



World Utilities
Congress



16-18 SEPTEMBER 2024 | ABU DHABI, UNITED ARAB EMIRATES

INSIGHTS REPORT

HYBRID RENEWABLE ENERGY SYSTEMS

Combining multiple distributed energy resources to
accelerate the energy transition



Prepared for World Utilities Congress by:

F R O S T & S U L L I V A N

Investment across renewable energy and battery storage soared to a record \$716 billion in 2023 and is forecast to accelerate further to \$995 billion by the end of the decade. Much of this growth is driven by large utility-scale wind and solar PV installations that supply electricity directly to the grid. The electricity generated can be utilized by the grid with few challenges, displacing electricity that would have come from fossil fuel sources such as coal, but particularly gas-fired power plants, which are a key source of flexible generation. However, there are times when there is excess electricity production beyond what the grid can handle. In these cases, the wind or solar plant is curtailed meaning that its electricity does not come to the grid and is effectively wasted. Or there is not enough electricity from renewables at certain times, meaning that fossil fuels must be relied on.

The existing grid infrastructure can do much of the work of balancing different forms of electricity production and contract with energy storage providers to provide grid balancing services, particularly for larger assets. But this becomes much more challenging for smaller renewable energy assets such as commercial, industrial and residential solar energy installations. This is where the hybridisation of energy assets comes into play. Combining solar PV with battery energy storage can enable the asset owner to maximise the value for themselves, either by increased self-consumption or supplying back to the grid at times of maximum profit. Combining a renewable energy asset with a fossil-based asset can act to lower the emissions level of the fossil-based asset, as the hours it operates can be lowered. Combining more than two assets can also be an attractive solution – so two forms of generation with storage.

Some of the key asset combinations are shown below.



Solar + Battery Storage



Wind + Battery Storage



Engines + Solar (+ Battery Storage)



Turbines + Battery Storage



Wind + Solar (+ Battery Storage)



KEY BENEFITS FOR OWNERS & DEVELOPERS OF HYBRID POWER SOLUTIONS

There are significant potential benefits for the owners and investors of hybrid power systems where expenditure can be reduced, leading to higher profitability.



Reduced Capital Expenditure:

Hybrid power plants provide cost savings in project design, shared equipment, labour, installation, permit, and interconnection. Savings are in the order of nearly 10% for the case of utility projects and 20% for distributed energy resources (DER).



Operations Optimisation:

Hybrid systems can overcome the limitations of individual generating technologies in terms of fuel efficiency, environmental footprint, dispatchability, firm capacity, and reliability, as well as flexibility to avoid curtailment and recover 'clipped' energy, in the case of solar PV plants.



Reduced Operational Expenditure (OPEX):

Hybrids provide fossil fuel savings, joint operation and maintenance, and utility bill savings, with reduced load costs and load shifting for industrial DER.



Multiple Revenue Streams:

Depending on market regulations and value stacking possibilities, hybrid power plants can provide additional revenue streams in the forms of ancillary services (ramp control, frequency regulation, spinning reserves, and firm capacity) or energy arbitrage, choosing when to sell electricity to the grid.

It is not just the developers that benefit from hybrid energy systems. There are wider societal benefits in the form of lower carbon emissions. The grid network benefits from the higher degree of flexibility and also increased grid resiliency, as hybrid assets can be connected to nano-grids, mini-grids or micro-grids. Lower technology costs for solar PV increase the attractiveness of projects, although much of this has been offset in the past two years by increases in overall project management costs and price increases for some key components. Battery energy storage costs increased in 2022, but they have now returned to a downward trajectory with significant falls forecast to 2030.

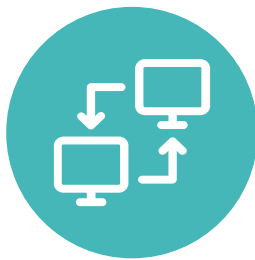
There are barriers to wider industry development. A majority of electricity markets lack the definition of hybrid systems and the operational rules for them in their regulatory frameworks. The absence of ancillary services and capacity markets reduced the potential to benefit from multiple revenue streams. Overall capex costs are higher than just one form of generation. Complexity, relative novelty, and limited standardization translate into higher risk and, hence, increased overall capital costs – although this is declining fast as market growth accelerates.

KEY BUILDING BLOCKS FOR A HYBRID ENERGY SYSTEM

There are a number of key elements required for a successful hybrid energy project. Either through in-house development, or acquisitions/partnerships, participants must address a set of capabilities to be successful in the hybrids market.



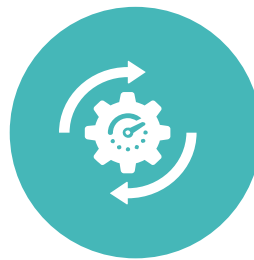
Generation Assets



Hybrid Control System



Ability to Handle Greater Complexities



Project Development Experience



Financing Aid



Beta Testing



Renewables Forecasting Software



(O&M) and Service Agreements



Storage Solutions



Plant Optimisation Capabilities

GEOGRAPHIC OPPORTUNITIES

There are significant opportunities for hybrid energy systems across a number of geographies. All regions have high levels of investment in solar PV, which will dominate the overall market new system installations. For other generation sources, the picture is more mixed, largely depending on whether the regulations make the use cases viable. For fossil fuel related assets, there are significant opportunities for adding a renewable energy source or storage to the existing asset.

The total market is forecast to reach \$30 billion by 2025. Asia is by far the largest market and is forecast to reach \$15.4 billion. China is the leading country market, but there

is strong growth in India, Australia, South Korea and the ASEAN nations. Rural and island electrification is a key driver across much of the region, as countries try and plug the gaps that remain in their electricity grids. For highly developed countries it is more about grid resiliency. North America is next, with a market forecast of \$6.7 billion by 2025, closely followed by Europe with a market forecast of \$5.1 billion. Grid resiliency is a key use case for North America, whereas supporting the integration of renewable energy and wider decarbonization are key use cases in both regions. The Middle East and North Africa market is forecast to be worth \$1.4 billion, with electrification, grid resiliency and decarbonisation key use cases.

Technology/Region	Solar + Battery Storage	Wind + Battery Storage	Engines + Solar (+Battery Storage)	Turbines + Battery Storage	Wind + Solar (+ Battery Storage)	Application
North America	High	Medium	Low	High	High	Utility-scale
	High	Low	High	Low	High	Village and Island electrification
	High	Low	Low	High	Low	Commercial and industrial power
Latin America	High	High	High	High	High	Utility-scale
	High	Medium	High	Low	High	Village and Island electrification
	High	Low	High	Low	Low	Commercial and industrial power
Europe	High	High	Low	High	High	Utility-scale
	High	Medium	High	Low	High	Village and Island electrification
	High	Low	Low	High	High	Commercial and industrial power
Asia	High	High	High	High	High	Utility-scale
	High	High	High	Low	High	Village and Island electrification
	High	Low	High	High	Low	Commercial and industrial power
Middle East & North America	High	High	High	High	High	Utility-scale
	High	High	High	Low	High	Village and Island electrification
	High	Low	High	Low	Low	Commercial and industrial power

Degree of Opportunity: ■ High | ■ Medium | ■ Low

ABOUT WORLD UTILITIES CONGRESS



World Utilities
Congress



Hosted by TAQA, the World Utilities Congress, scheduled to take place in Abu Dhabi from 16 - 18 September 2024, serves as an international platform that brings together global energy leaders, policymakers, innovators, and industry professionals from across the power & water utilities value chain to discuss the major trends and challenges shaping the industry as utilities worldwide work to deliver secure, sustainable, and affordable energy.

This congress will provide a vital platform for the sector to engage in discussions about the role and pace of decarbonisation in the utility industry's future. It will also showcase the latest innovations and solutions aimed at establishing a renewable utilities sector.

With over 180 global exhibitors and 12,000 utilities professionals expected to attend, seize the opportunity to explore the latest trends and innovations in power generation, transmission and distribution, nuclear energy, water management, and desalination.

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