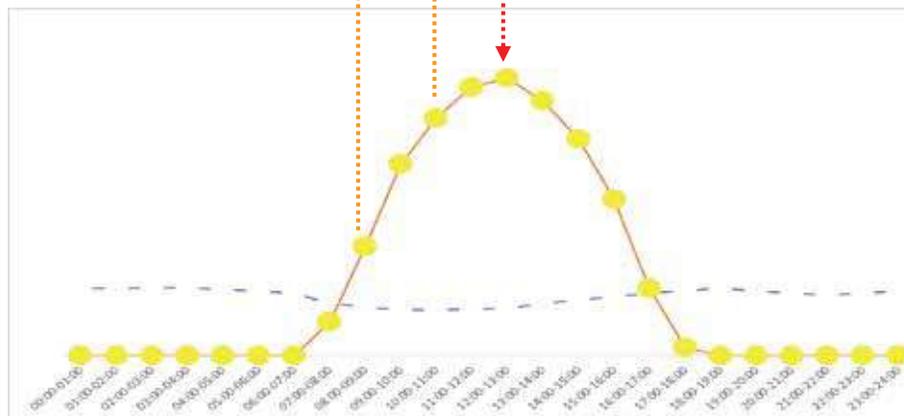
DAILY LOAD CURVE ON WORKING DAY

Strongest wind in occurs at system peak load



Solar power fits load curve on workdays

Load drop during lunch break



Key Message

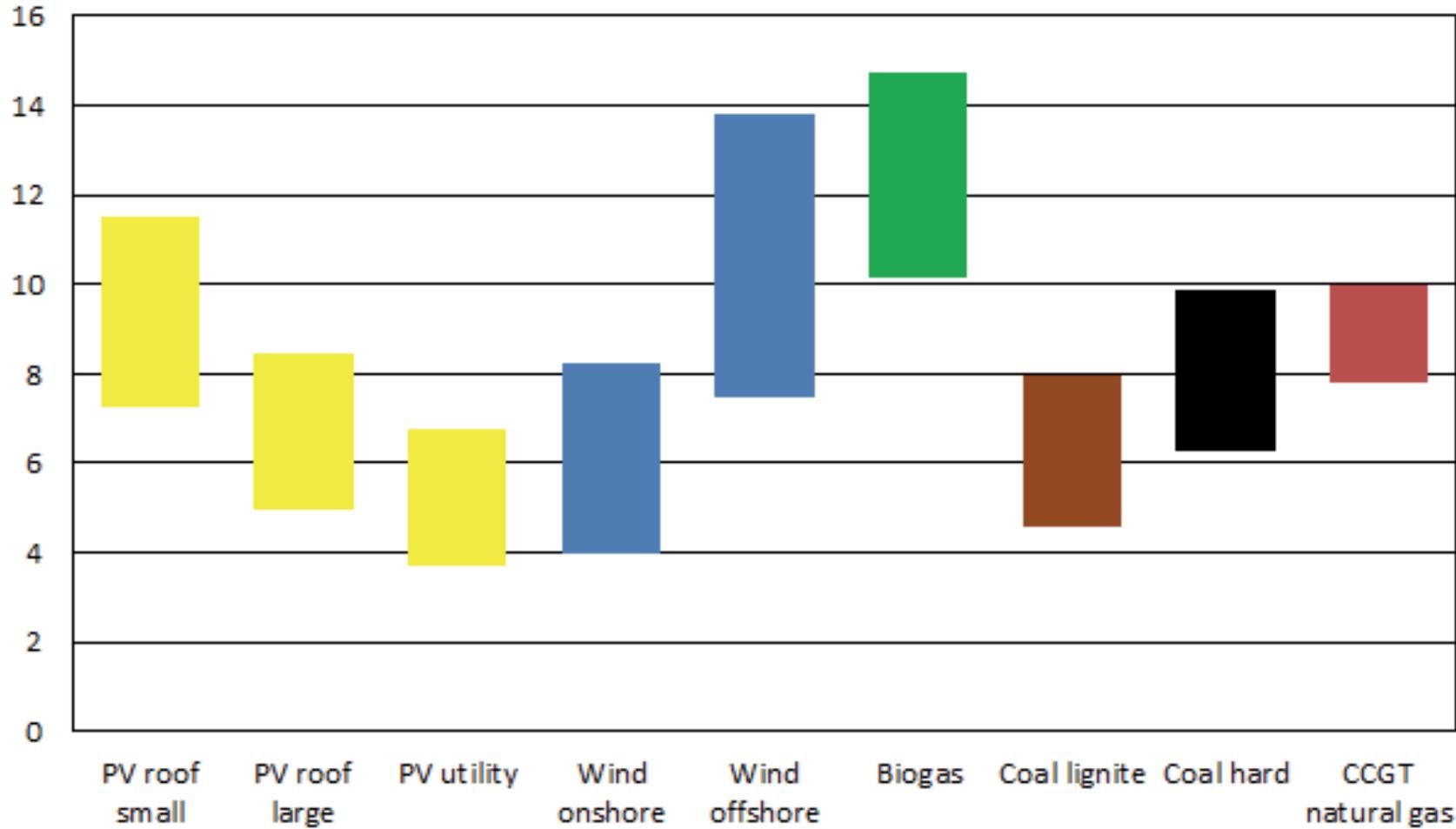
Role of Storage:

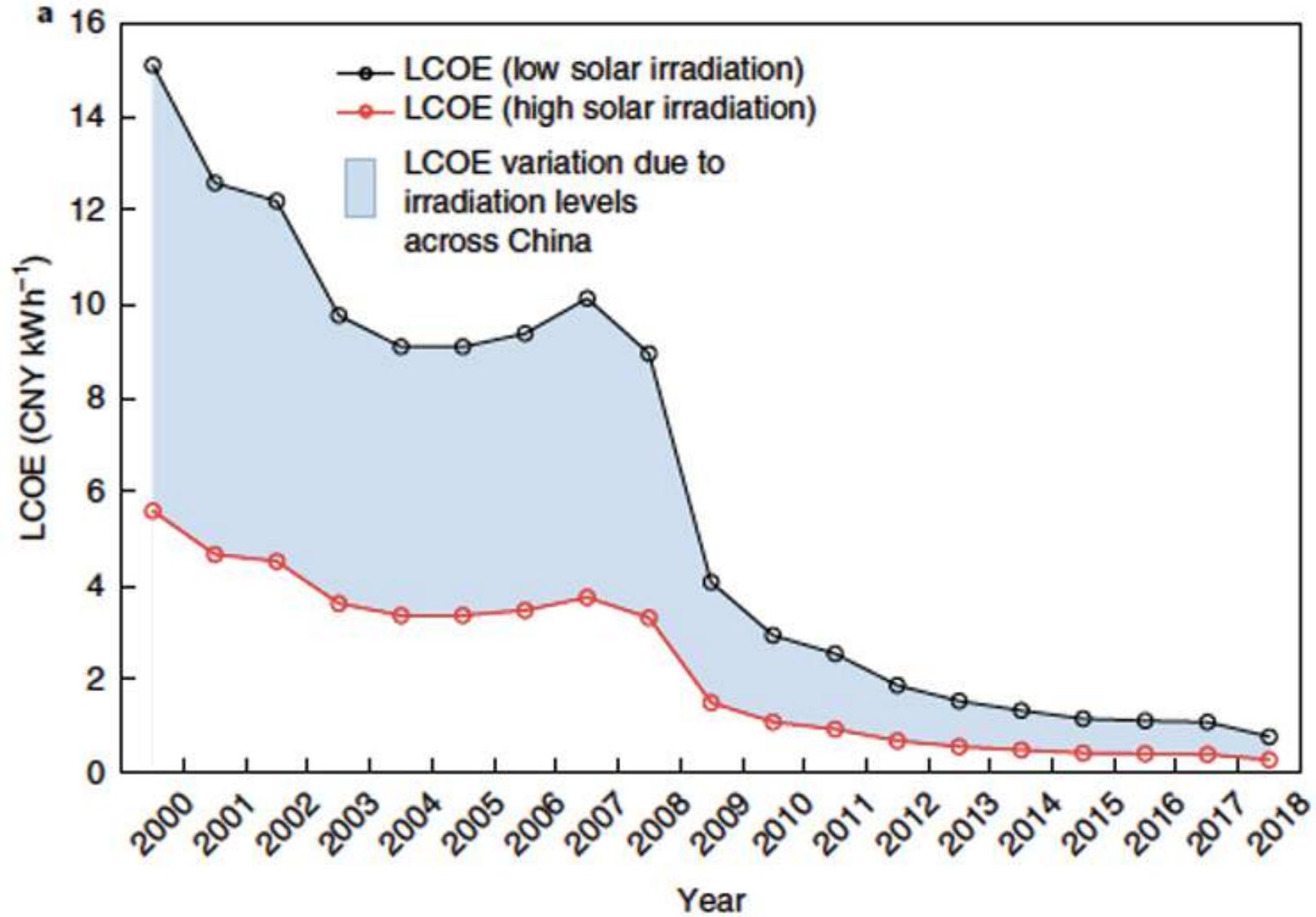
- ✓ Peak shaving
- ✓ Firming of peak loads in the evening

Girana Anuman-Rajadhon, Solar Projects & Project Finance

Levelized cost of electricity for Germany

in EuroCent/kWh, source: Fraunhofer ISE; March 2018





Solar Hydrogen System 2019

| | | | |
|--|---------|---------|--------|
| Enapter System Total Production | | | |
| kWh | 122,100 | | |
| Lifetime | 20 | years | |
| Total load kWh | 891330 | | |
| Euro/kWh | € 0,37 | ฿ 14,15 | \$0,41 |

Solar Hydrogen System 2024

| | | | |
|--|---------|--------|--------|
| Enapter System Total Production | | | |
| kWh | 122,100 | | |
| Lifetime | 20 | years | |
| Total load kWh | 891330 | | |
| Euro/kWh | € 0,13 | ฿ 5,11 | \$0,15 |

Solar Hydrogen System 2019 - 2024

| Year | | 2019 | 2021 | 2024 | 2026 | | |
|--------------------------------------|-------------------------------|--------------|-------------|-------------|-------------|-------|---------------|
| Hydrogen Cost ex Ops | Enapter Hydrogen | EL 2.0 | EL 4.0 | EL 4.0 mass | EL 4.1 mass | | |
| | CAPEX Electrolyzer | 10.000 | 8.000 | 5.000 | 2.000 | Euro | |
| | estimated life-cycle in hours | 35.000 | 35.000 | 35.000 | 38.000 | Hours | |
| | Capacity Nm3/hr | 0,5 | 0,5 | 0,5 | 0,5 | Nm3 | |
| | Unit in kg | 1 | 1 | 1 | 1 | kg | |
| | 1kg Hydrogen in Nm3 | 11,1 | 11,1 | 11,1 | 11,1 | Nm3 | |
| | Cost per kg | 6,34 | 5,07 | 3,17 | 1,17 | Euro | ex Rate E/USD |
| | Cost per kg | 6,98 | 5,58 | 3,49 | 1,29 | USD | 1,1 |
| Total Hydrogen System | Total System in EUR | 0,37 | | | 0,13 | kWh | |
| | Total System in USD | 0,41 | | | 0,15 | kWh | |
| Solar System | Price of Solar kWh | 0,038 | | | | kWh | |
| | | 0,027 | | | | | |
| Total Cost for Solar Hydrogen | | | | | 0,15 | kWh | |