

Tripling renewable capacity: Do-able, profitable, but...

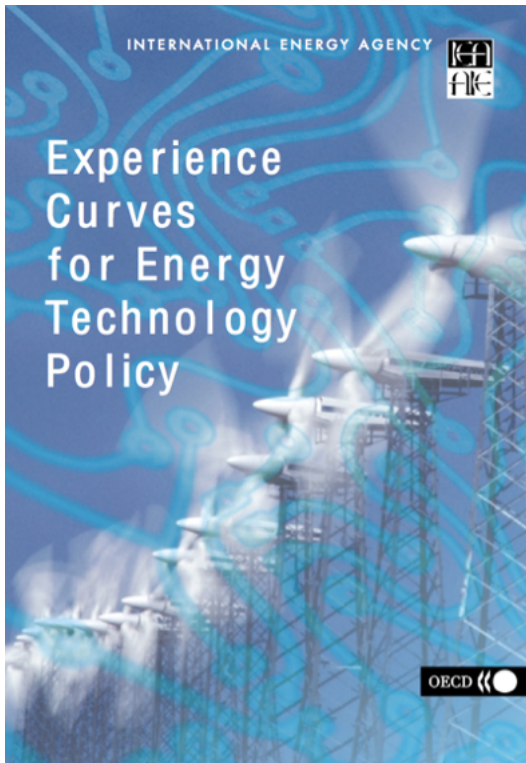
Tokyo
2024-01-17

Tomas Kåberger

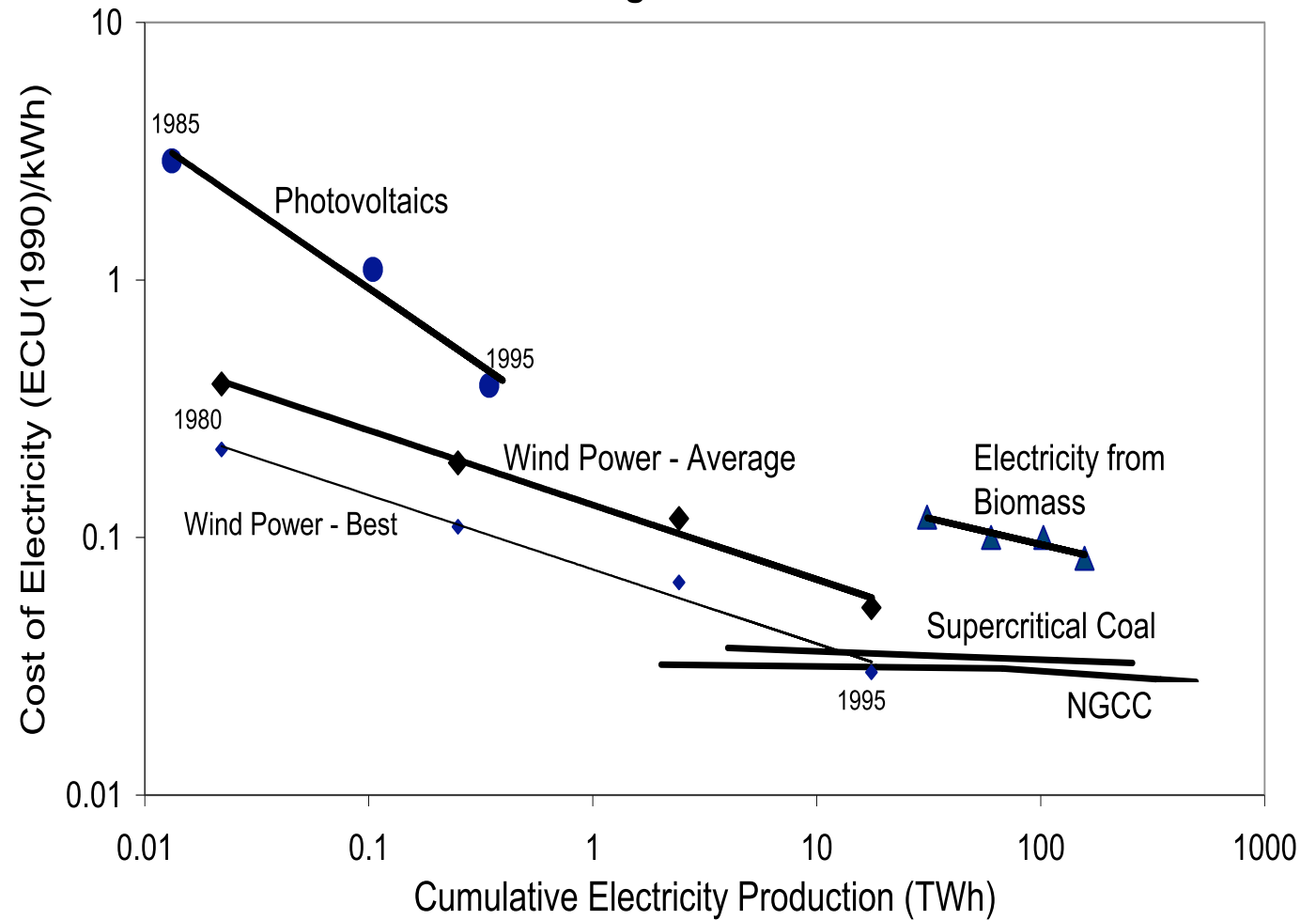
*professor Chalmers tekniska högskola
Executive Board Chair of Renewable Energy Institute, Tokyo
Ledamot IVA och Sveriges EnergiEkonomers Förening*

Industrial learning by experience

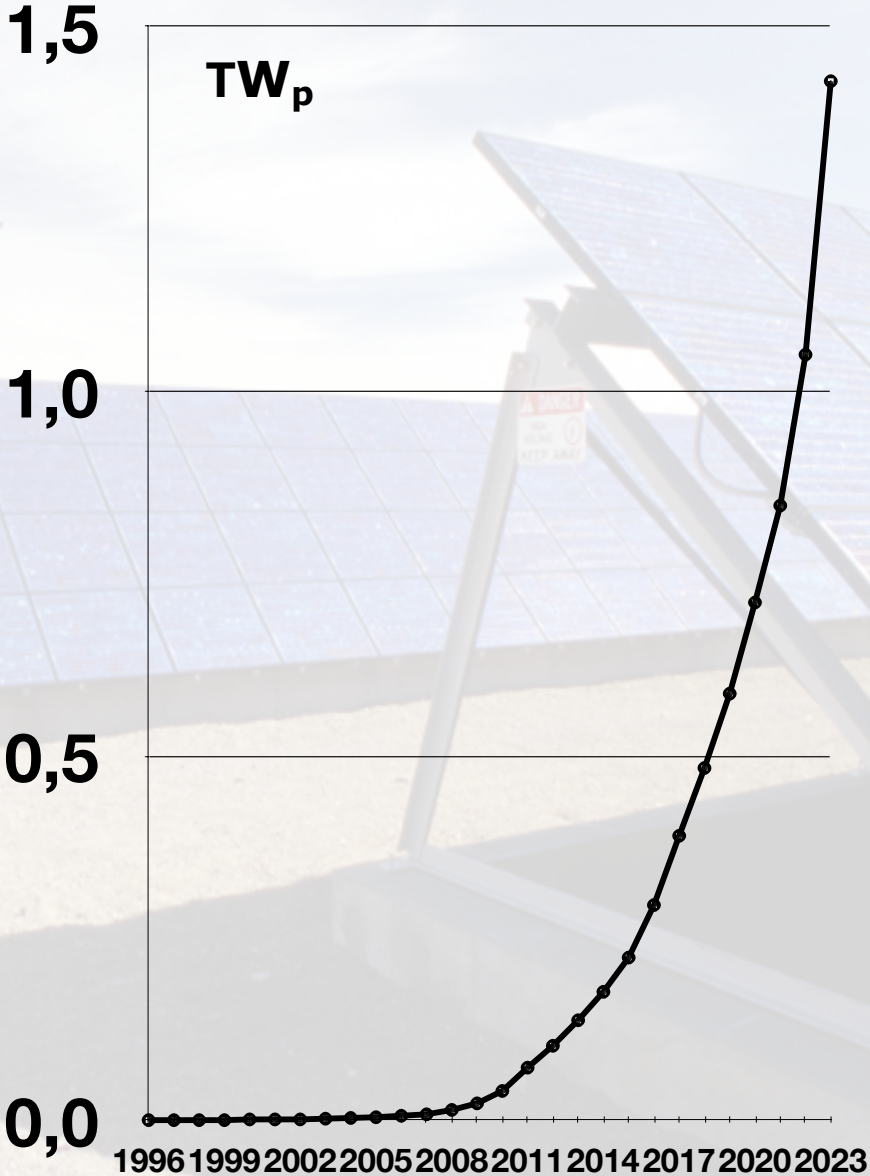
Electric Technologies in EU 1980-1995



Prof. Clas-Otto Wene, Chalmers Univ. of Technology, 2000



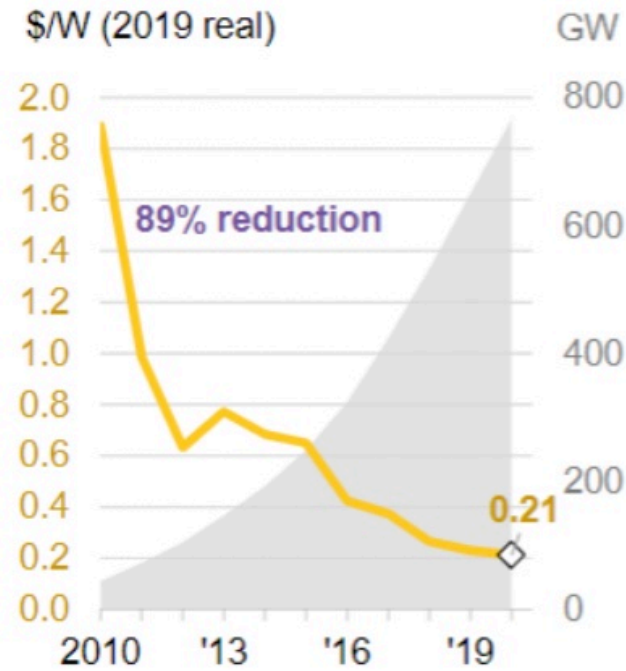
Global solar PV capacity 1996-2023



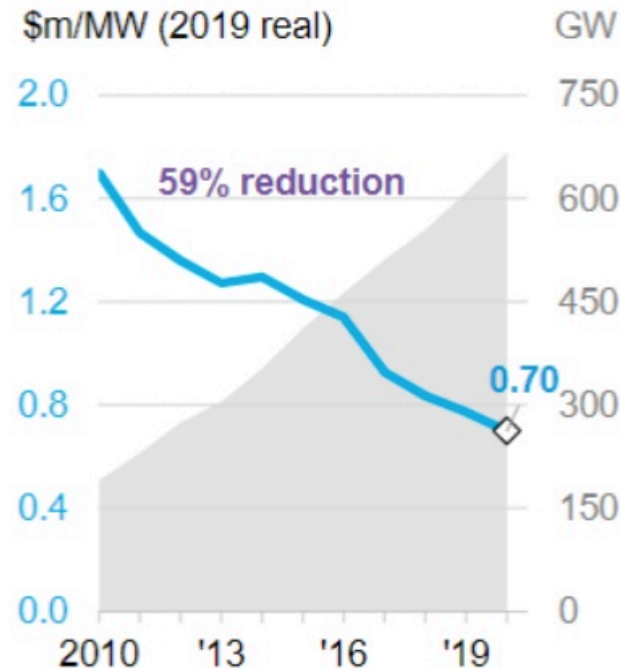
Data: Statistical review world Energy, 2023, 2024:IEA est

Innovation and scale impacts on renewable technologies

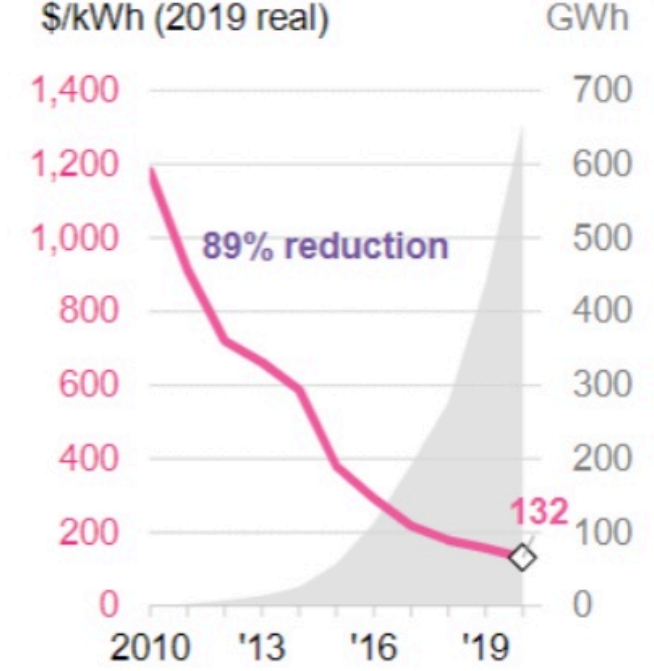
PV module price and cumulative installed capacity



Onshore wind turbine price and cumulative installed capacity



Li-ion battery pack price and demand



Source: BloombergNEF.

NEWS • WIND • 5 JULY 2021 • 2 MIN

Vattenfall starts construction of offshore wind farm Hollandse Kust Zuid



The construction of the 1.5GW Hollandse Kust Zuid offshore wind farm has started. The first vessel transporting foundations to the construction site departed today. Over the next two years, the world's first subsidy-free offshore wind farm will be built off the Dutch coast. The fossil-free energy generated by the wind farm will benefit both households, businesses and industrial partners.



NEWS • WIND • 2 AUGUST 2022 • 1 MIN

First power from offshore wind farm Hollandse Kust Zuid delivered

The first power from Hollandse Kust Zuid wind farm has been successfully delivered to the Dutch electricity grid.



NEWS •

Vattenfall's offshore wind

The construction of the Hollandse Kust Zuid offshore wind farm is a milestone for Vattenfall. The vessel used for the construction of the wind farm is a fossil-free energy source, benefiting the environment.



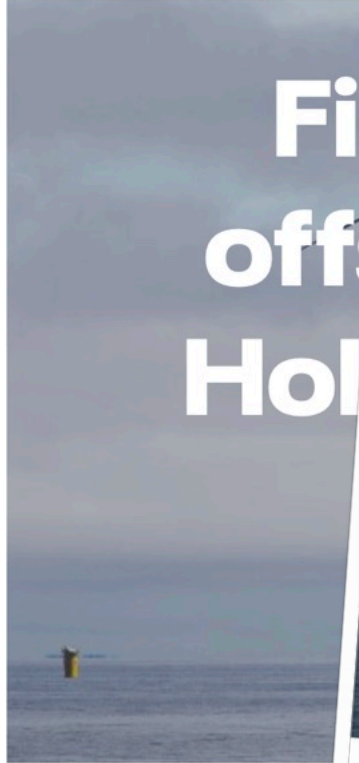
NEWS •

Vattenfall's offshore wind



The construction of the Hollandse Kust Zuid offshore wind farm is well advanced. The vessel used for the construction is expected to be completed in two years, and the wind farm will generate fossil-free electricity with significant benefits.

First offshore wind farm in Holland inaugurated



The first offshore wind farm in Holland has been inaugurated.

VATTENFALL

PRESS RELEASE • WIND • 29 SEPTEMBER 2023, 13:25 CET • 5 MIN

Offshore windfarm Hollandse Kust Zuid inaugurated: Vattenfall, BASF and Allianz showcase innovation and biodiversity



Today, Dutch King Willem-Alexander officially inaugurated wind farm Hollandse Kust Zuid.

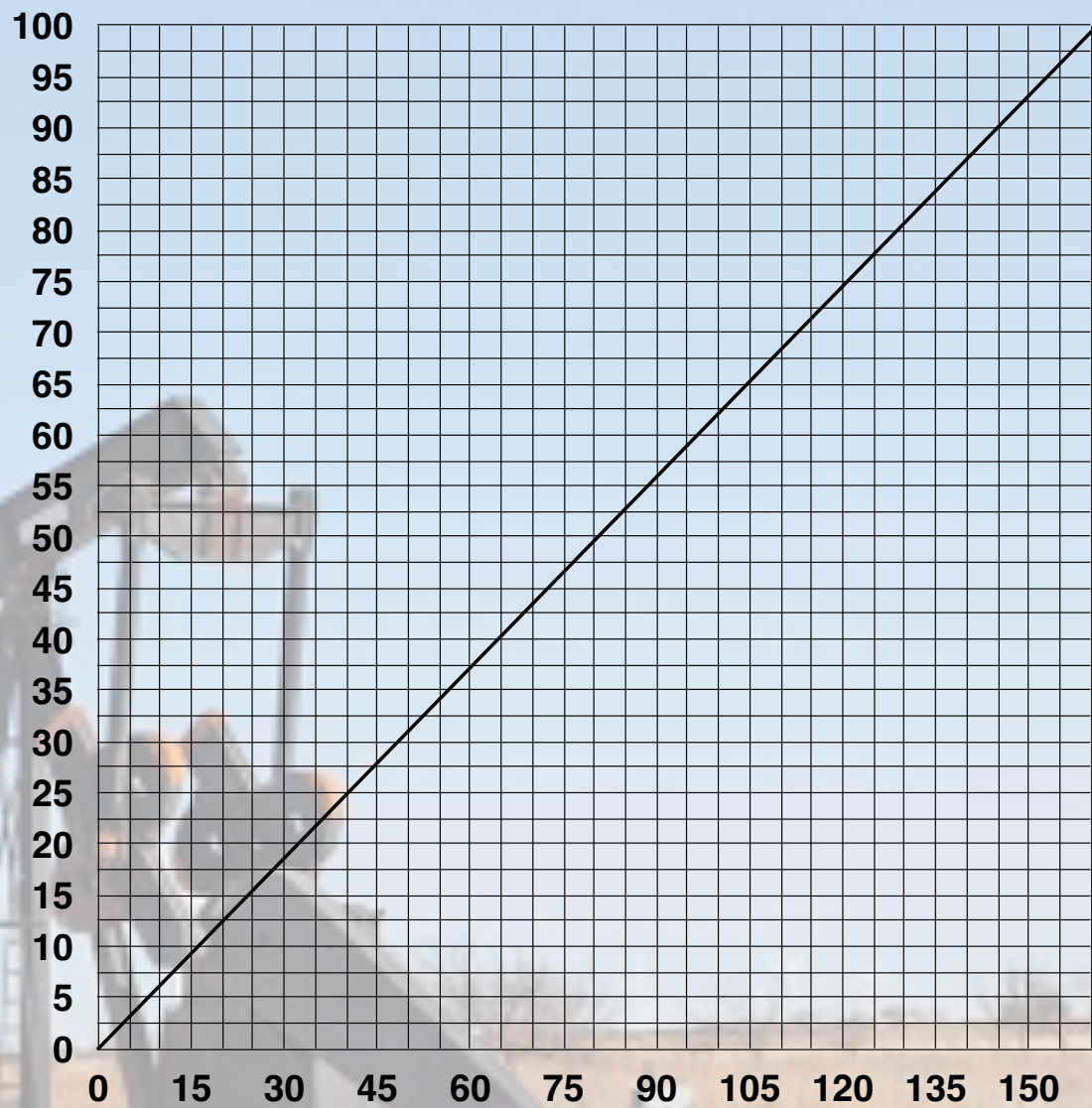
Renewables 2023

Analysis and forecast to 2028

Over the coming five years, several renewable energy milestones are expected to be achieved:

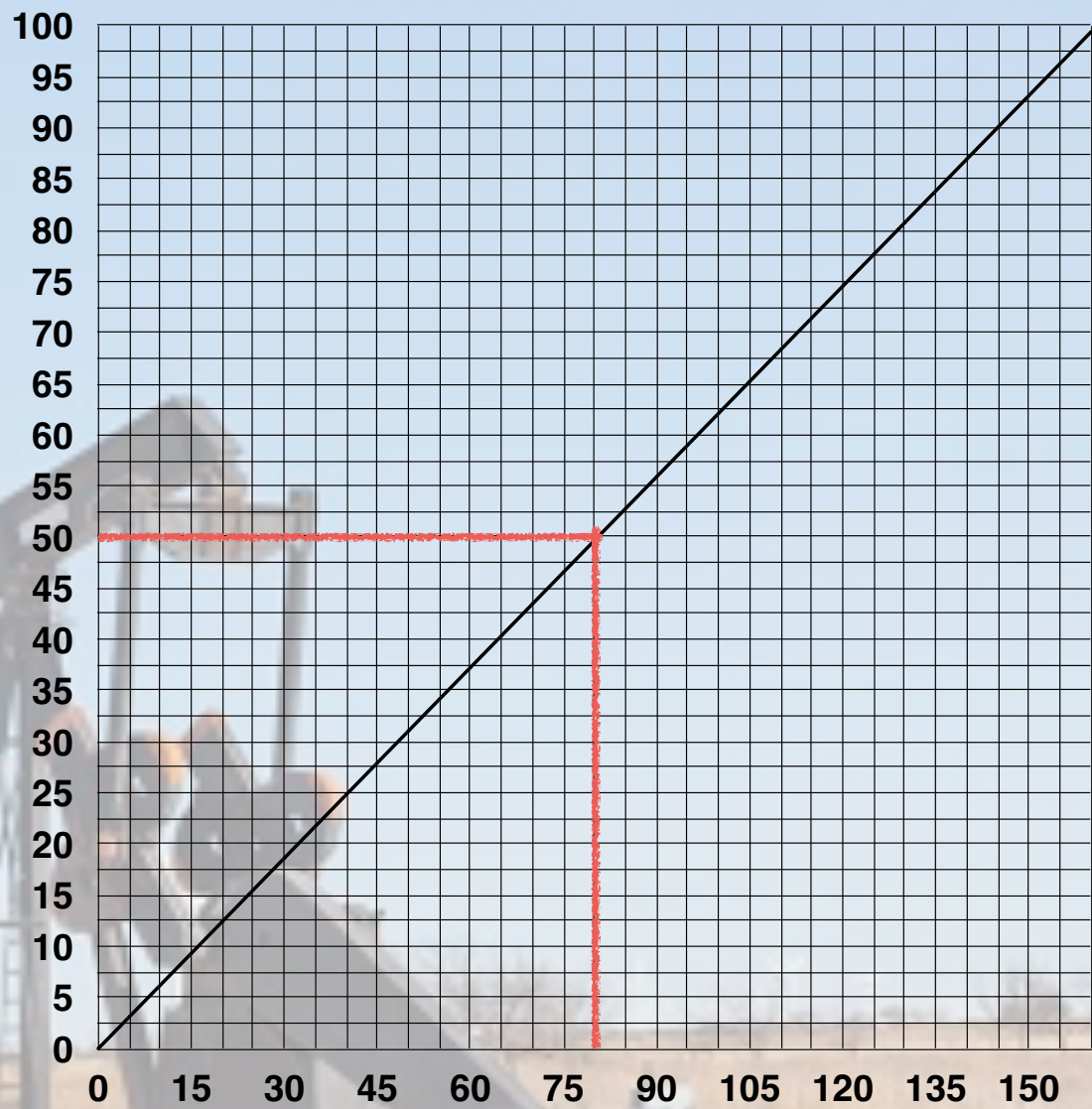
- In 2024, wind and solar PV together generate more electricity than hydropower.
- In 2025, renewables surpass coal to become the largest source of electricity generation.
- Wind and solar PV each surpass nuclear electricity generation in 2025 and 2026 respectively.
- In 2028, renewable energy sources account for over 42% of global electricity generation, with the share of wind and solar PV doubling to 25%.

USD/MWh



Crude oil price, USD/bbl

USD/MWh



Crude oil price, USD/bbl

BRIEF

Storage will replace 3 California gas plants as PG&E nabs approval for world's largest batteries

By Gavin Bade

Published Nov. 9, 2018

Dive Brief:

- The California Public Utilities Commission on Thursday approved four energy storage projects for Pacific Gas & Electric (PG&E) to replace retiring gas generators, including two batteries that would be the largest in the world.



BRIEF

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South Australia's Tesla big battery saves \$40 million in grid stabilization costs

A new report analyzing the world's largest lithium-ion battery's performance in the first year of operation shows the Hornsdale Power Reserve has delivered on high expectations of its performance and market impact. It has helped stabilize the grid, avoid outages and reduce system costs, as well as triggered a surge in uptake of similar fast response systems across Australia.

DECEMBER 5, 2018 **MARIJA MAISCH**

ENERGY STORAGE HIGHLIGHTS UTILITY SCALE STORAGE AUSTRALIA



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Battery backup system for Olkiluoto plant

16 June 2021



One of Europe's largest battery energy storage systems is to be built at the Olkiluoto nuclear power plant in Finland under a contract signed by Teollisuuden Voima Oyj (TVO) and Hitachi ABB Power Grids. The 90 MWe system will act as a fast-start backup power source to ensure the stability of the country's energy network in the event of an unplanned shutdown of the Olkiluoto 3 (OL3) EPR unit, currently being commissioned at the site.



The Olkiluoto plant in western Finland (Image: TVO)

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16 June 2021

One of Europe's
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at the site.



The Olkiluoto plant in v

Upgrade at Tesla battery project demonstrates feasibility of 'once-in-a-century energy transformation' for Australia

By [Andy Colthorpe](#)

July 28, 2022

[Southeast Asia & Oceania, Asia & Oceania](#) [Grid Scale](#) [Technology, Software & Optimisation](#)



HPR, commissioned in 2017 in South Australia and expanded to its current capacity two years ago.
Image: Neoen.

The landmark Hornsdale Power Reserve battery storage system in South Australia now has upgraded capabilities, enabling it to provide inertia to the grid.

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ENERGY STORAGE

A new report on performance of Power Reserve and market to reduce system fast response



Battery ba

16 June 2021

One of Europe's nuclear power plants and Hitachi ABB source to ensure unplanned shutdown at the site.



The Olkiluoto plant in v

Upgrade at Tesla battery demonstrates feasibility of century energy transform

By [Andy Colthorpe](#)

July 28, 2022

🌐 [Southeast Asia & Oceania](#), [Asia & Oceania](#) 📄 [Grid Scale](#)



The landmark Hornsdale Power Reserve now has upgraded capabilities, enabling it to provide



An aerial view of Plus Power's KES Facility in Hawaii.

Plus Power, a US-based developer and operator of utility-scale battery storage projects, on Thursday announced that it has started operations of a pioneering **grid-scale battery energy storage system** – Kapolei Energy Storage (KES) facility – fast-tracking Hawaii's transition to 100% renewable energy.

What makes KES a landmark project is that for the first time, a standalone battery site will be providing a diverse range of grid-forming services at such a large scale. The KES battery facility is set to replace the grid capacity formerly provided by an AES coal power plant which once produced up to one-fifth of the electricity on the island of Oahu. The coal plant closed in September 2022.

"This is a landmark milestone in the transition to clean energy," said Brandon Keefe, Plus Power's Executive Chairman.

"It's the first time a battery has been used by a major utility to balance the grid: providing fast frequency response, synthetic inertia, and black start. This project is a postcard from the future — batteries will soon be providing these services, at scale, on the mainland."



European Energy helps Lego bricks go green

Danish renewables and PtX player will supply e-methanol for plastics production from its Kassø facility from 2024

[Image: European Energy]

20 April 2023 Other News

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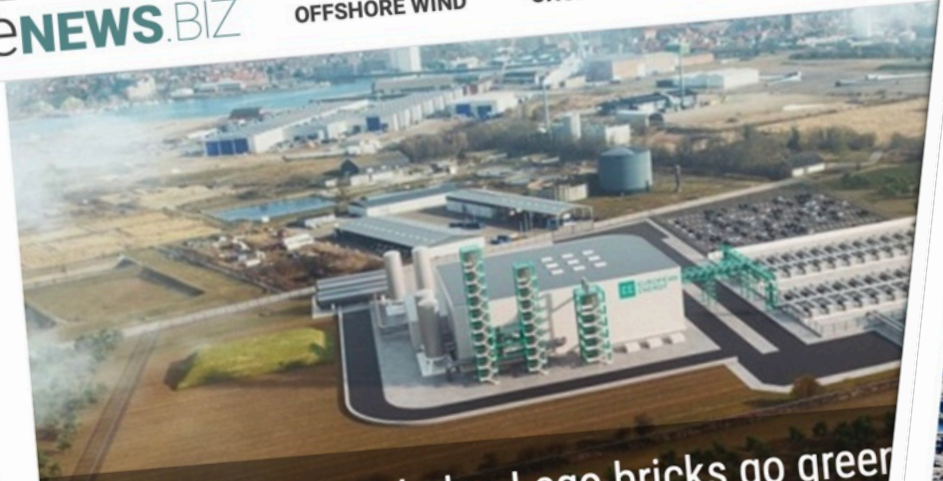


European Energy orders Stiesdal electrolyser
27 MARCH 2023

European Energy has entered into an agreement with Lego, as well as medical products producer Novo Nordisk, to deliver e-methanol to reduce fossil fuels in the companies' plastics production processes.

The e-methanol will be produced at European Energy's PtX facilities in Kassø, in Aabenraa, Denmark.

The production of e-methanol will be based on renewable energy from wind and solar plants which is first used to produce green hydrogen via electrolysis, before further processing into e-methanol, which also requires biogenic CO₂.



European Energy helps Lego bricks go green

Danish renewables and PtX player will supply e-methanol for plastics production from

20 April 2023 Other News

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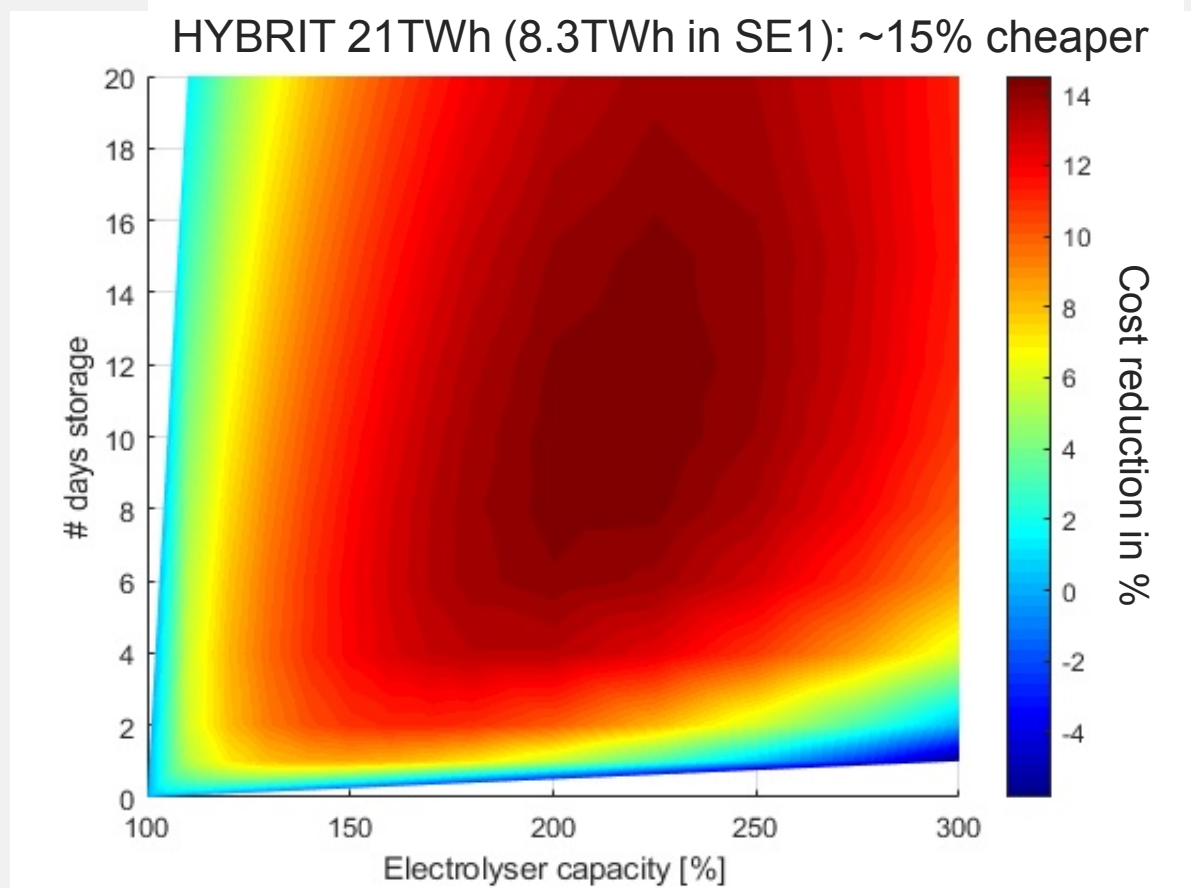
The production of e-methanol will be based on wind and solar plants which is first used to produce hydrogen before further processing into e-methanol

Liquid Wind today announces that Ørsted will acquire full ownership of FlagshipONE, the Swedish green electrofuel plant previously co-owned by Liquid Wind and Ørsted. Located in Örnsköldsvik, FlagshipONE is Europe's largest green electrofuel facility that has reached a final investment decision.



Bild: Illustration av FlagshipONE, Örnsköldsviks kommun. Liquid Wind och Ørsted

Optimal storage capacity for continuous steel making in wind rich system





A joint venture between SSAB, LKAB and Vattenfall

2021-06-21

HYBRIT: SSAB, LKAB and Vattenfall first in the world with hydrogen-reduced sponge iron

SSAB, LKAB and Vattenfall have now produced the world's first hydrogen-reduced sponge iron at a pilot scale. The technological breakthrough in the HYBRIT initiative captures around 90% of emissions in conjunction with steelmaking and is a decisive step on the road to fossil-free steel.

The HYBRIT pilot plant in Luleå, Sweden has completed test production of sponge iron and demonstrates that it is possible to use fossil-free hydrogen gas to reduce iron ore instead of using coal and coke to remove the oxygen. Production has been continuous and of good quality. Around 100 tonnes have been made so far. This is the first time ever that hydrogen made with fossil-free electricity has been used in the direct reduction of iron ore at a pilot scale. The goal in principle is to eliminate carbon dioxide emissions from the steelmaking process by using only fossil-free feedstock and fossil-free energy in all parts of the value chain.

The world's first fossil-free steel ready for delivery

AUGUST 18, 2021 15:00 CEST

6 MIN READ

SSAB has now produced the world's first fossil-free steel and delivered it to a customer. The trial delivery is an important step on the way to a completely fossil-free value chain for iron- and steelmaking and a milestone in the HYBRIT partnership between SSAB, LKAB and Vattenfall.



In July, SSAB Oxelösund rolled the first steel produced using HYBRIT technology, i.e., reduced by 100% fossil-free hydrogen instead of coal and coke, with good results. The steel is now being delivered to the first customer, the Volvo Group.

"The first fossil-free steel in the world is not only a breakthrough for SSAB, it represents proof that it's possible to make the transition and significantly reduce the global carbon footprint of the steel industry. We hope that this will inspire others to also want to speed up the green transition," says Martin Lindqvist, President and CEO of SSAB.

2021-06-21

HYBRIT: SSAB hydrogen-red

SSAB, LKAB and Vattenfall
a pilot scale. The technology
emissions in conjunction

The HYBRIT pilot plant
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100 tonnes have been produced.
electricity has been used.
eliminate carbon dioxide emissions
and fossil-free energy in all parts of the value chain.

HYBRIT

▶▶▶ FOSSIL-FREE STEEL

Articles

The world's first fossil-free steel

AUGUST 18, 2021 15:00 CEST

SSAB has now produced the world's first fossil-free steel, an important step on the way to a completely fossil-free steel. This is a HYBRIT partnership between SSAB, LKAB and Vattenfall.

2021-06-21

HYBRIT: SSAB and Vattenfall produce hydrogen-reduced steel

SSAB, LKAB and Vattenfall have produced the world's first fossil-free steel at a pilot scale. The technology uses hydrogen to reduce iron ore, which significantly reduces emissions in conjunction with fossil-free energy.

The HYBRIT pilot plant demonstrates that it is possible to produce steel from coal and coke to reduce emissions. 100 tonnes have been produced and electricity has been used to eliminate carbon dioxide and fossil-free energy in all parts of the value chain.



In July, SSAB Oxelösund rolled the first steel produced using hydrogen-reduced iron ore, coal and coke, with good results. The steel is now being delivered to Volvo Construction Equipment's facility in Braås, Sweden.

"The first fossil-free steel in the world is not only a breakthrough, it also significantly reduce the global carbon footprint of the steel industry. This is a green transition," says Martin Lindqvist, President and CEO of SSAB.

■ Press release

VOLVO LAUNCHES WORLD'S FIRST VEHICLE USING FOSSIL-FREE STEEL

10/13/2021

By Press Information

Volvo Group is proud to reveal the world's first vehicle made of fossil-free steel from SSAB – made in Volvo Construction Equipment's facility in Braås, Sweden. During today's green steel collaboration event, it was announced that more vehicles will follow in 2022 in what will be a series of concept vehicles and components using fossil-free steel from SSAB.



Conclusions:

- Low and falling costs for solar- and wind electricity
- Electrification of transport sector has resulted in rapidly falling costs of batteries
- Batteries solving stability in the time-scale from < 1 s to several hours
- Hydrogen substituting fossil fueled in industry will reduce electrolyser costs
- Hydrogen production will solve stability in timescale from minutes to weeks
- Cost of energy will fall
- Great opportunity for Japan to get rid of import dependence!