Webinar Technology Watch, May 3 2022

Tecnologie per lo sviluppo delle rinnovabili e l’indipendenza energetica

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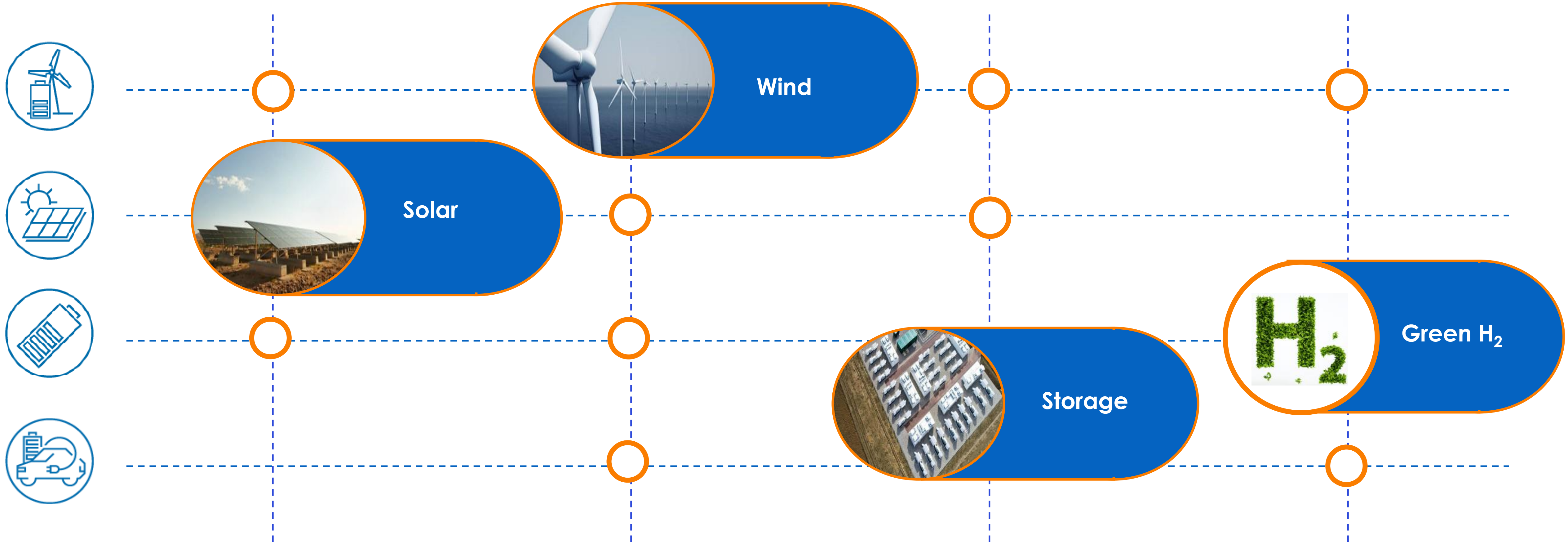
Accelerare lo sviluppo delle rinnovabili verso l’indipendenza energetica

SOLUZIONI TECNOLOGICHE RINNOVABILI PER L’ATTUALE CRISI ENERGETICA

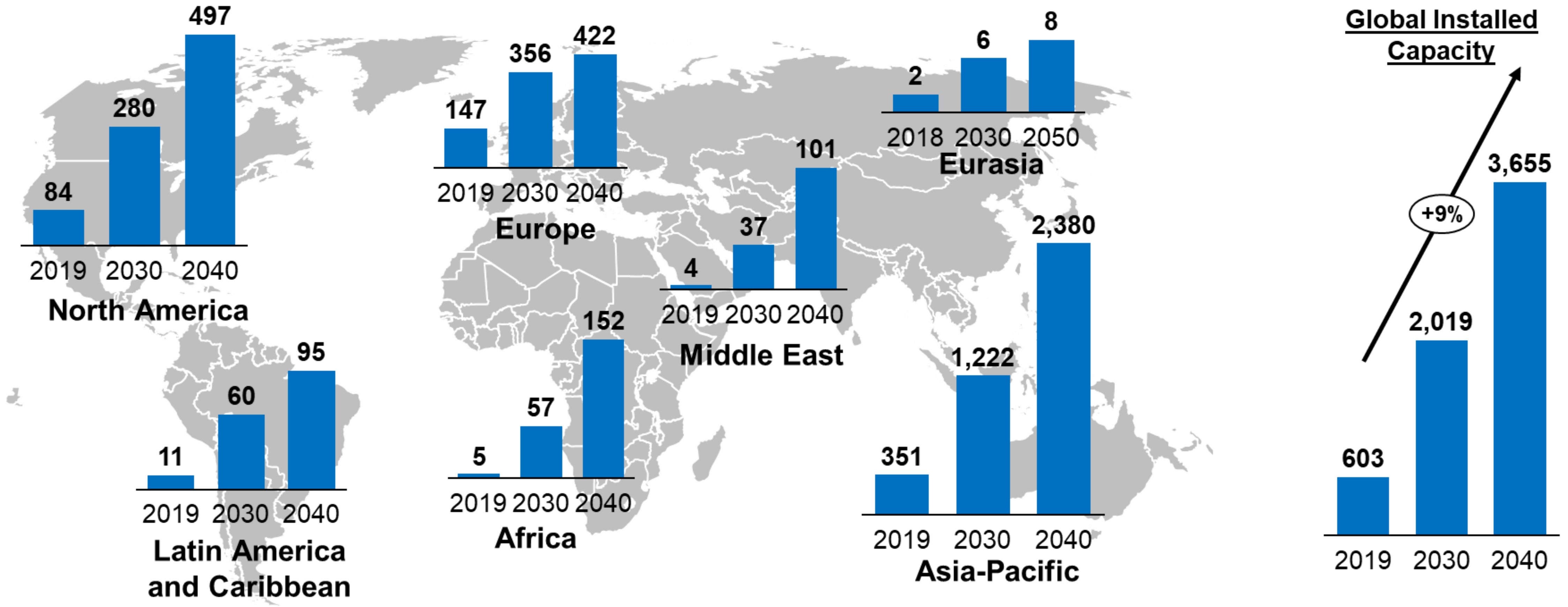
Renewables & Distributed resources

60 GW of new renewable capacity over the next 3 years



Solar PV installed capacities (in GW)

By 2040, all regions will witness an exponential increase in solar capacity with Asia dominating global installations



- Source: IRENA, World Energy Outlook 2020, Strategy& analysis

Ground or rooftops using fixed or tracking frames

Ground mounted

- Easy access for maintenance purposes

Roof mounted

- Increased immunity against tampering / vandalism

Fixed Frame

- Allowing for seasonal tilt adjustments

Single axis tracking

- To reduce reciprocal shading and increase output by 15% to 30%
- Increases the system cost by around 5-10%

Dual axis tracking

- To increase output by 25% to 40%
- Increases the system cost by 10 to 20 %

However, innovative mounting methods nowadays go well beyond conventional ground and rooftop installations

- Source: Riverside energy systems, CESI/Strategy& analysis

Innovative mounting methods

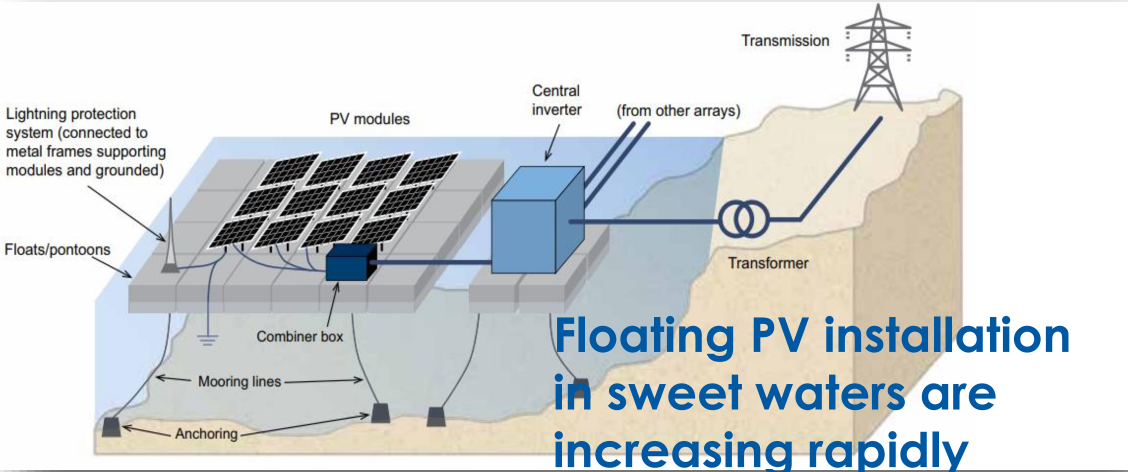
Floating Solar Farms

Sekdoorn farm in Netherlands

Coal mine area in China

Nanatsujima Mega in Japan

To reduce land requirements - installed in industrial pools and other small lakes



Floating PV installation in sweet waters are increasing rapidly

Agrivoltaics

Aurora Solar Park in USA

Solar farm design optimizing energy production and crops

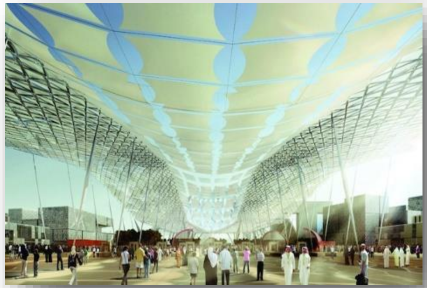
Solar Facades

Solar facade in *Brussels, Belgium*

Against or integrated in the facade , to make the building energy self-sufficient

Solar Trees and Canopies

Solar canopies covering Expo Dubai Pavilions



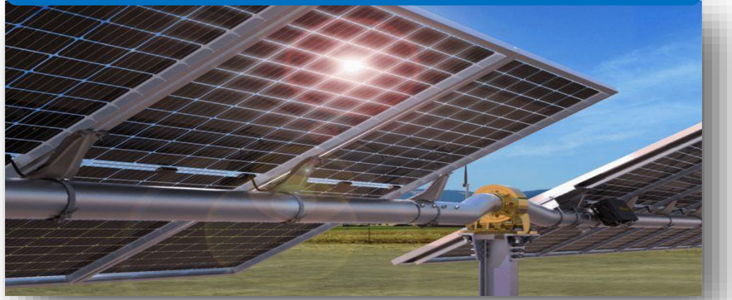
“Supertrees” in Singapore

Able to provide shade or shelter from weather conditions such as sun, snow and rain

- Source: MIT Labs, WIRED, ENEL Green Power, CESI/Strategy& analysis

New architectures and O&M innovation

Bifacial Solar Cells



Cost

15% higher
Costs compared to monofacial cells

Efficiency

10 – 20%
Power yield increase over monofacial cells

Al Dhafra PV2 in Abu Dhabi

- **2 GW** of generation power
- **8 km², of solar panel, 3,3 Mn** modules
- **Abu Dhabi, UAE**
- Executed by the consortium of Jinko Power HK (China) and EDF Renewables (France)

Source: World Energy Output 2020, IRENA Report, Researchgate: EDF Labs France Report

DRONES FOR SOLAR PLANT MONITORING

Large-scale power plants require better tools for inspection and monitoring. Manual inspections are thus being replaced by drone surveillance, enabling time efficiency and increased report accuracy for long-range inspections.

ANTI-SOILING SOLUTIONS

Advanced panel-cleaning solutions to prevent loss of efficiency due to soiling, including robotic panel cleaning technology[1], and sprinkler systems that dispense water and soap to clean solar panels.

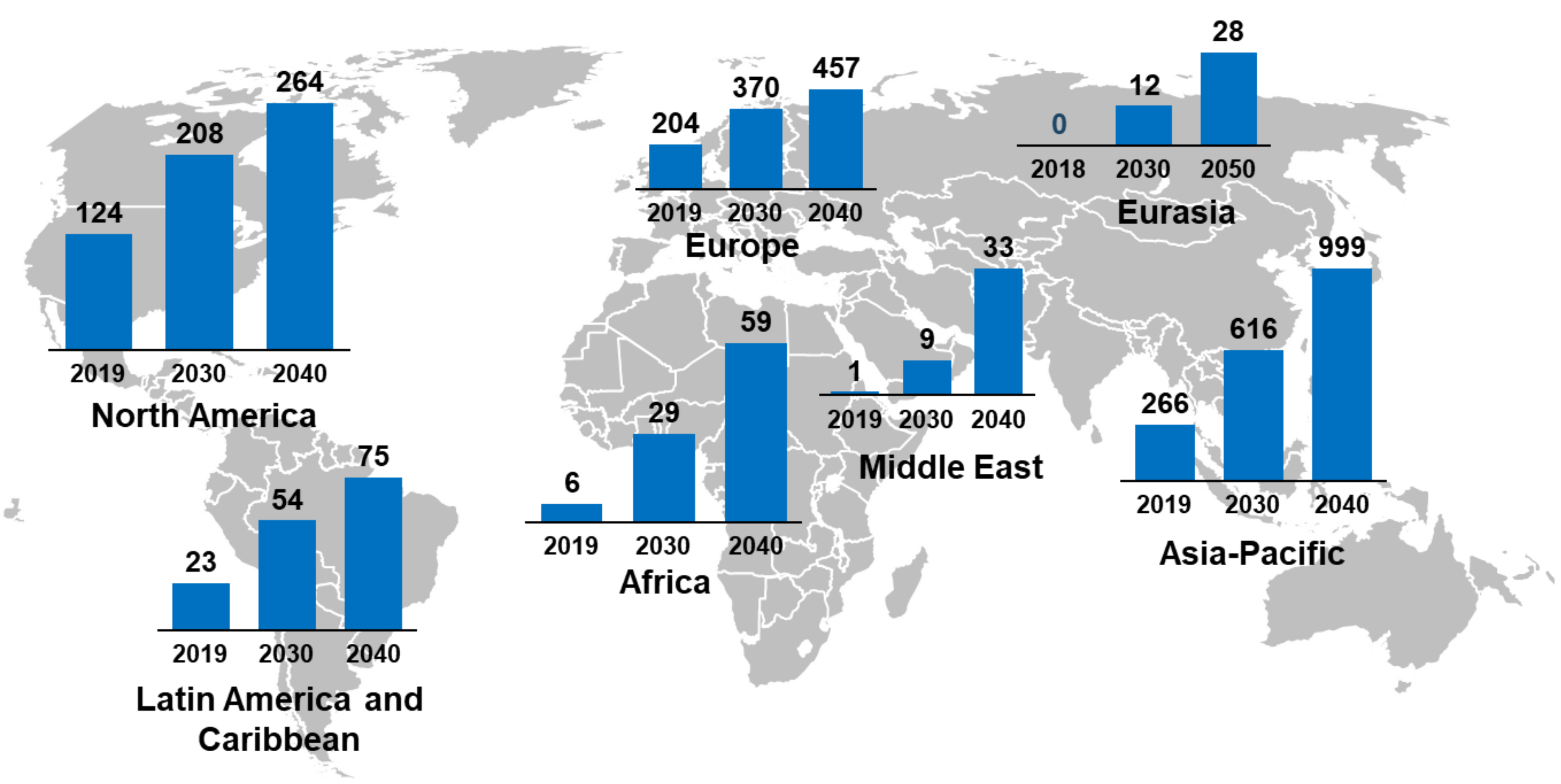
SOLAR POWER COOLANT

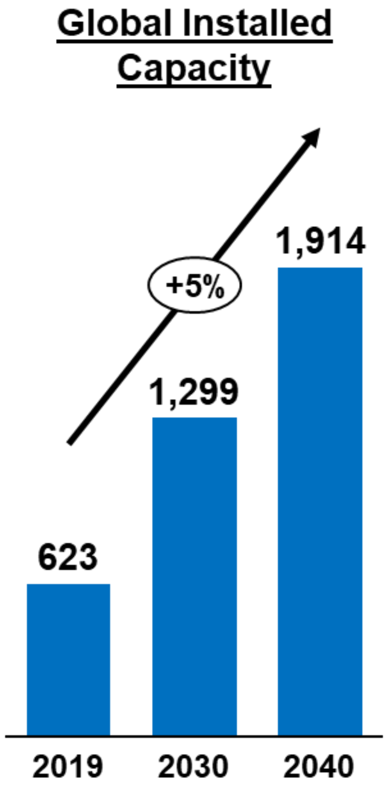
Solutions aimed to keep solar PV modules cool and thus extend their performance[2]. Heat exchanger panel that can be attached to the back of Solar PV panels.

1) Suitable for regions that have low rainfall
2) Efficiency of solar PV panels drops by 0.05% for every 1 degree Celsius above 26 C
Source: Thermalcity, IRENA Report, World Energy Outlook 2020, Sunovate, Strategy&/CESI analysis

Wind power installed capacities (GW)

Over the next 20 years, wind capacity is forecasted to continue increasing at 5% CAGR, reaching ~2 TW by 2040





- Source: IRENA, World Energy Outlook 2020, Strategy& analysis

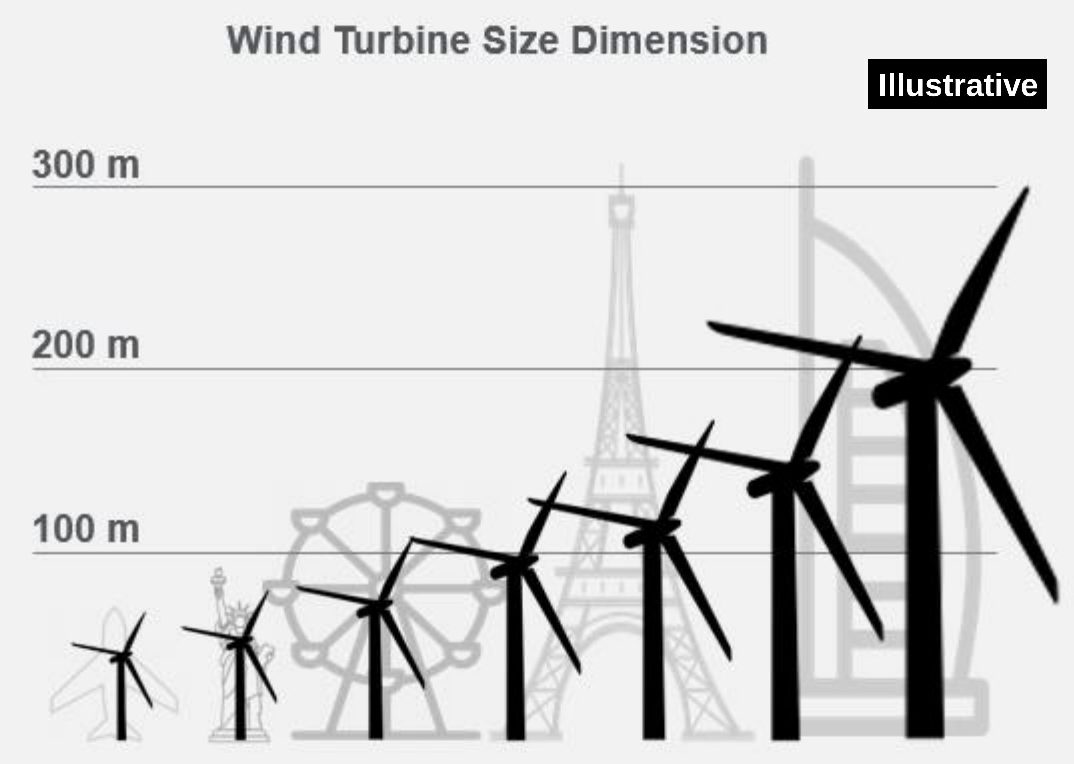
Turbine size, height and capacity

Advancements in turbine size and height are driving improved power output for wind power projects

Turbine size, height and capacity

About

- Continued trend towards taller and higher capacity turbines
- Over 40% projects in 2019 with over 150m height
- 15 MW turbine platforms in market
- 239% increase in avg. rated capacity since 1999



Output (MW)	0.5	1.2	2	3.6	4.2	6.6	13-15
Rotor Diameter (m)	40	70	90	117	136	170	236

- Source: Researchgate, German Development Institute Report, US Dept. of Energy Wind Technology Report 2018, Strategy&/CESI analysis

Innovative wind turbine applications

Floating Wind Turbines

Floating wind turbines in Norway

Onshore will continue to dominate, but offshore share is expected to increase exponentially to constitute ~17% of global market by 2050

Drivers for Offshore Wind Farms

- Potential for higher output as offshore wind is faster and steadier
- Politically "acceptable" with minimized impact on landscape visual

Multi-Rotor Turbines

A test turbine in Roskilde, Denmark

A concept of a large-scale multi-rotor turbines with two or more rotors atop a single support structure

VWT in Open Spaces

VWT in a park, USA

Vertical wind turbines installed in series in parks and open spaces that benefit surrounding communities

Skyscrapers with Wind Turbines

London Razor skyscraper with turbines

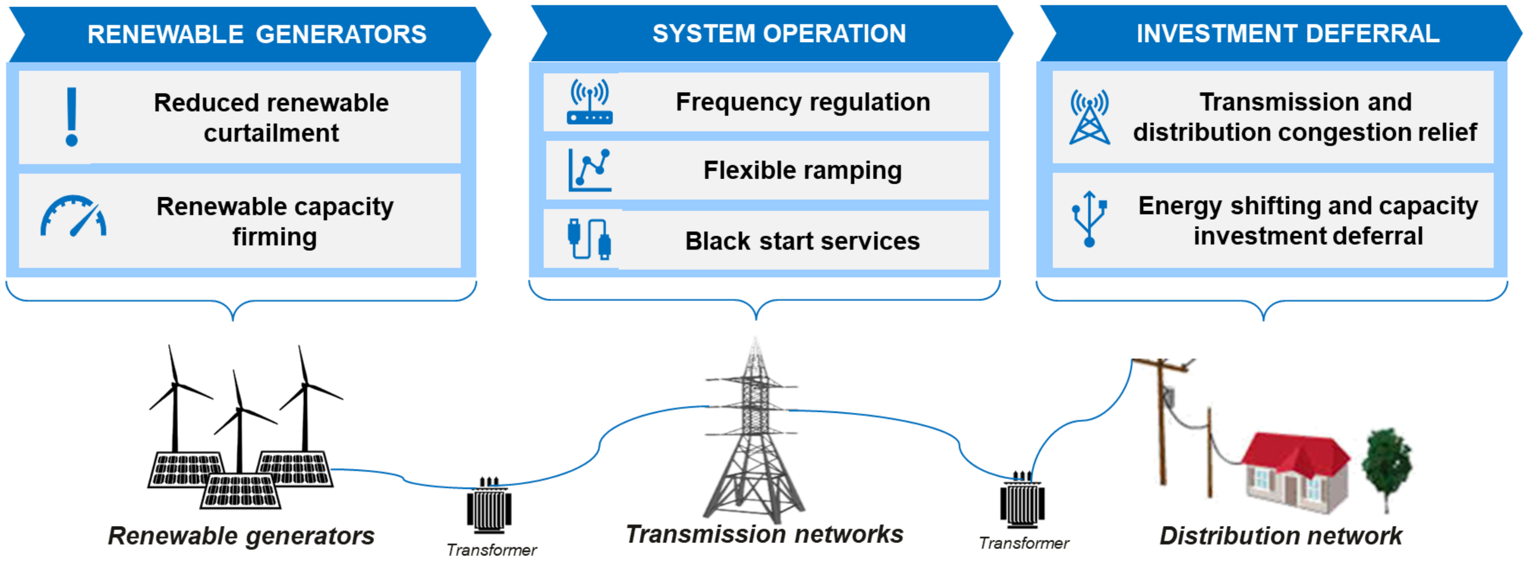
Wind turbines integrated into architecture of buildings, contributing to their energy needs

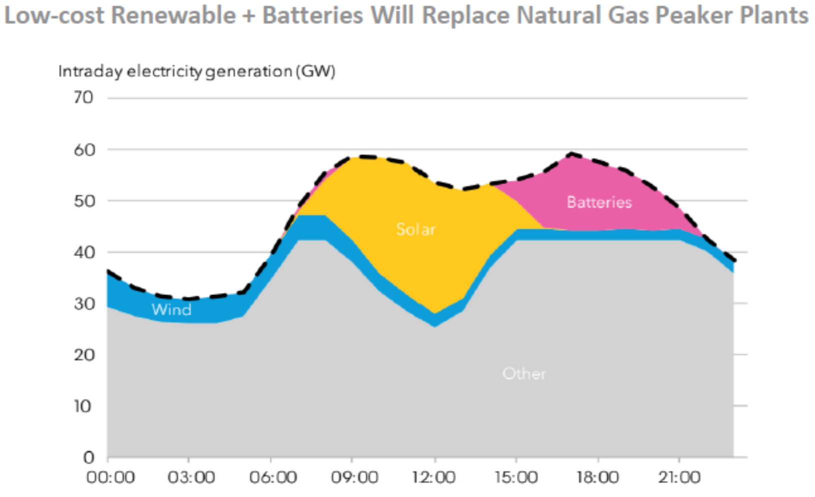
- Source: Offshore Energy website, Det Norske Veritas website, NEOM report, Strategy&/CESI analysis

Storage for higher system flexibility

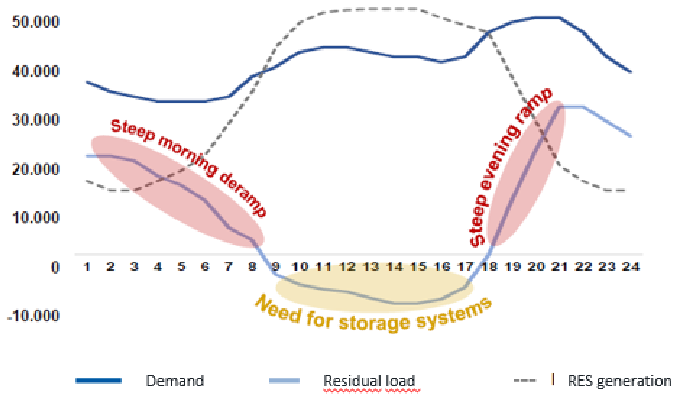
Need for Storage capacity and new paradigms for storage facilities, not only hydro pumping, but:

- √ Utility scale batteries;
- √ clusters of EV;
- √ non conventional devices (CAES, thermal energy storage, green hydrogen, etc.)





Source: Bloomberg NEF



Italy: example of residual load with high RES penetration. Simulation at 2030*

Up to 15÷20 GW of RES generation would be curtailed in many occurrences without appropriate energy storage facilities

RES generation growth will be largely based on variable energy sources (wind and solar) calling for an **enhanced system flexibility**

* *Simulation applied to Italy referring to the National Energy Strategy*

Storage families

Mechanical

Pumped Hydro Storage

Uses elevation or motion to store energy in mechanical form

Thermal

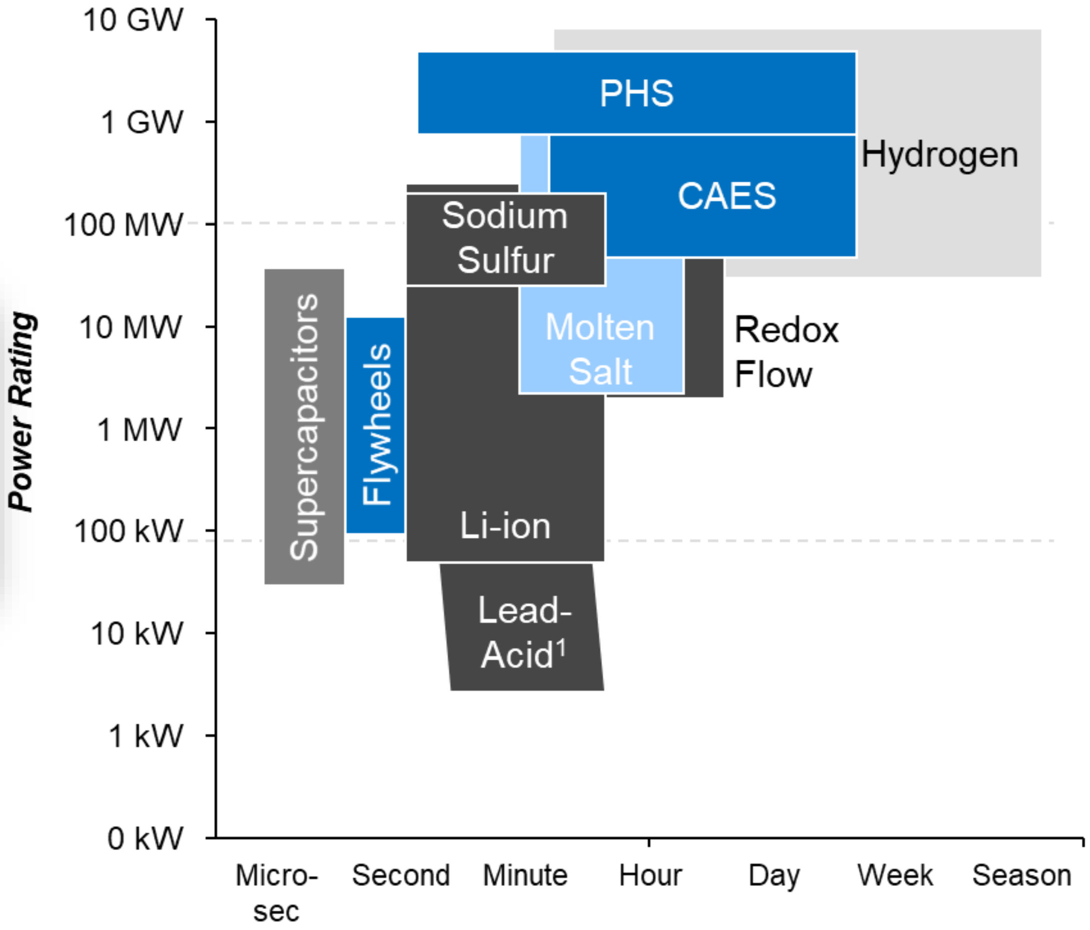
CSP with Thermal Storage

Converts electricity to heat that is then stored in a medium (e.g., molten salt)

Electro-chemical

Li-Ion Energy Storage

Uses battery technology to store electricity



Chemical

Hydrogen Storage System

Uses electrolysis to separate natural elements and store energy in gas form

Electrical

Supercapacitor System

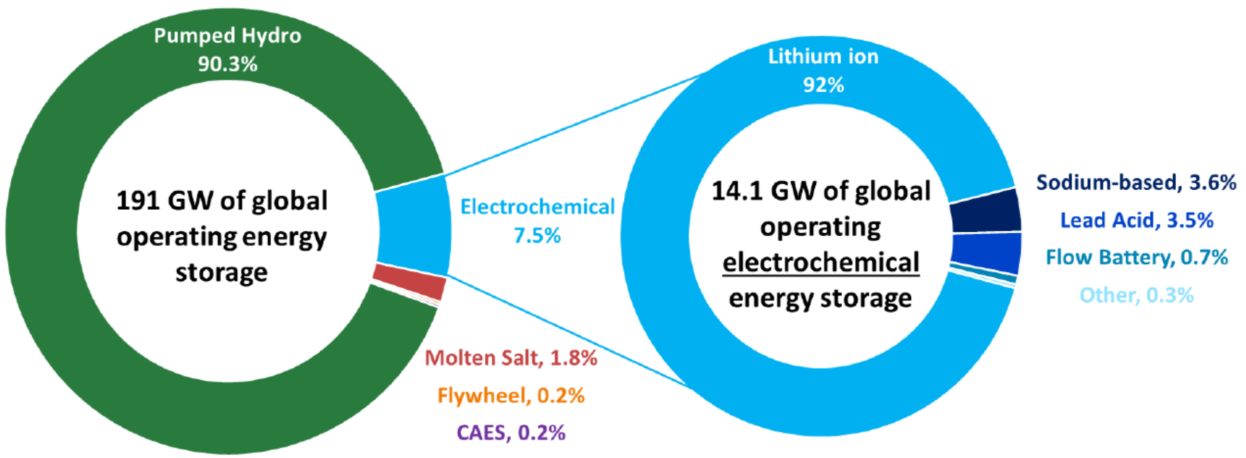
Stores electrical energy on 2 metal plates separated by a semiconductor

1) While lead acid is the most mature battery technology, its adoption is reducing year on year and increasingly being replaced by other batteries for utility-scale applications due to its short lifetime and low energy density

Source: IRENA Electricity Storage And Renewables, CESI/Strategy& analysis

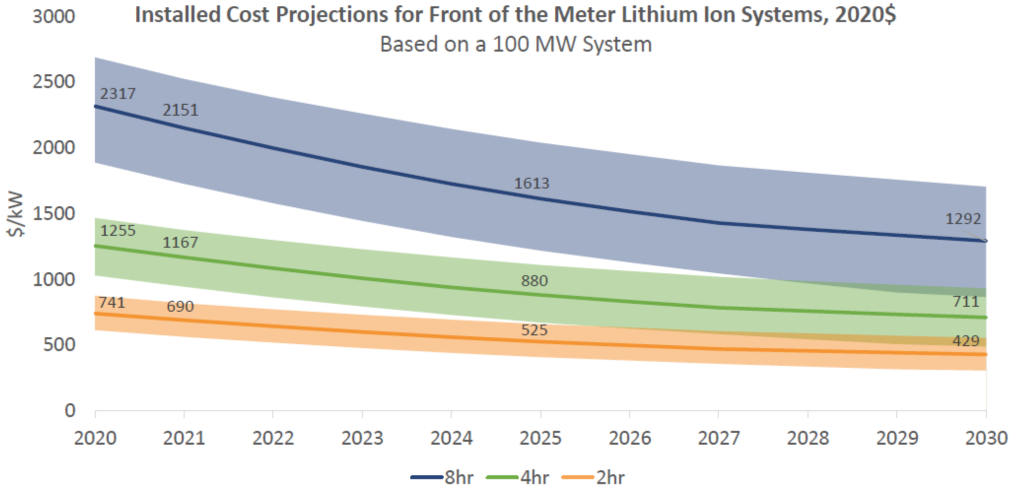
Energy Storage Growth Drivers

Global Operational Energy Storage Capacity (MW)



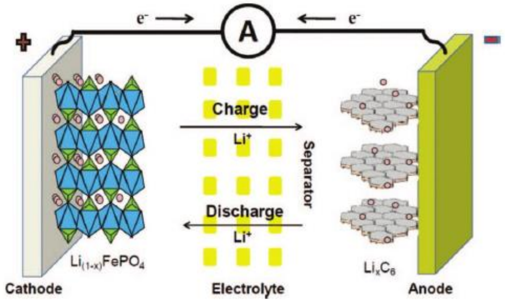
Source: China Energy Storage Alliance, Energy Storage Industry whitepaper, 2021

Rapid cost reduction in lithium ion Batteries and expected growth with a CAGR of ~25%



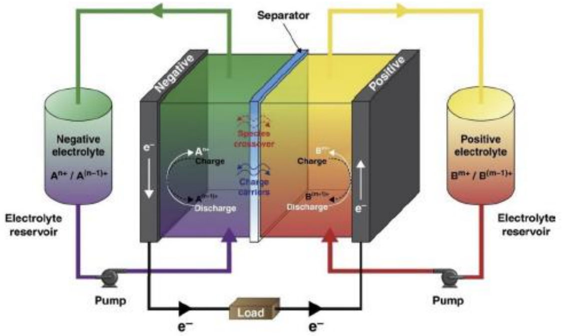
Source: EPRI, Battery Energy Storage Lifecycle Cost Assessment Summary, 2020

Improvement in existing technologies and development of new ones



Li-ion Battery : e.g. stable cathode at high voltage and anode optimization to increase energy density

Redox Flow Battery : e.g. membrane with lower resistance, reduced leakage and longer life

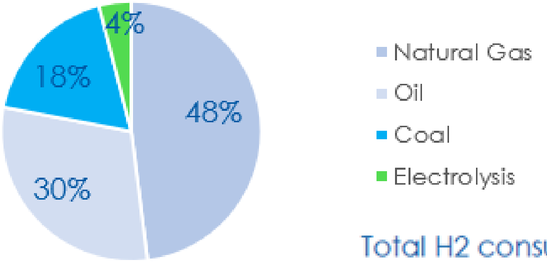


- All Solid State / Li Metal Battery (high energy density, fast charging)
- Lithium Sulphur Battery(high energy density, low cost)

Source: GCCIA/EPRI Energy Storage Forum – Dubai March 2022

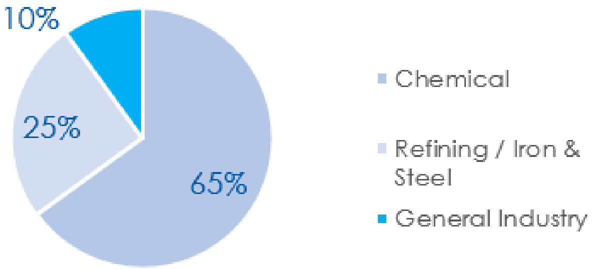
Green Hydrogen

Current hydrogen sources



Total H2 consumption worldwide: 110 Mton

Current uses of hydrogen



Chemicals
- Fertilizers ammonia
- Polymers
- Resins

Refining
- Hydrocracking
- Plastics

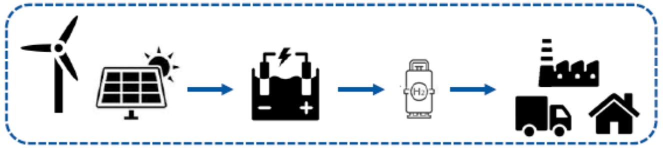
Iron & Steel
- Thermal treatments
- Process gases

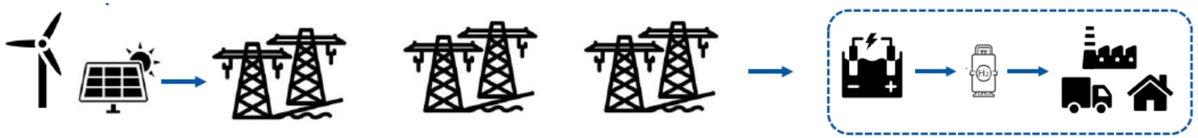
Other industrial uses
- Semiconductors
- Propellant fuel
- Glass production
- Cooling of generators

Heavy transports
- Trucks
- Ships
- Trains
- Aviation

Storage & transport of hydrogen

✓ *Optimal location and sizing of electrolysers*





✓ *Need for upgrading existing gas infrastructures or building new ones: hydrogen-pipelines*

Potential to produce H_2 with electrolysers from RES and use in hardly to decarbonize sectors and possibility also to use green H2 to ensure security of supply in the power sector thanks to weekly / seasonal energy storage

Possibility **Strong political driver**

- ✓ *EC communication on "A hydrogen strategy for a climate-neutral Europe", July 2020*
  - ✓ *At least 6 GW of green hydrogen electrolysers in the EU by 2024*
  - ✓ *40 GW of green hydrogen electrolysers by 2030*
- ✓ *European Clean Hydrogen Alliance - 2050 objective: 14% of energy demand covered by green hydrogen*

Shaping a Better Energy Future

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