# HYBRID RE POWER PLANTS:

## OPPORTUNITIES AND CHALLENGES

# RENEWABLE HYBRIDS - DEFINITION

Renewable Hybrids combine multiple renewable generation sources (i.e. Wind + Solar) and/or energy storage where energy storage can be batteries, pumped storage, thermal storage, etc.

An Advanced Control System manages, monitors and controls both the wind and solar generation assets to optimize the farm's output energy mix.

They are ideal in cases where multiple energy sources complement one another in addition to:

- limited land availability;
- limited or weak grid connections;
- high Capacity Factor (CF) expectations; and
- avoidance of additional grid infrastructure investments

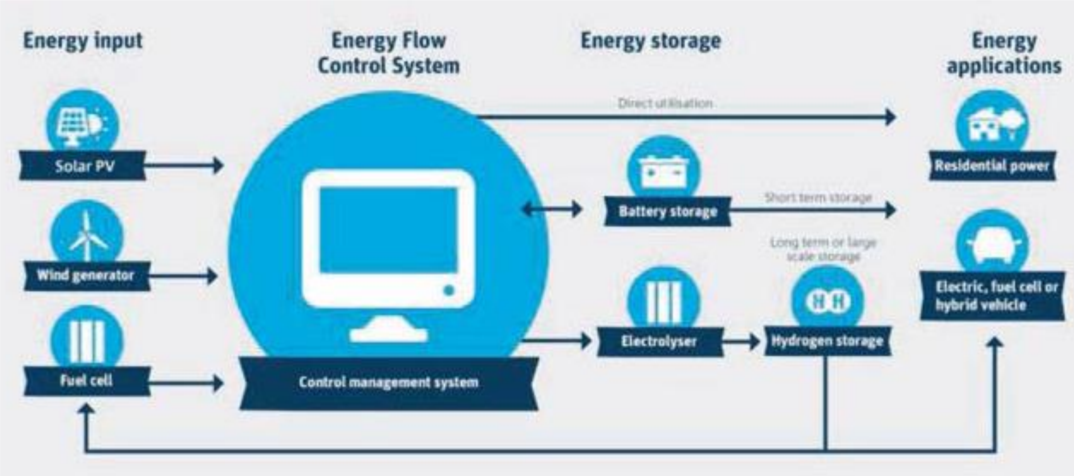



Figure 1: Hybrid energy system [1]

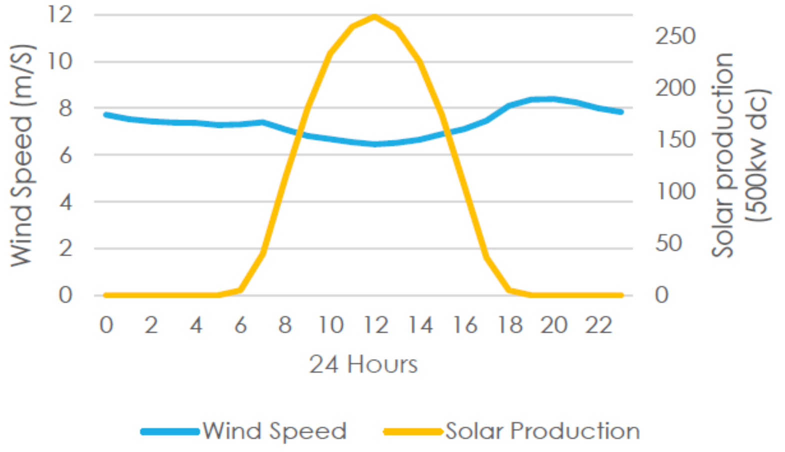



Figure 2: Yearly Complementary Wind and Solar Profile in Pakistan [2]

# HYBRID TECHNOLOGY – A GLOBAL OVERVIEW

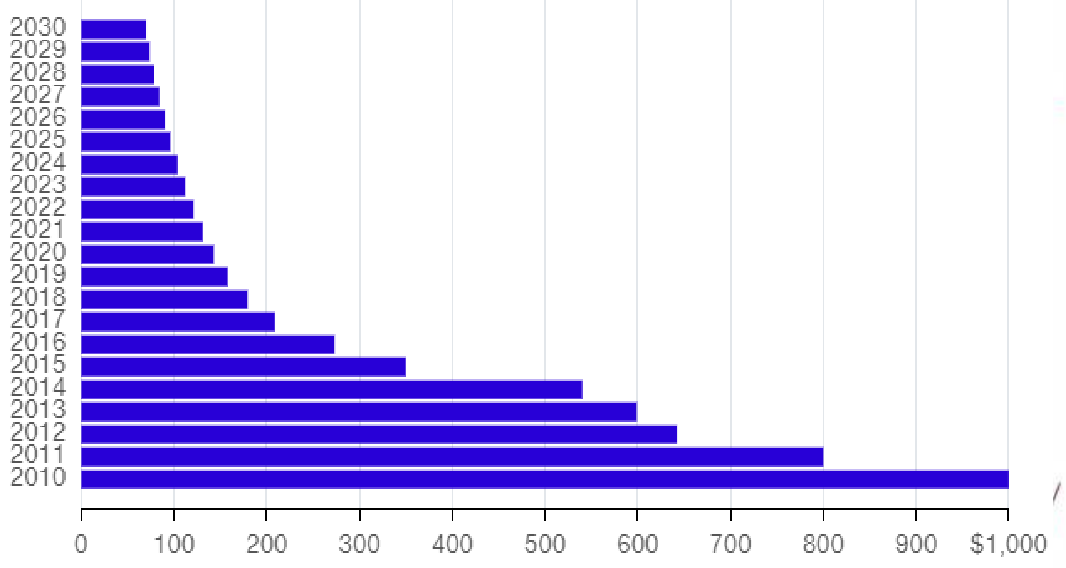
Crucial global renewable energy market disruptions:

Projects more bankable and marketable due to RE core technology maturity:

- Capital is more readily available
- Matured market participants capable of better country risk assessment

Embracing storage's potential to disrupt traditional power market (base load) models:

- Distributed Generation on the rise
- Falling storage prices (battery prices have fallen 24% since 2016 and 80% since 2010) [3]
- Digitalization of Industry - Integration of storage and RE solutions to operate on rapid demand response times so as to create virtual power plants.




Source: BNEF
Note: Figures for 2018 and beyond are projections

Figure 3:
Lithium-ion Battery price, historical and forecast [3]

# GLOBAL PROJECTS

India

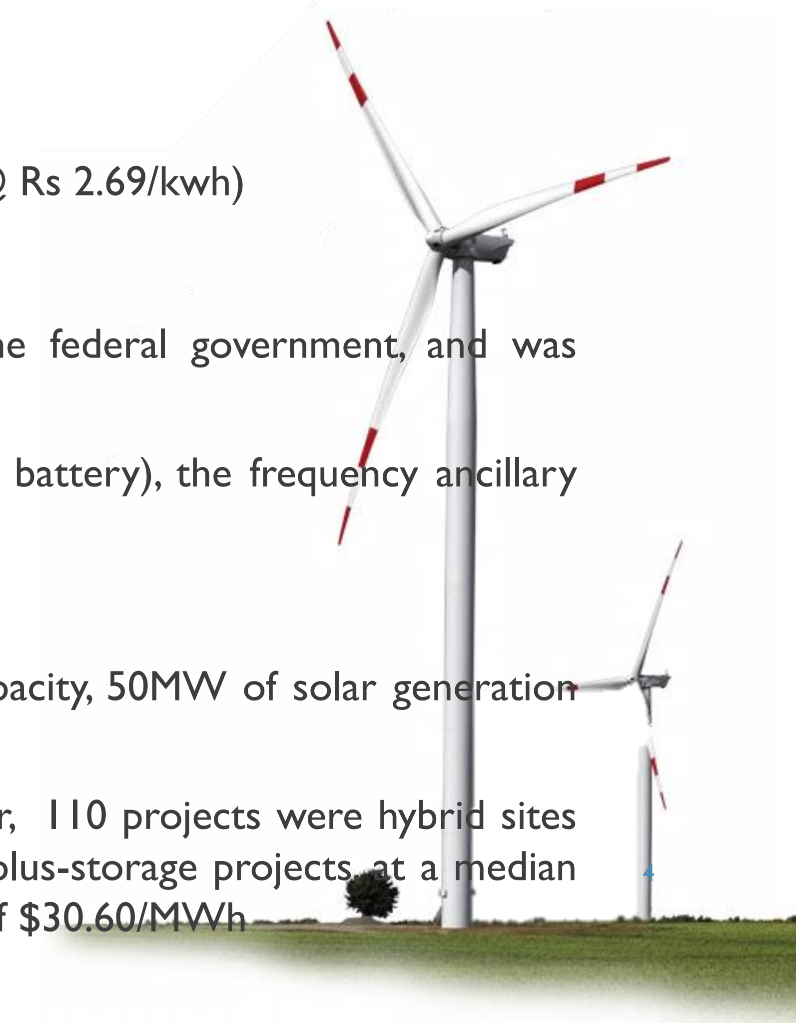
- First Solar Hybrid Policy (2018) - "National Wind-Solar Hybrid Policy"
- SECI conducts first wind-solar hybrid auction (450 MW @ Rs 2.67/kwh + 390 MW @ Rs 2.69/kwh)

Australia

- 800MW Clarke Creek Wind Farm had secured environmental approval from the federal government, and was preparing for construction to begin in 2019
- "In the first four months of operations of the Hornsdale Power Reserve (Tesla big battery), the frequency ancillary services prices went down by 90 per cent"

US

- Eastern Oregon - The Wheatridge Renewable Energy project - 300MW of wind capacity, 50MW of solar generation and a 30MW battery.
- 2017 - Xcel Energy received 430 proposals, of which 358 were for wind and/or solar, 110 projects were hybrid sites combining wind, solar and storage in different scenarios. The bids included 11 wind-plus-storage projects, at a median price of $21/MWh, and seven wind-plus-solar-plus-storage sites, with a median price of $30.60/MWh



# HYBRID OPTIONS

## WIND – SOLAR CONNECTION SCENARIOS

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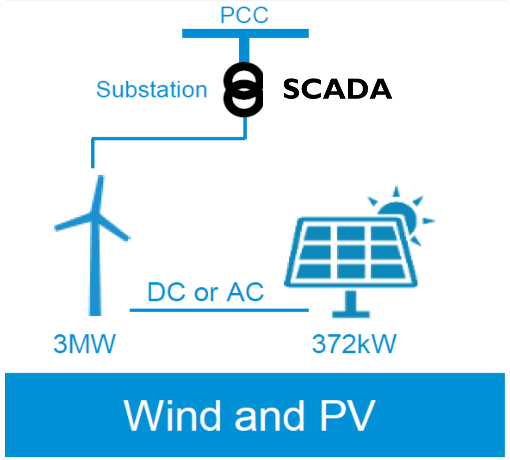
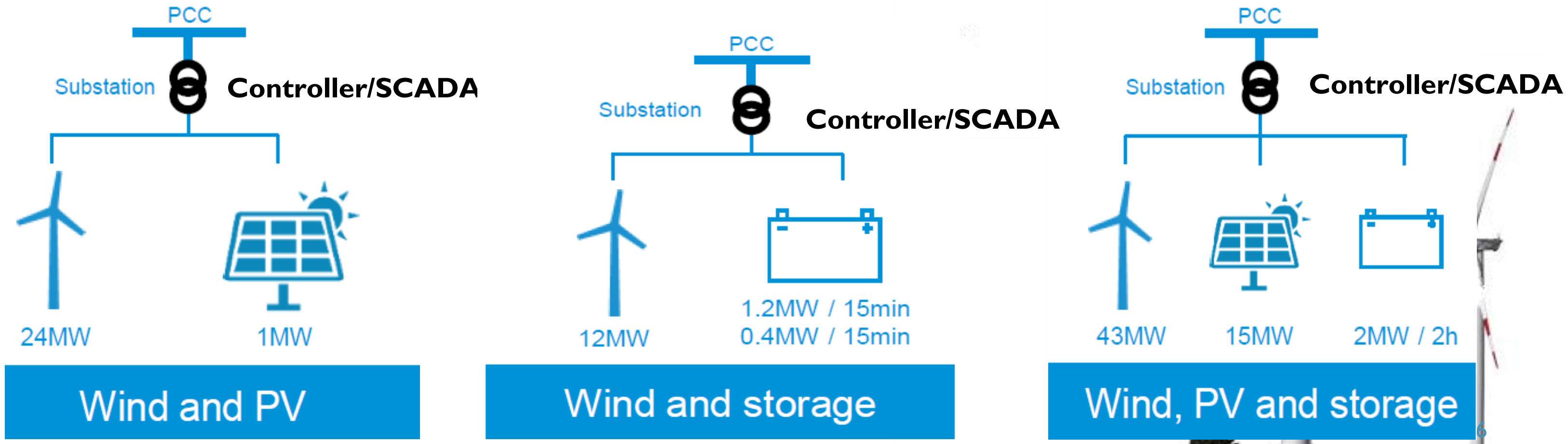
- Green field (GF) vs Brown field (BF) installations
  - Brown Field sites - Extension in existing projects ideal for cases where there is land unavailability, planning constraints, environmental concerns coupled with expensive supporting infrastructure.
  - Green field Sites – Ideal for optimized mix to achieve higher capacity factors and most optimal LCOE
- Hybrid Topologies: WTG Coupled vs Co-located [4]




Integration of wind and solar at the wind turbine level (pilot)




Co-located: Integration at plant level

# HYBRID VALUE ADDITIONS

HYBRID SOLUTIONS OFFER HIGHER CAPACITY FACTORS AND GRID UTILIZTION RATES – OFFER A SOLUTION TO THE INTERMITTENCY CHALLENGE!

Sapphire

# WIND SOLAR HYBRID VALUE ADDITION

- **Increased Plant Capacity Factors**
  - Annual Energy Production (AEP) increases through the most efficient use of complementary wind and solar resources in green field installations

- **Reduced Intermittency**
  - Complementarity of wind and solar resources addresses the challenge of variable renewable energy integration in the grid
  - Allows better power planning and dispatch as the generation profile can closely follow demand in many regions

- **Improved Grid Utilization and Ancillary Support**
  - More electrons feed into the grid at the same cost
  - Improved frequency control through Solar Inverters and Battery Storage

# CHALLENGES TO HYBRIDIZATION

## TECHNICAL AND POLICY CHALLENGES

Sapphire

# POLICY CHALLENGES - HYBRID POWER PLANTS

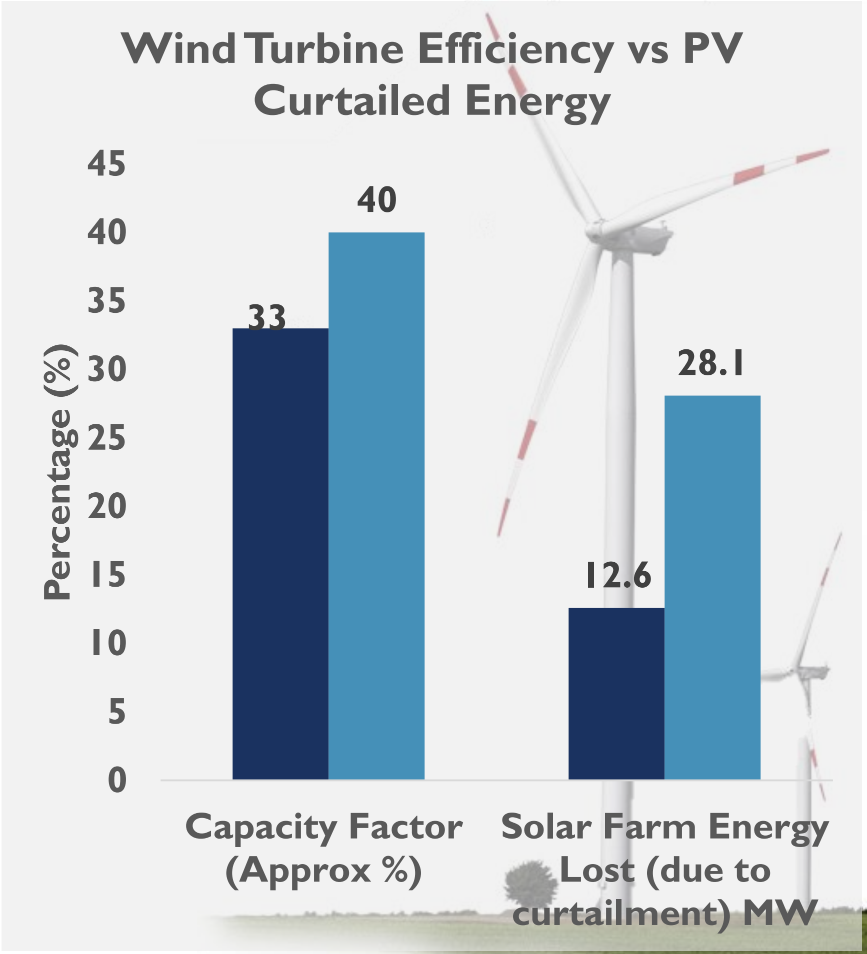
- **Technological advances have outpaced policy evolution**
  - Policy frameworks do not embrace technological advancement
  - Lack of policy instruments enhances sector risks – impacts availability and cost of capital

- **Land Lease Issues**
  - Existing lease upgradation for installation of solar plants at brown field installations
  - Possible usage of buffer area at brown field installations

- **Non-availability of workable tariff models**
  - Blended tariffs for hybrid RE plants versus tariffs for individual technologies (for brown field plants)

# TECHNICAL CHALLENGES

- **Weak and saturated grids**
  - Grid outages and curtailments offset the envisaged AEP gains
- **Grid throughput limitations on brown field installations**
  - Lead to energy curtailments – *storage a possible solution*
- **Improving technologies enhance energy curtailment risks**
  - Solar PV curtailment level a function of Wind Turbine Efficiency on brown field installations
  - Better WTG efficiency results in higher solar curtailments
- **Wind Turbine Shadowing**
  - Turbine shadows limit Solar PV yields on green field
- **SCADA for Integration of Wind & Solar**
  - Expensive solutions available!
- **Metering Scheme to align with PPA**
  - Multiple meters and predefined formulae required



# STORAGE VALUE ADDITION

- **Base-load Transition**: variable renewables (e.g. wind and solar) to provide the bulk of the energy, and dispatchable renewables will ramp up as required to meet the demand
- **Loss Recapture**: Integrating storage technologies reduce plant curtailment by storing excess power
- **Ancillary Services**: reducing intermittency of supply adding frequency and voltage support via storage, hence stability to manage increasing MWs of renewable assets
- **Arbitrage opportunity:** Together with storage solutions, Renewable Hybrids can be used to shift energy to times with high prices thereby unlocking new revenue streams
- **Islanding:** Storage makes up for the needed power when the grid drops off
- **Black Start:** Storage restarts the plant after an outage and self-synchronizes with grid

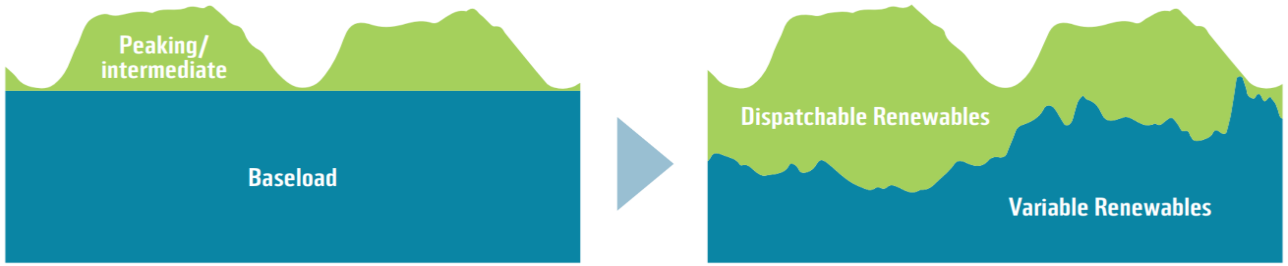



Figure 4:
Transition from base-load to Renewables plus storage

# REFERENCES


1) Zohuri, Bahman (2018), Hybrid Renewable Energy Systems.
2) GE Renewable Energy (2018), Unlocking New Revenue Streams in MENAT (Whitepaper)
3) Martin, C. (2018). *Bloomberg*. [online] Bloomberg.com. https://www.bloomberg.com/quicktake/batteries
4) Lennart Peterson (2018), 3rd International Hybrid Power Systems Workshop Presentation.
5) *BEYOND BASELOAD: 100% RENEWABLE ENERGY IN AUSTRALIA (2016)* https://go100re.net/wp-content/uploads/2014/01/fs096_beyond_baseload_100_per_cent_renewable_energy_in_australia_08jun16.pdf


# THANK YOU!