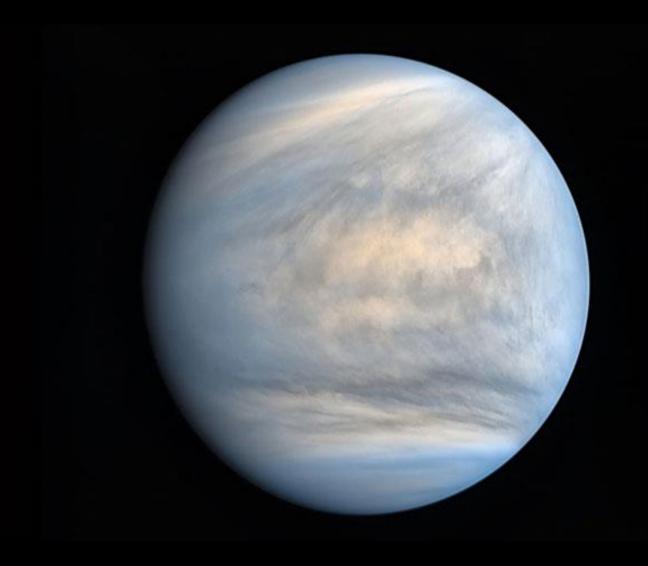


Technologies for zero carbon emissions and how to make them marketable

Tobias Kadziela – Director Sales Operations Asia & Pacific – Siemens Energy October 2020, Singapore – SIEW 2020





Temperature: 470 degC

CO₂ content: 97%

Image source: JAXA / ISAS / DARTS / Damia Bouic





Globalization

Demographic change Urbanization Climate change

Digitalization

are drastically changing our environment.



We are a world leader in energy

>90 countries

~1/6

of global electricity generation based on our technology

>50% decarbonized portfolio

SIEMENS Fuel shift / Hybridization energy Coal-to-Deep decarbonization Low Carbon Power from Shore **Biomass Shift** (Hille) Gas Turbine and Subsea Grid Efficiency increase Thermal Storage Hydro \mathcal{M} Integration **Next Generation** Heat **Grid Access** Utilization Biomass / 111 Battery Solutions Geothermal Integrated Low Carbon Integration Hybrid Solutions Seafloat Transmission Cells Green Energy for PV and 4 » } } } Power-to-Heat Storage Plant Flexibility Wind Power Solutions «» Combined Heat Solar Power Pipeline Grid and Power Power-to-X Upgrades Stability **Highly Efficient** Packages **HVDCs** Carbon Brownfield H, Gas Capture Blue Products (SF6 free, (H2 Engine Turbines GHG free transmission) Engines Exchange (Co-firing) Off-shore & Marine Energy & Efficiency Solutions New Energy H. Gas Coal-to-Electrolyzers Turbines Carriers Gas Highly Efficient Turbines, Turbine / Compressor / (100%)Shift Compressors and Plants Generator Upgrades Off-shore & Marine Eco Design Zero Carbon Wind Plant Performance Net Zero Production Power Hybrid Solutions Optimization

Two examples from ASEAN



SeaFloat Estrella Del Mar III - From ASEAN for the world

- Floating power plant based on our SGT-800 gas turbine
- Highest efficiency of its class replacing existing asset
- Integrated battery storage
- "Plug and Play" concept jointly delivered with our Singaporean partner ST Engineering
- Large portion of commissioning performed using standardized equipment under strictly controlled conditions in shipyard
- Final destination: Dominican Republic



Vietnam – Siemens Energy contribution across portfolio

- Hiep Phuoc 1 steam power plant conversion to combined cycle power plant – Using gas instead of oil
- Fifty percent lower CO2 emissions per kilowatt hour produced
- eBoP for 204 MWp PV farm incl. digital connected Sensformer® units
- Delivering wind turbines into four nearshore projects



Technology is available but can only applied in a profitable manner with infrastructure and reward mechanisms in place



World's first

1882: commercial cogeneration plant

1884: rooftop PV array

1887: first wind turbine / 1941 first MW sized turbine

~1900: commercial electrolyzer

Recommendations (not exhaustive)



Electrify the Economy!

Sector coupling brings renewable energy from the power sector into transport, industry or heating applications: The power sector becomes the backbone of energy supply!

- Encourage use of electricity over primary fuels by de-burdening electricity tariffs from non-supply costs
- Incentivize infrastructure investments
- Energy transition as part of stimulus packages
- Support for R&D investments

Cost & Value to be considered

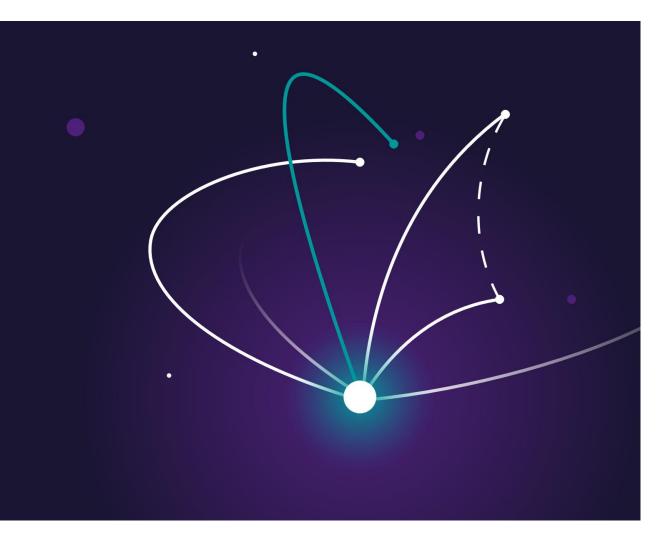
Reliable power supply is indispensable: Low/Zero carbon applications are only of value if they are available and/or are enabled by other technologies. Cost of integration to be considered not just LCoE.

- Capacity mechanisms to ensure firm capacity is valued
- Reward high efficient low carbon applications e.g. CHP
- Monetization of grid services will allow for revenue stacking of existing assets (e.g. power trains) and push for commercial viability of new assets (e.g. storage, electrolyzers) → Positive feedback loop for higher share of RES

Competition of Technologies

Policy makers should be cautious deciding on the technology. Instead **create a framework where competition of technologies takes place**, such as the "polluter pays" principle.









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