Renewable Energy in Remote Locations

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Presented by

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Managing Director, Senior Engineer

- Over thirty years of experience performing loss investigations of various types of incidents including fires, explosions, machinery breakdown, workplace accidents, lightning, flooding and other natural catastrophes.
- Have been instructed on claims involving different equipment and systems, including:
  - Power generation, transmission and distribution,
  - Industrial machinery,
  - Medical, pharmaceutical, analytical and other equipment
  - Printing presses, packaging,
  - IT servers, data centres, enterprise computers
  - Communication and broadcasting
  - BMS, PLC, Automation and other control systems
- Acted as expert witness in different jurisdictions giving evidence on multiple engineering issues related to different matters of dispute.

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Risk Engineering

Forensic Engineering

Claims Consulting

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Case Study

Challenge: Accuracy of weather data in remote locations

The Project

- A 60.3 MW PV power plant in the Mafraq region in north Jordan.
- Construction commenced in July 2017 and is expected to be completed in May 2018
- PV solar panels were installed using a single axis tracking system

Loss

- Once panels were installed, they were moved to “Neutral” position parallel to the ground
- This is done during the installation phase to successfully calibrate the arrays during commissioning phase

Damage

- By the time engineers made it to site, they discovered panels damaged as a result of wind
- Some damage occurred when panels were forced to move while held in place by the clamps

Damage

- Impact with the vertical support brackets underneath which caused physical damage to panels installed over the support bracket

Damage

- The same physical damage was found on all panels above the support brackets

Damage

- Some panels came out of the clamp holding them in place and impacted the ground

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What is the cause?

“UNUSUALLY” strong wind?

DESIGN defect?

FABRICATION (MANUFACTURING) defect?

Workmanship defect?

What is a “Remote Location”

- Characteristics of Remote Communities:
  - Low population densities
  - Limited conventional energy sources
  - Lack of infrastructure
  - Low levels of economic activity
  - Physical access constraints
  - Long distances to external markets
  - Limited information
  - Loosely defined or implemented regulations

Renewable energy in remote locations

RAPS

Remote Area Power Supplies

Utility Scale

Wind, PV Solar, CSP, Geothermal

Hybrid Renewable

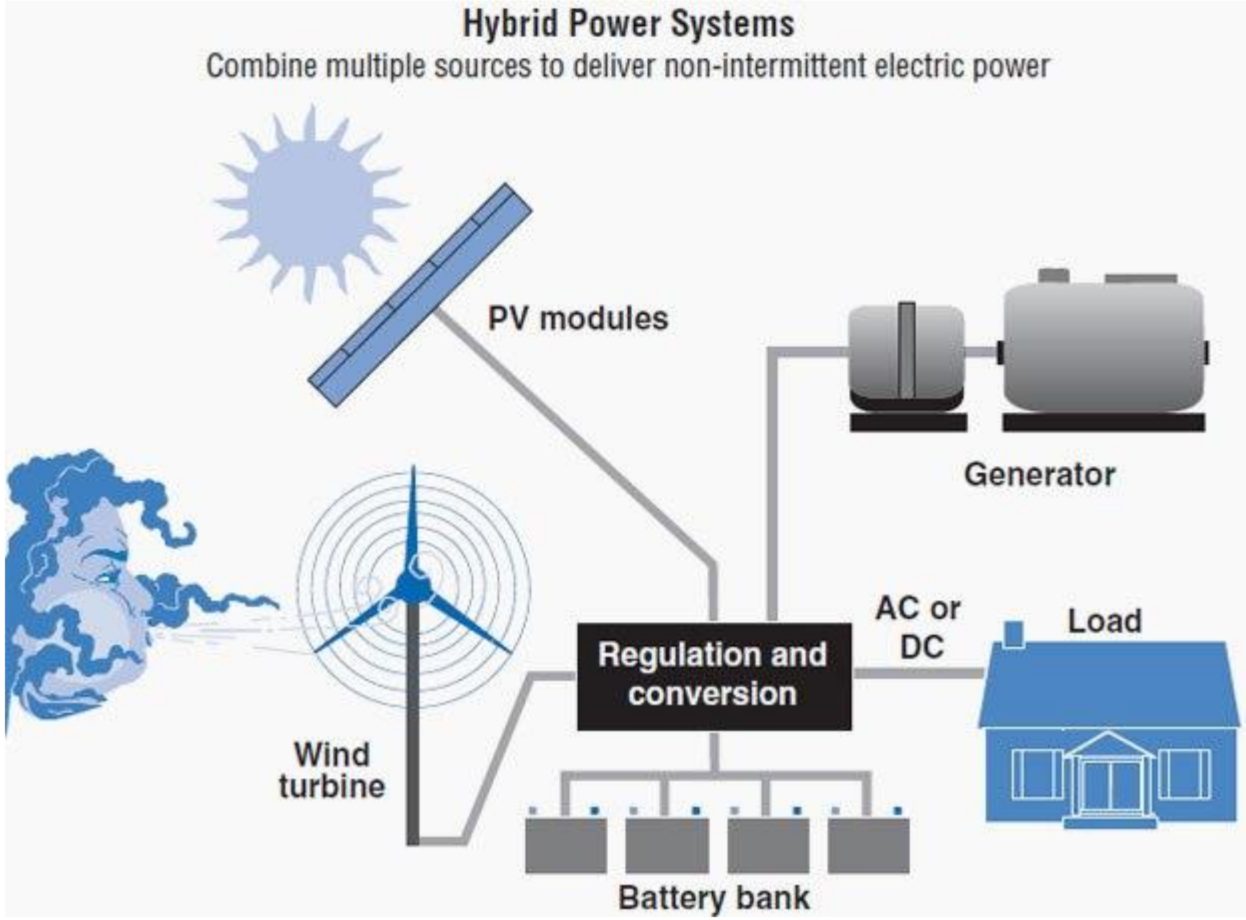
Solar/wind combined with diesel generator

RAPS

Self Powered Irrigation System

Self Powered Communication Building

Hybrid



Hybrid Power Systems
Combine multiple sources to deliver non-intermittent electric power
PV modules
Generator
Wind
turbine
Regulation and
conversion
AC or
DC
Load
Battery bank

Utility Scale

PV Solar in Egypt

Wind farm in Jordan

THERE IS NO COMMONLY ACCEPTED DEFINITION AS TO WHAT SIZE CONSTITUTES "UTILITY-SCALE"

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Remote Utility Scale Wind

- Utility-scale turbines are usually defined as turbines that exceed 100 kilowatts in size. Utility-scale wind turbines are typically installed in large, multi-turbine wind farms connected to the nation's transmission system.

Remote Utility Scale PV

- A utility-scale solar facility is one which generates solar power and feeds it into the grid, supplying a utility with energy
- Virtually every utility-scale solar facility has a power purchase Agreement (PPA) with a utility, guaranteeing a market for its energy for a fixed term of time

Remote CSP

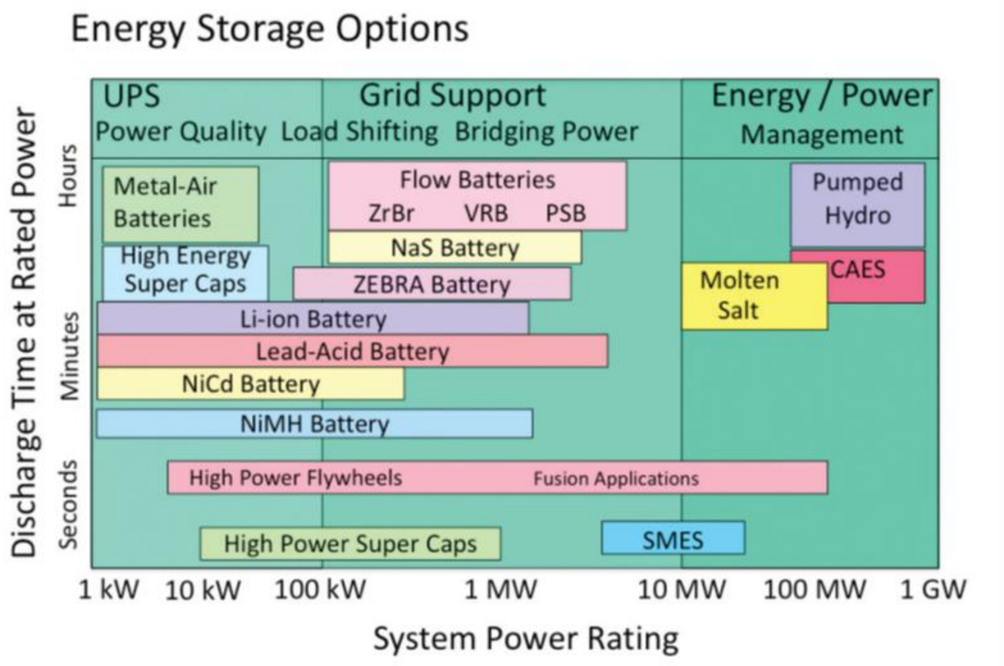
Shams Plant in Zayed City, UAE

- CSP plants require significant infrastructure for collecting steam and generating electricity, and large areas of land, which limits project design options and locations for CSP plants and generally makes them an option for large-scale generation only

Challenges of Remote Locations

Energy Storage

- Due to variability of renewable resources, capture of electricity generated by wind, solar and other renewables for later use is required:
  - Transmission level energy storage options include, pumped hydroelectric, compressed air electric storage, and flywheels.
  - Distribution level options include: conventional batteries, electrochemical flow batteries, and superconducting magnetic energy storage (SMES).
  - Batteries also might be integrated with individual or small clusters of wind turbines and solar panels in generation farms to mitigate fluctuations and power quality issues.

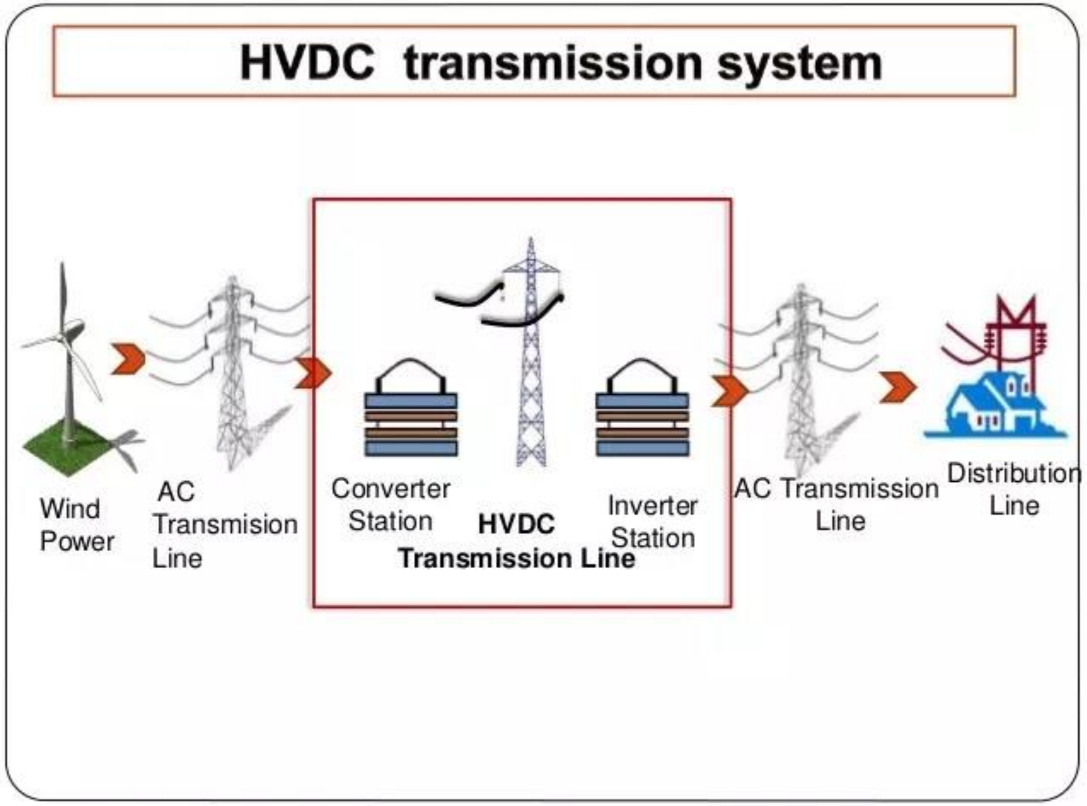


Long Distance Transmission

- Renewable sources are typically distributed over large areas
- New large area collection strategies and new long distance transmission capability are required to deliver large amounts of power a thousand miles or more
- This long distance transmission challenge is exacerbated by a historically low investment in transmission generally

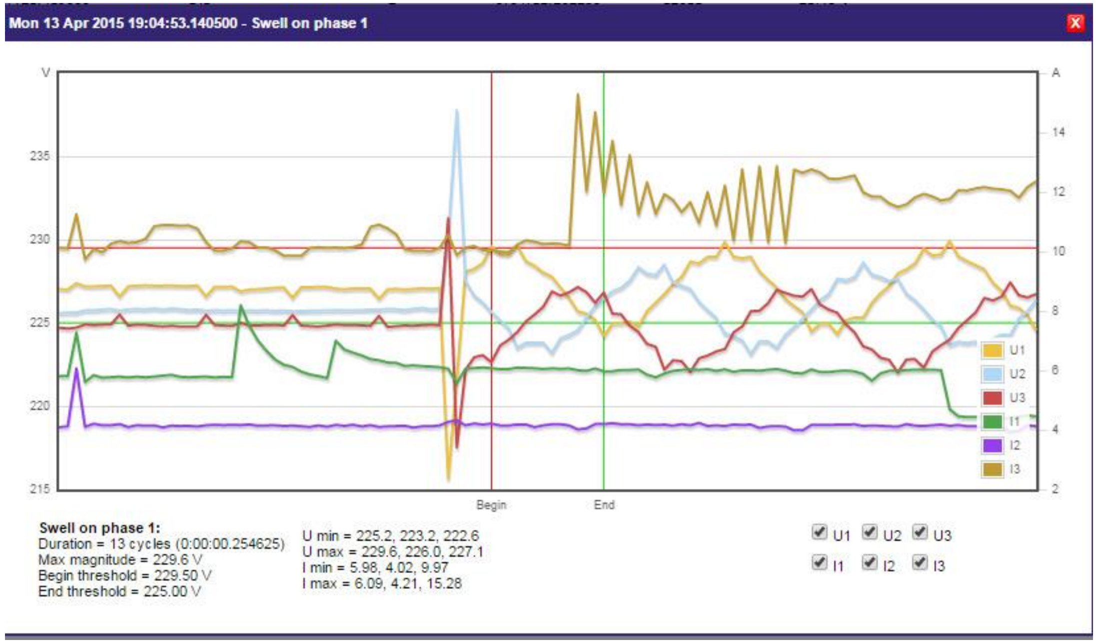
HVDC Transmission

- While high voltage DC is the preferred transmission mode for long distances
- The drawbacks include:
  - Single terminal origin and termination,
  - Costly AC-DC-AC conversion,
  - Extremely long approval process for long lines
- Superconductivity provides an new alternative to conventional high voltage DC transmission



Power Quality

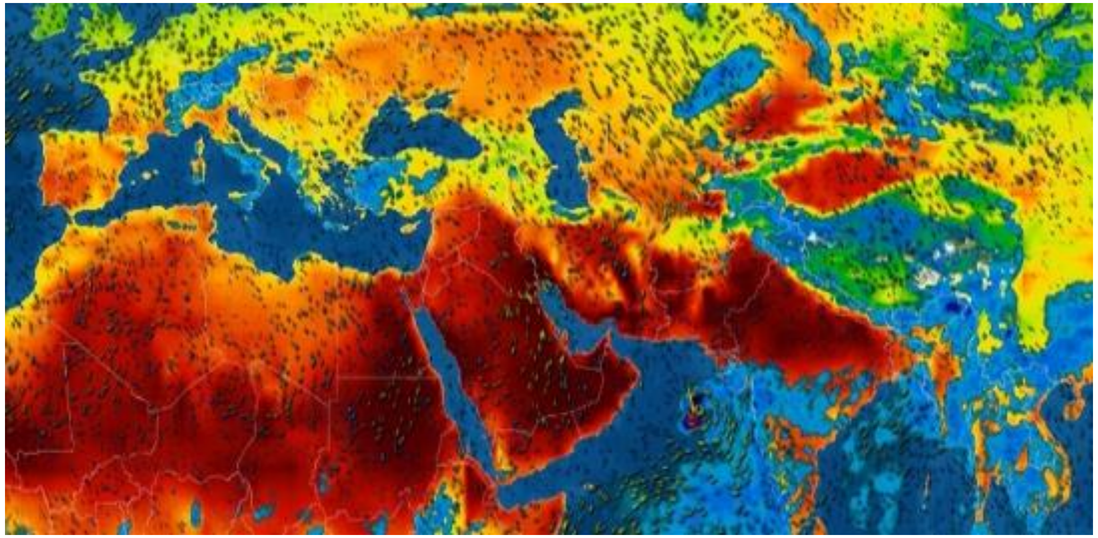
- Renewable energy can cause several operational problems for distribution networks:
  - Inrush current at time of connection
  - Islanding
  - Under-voltage/over-voltage
  - Power fluctuation
  - Harmonic Distortion
  - Frequency fluctuation



Integration

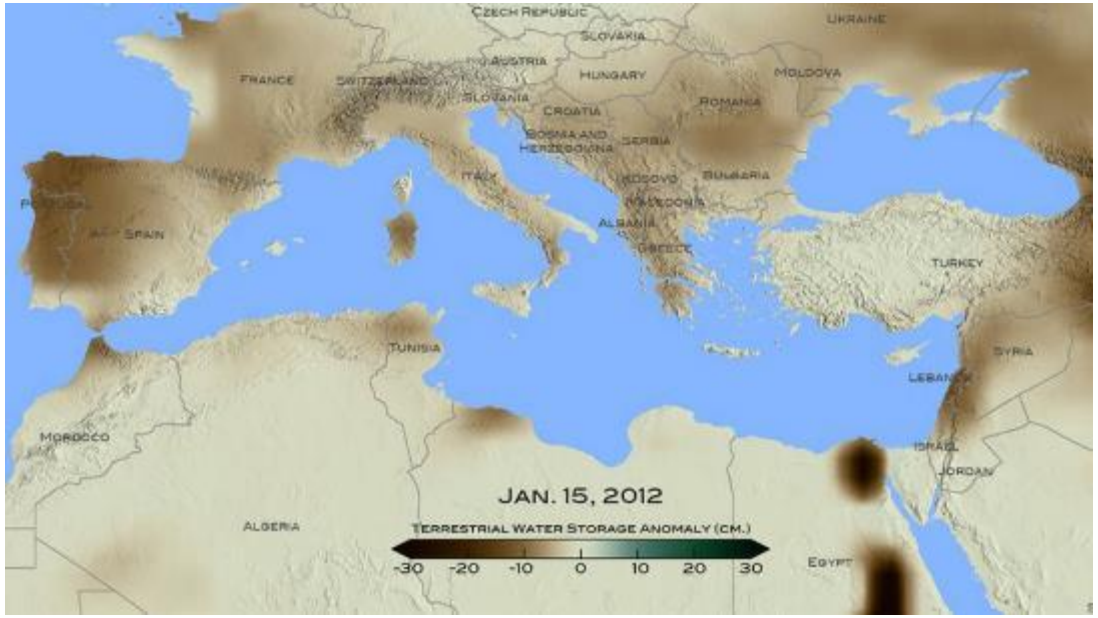
Climate Change Risks

- **More frequent and intense heat waves:**
  - more intense,
  - more frequent,
  - longer lasting heat waves.
- These periods of extreme heat decrease the efficiency of power plants during periods when electricity demand is highest, placing additional stresses on the electricity system.



Climate Change Risks

- **Droughts and reduced water supplies**:
  - The electricity sector is highly dependent on water for cooling.
- As temperatures continue to rise, droughts and reduced water supplies are likely to become the norm in some regions, increasing the risk to the power sector.



Sandstorms

Hazards Combination

- Combinations of events occurring together or in succession (e.g. heavy rainfall following a long dry spell)

Social Risks

Security of Assets

- Physical Security

Human Infrastructure

- Trained personnel in most of the technical subjects and at all levels
- It necessarily includes:
  - regulators with training in all technical areas and in legal matters;
  - inspectors and quality assurance
  - experts in engineering and safety areas; as health and public health professionals;
  - knowledgeable local officials,
- In 1997, for example, UAE universities produced only half the number of scientists and engineers that the country needed

Market Structure

- Availability of repair facilities
- Availability of temporary replacements

Regulations

- Discrepancy between local and international standards
  - Type testing
  - Changing standards
  - Jurisdictions

Losses

Are there typical types of losses?

Natural Catastrophes

- Remote renewable energy plants can be affected by flooding, earthquake, windstorm, landslide and even lightning during construction and operational phase.
- Climate change is leading to a rise in extreme weather events and its effect on natural catastrophe losses will increase.

Earthquake / Tsunami

- The earthquake exposure of a renewable energy plants varies on one hand with the location and on the other hand with the type of park.
- Earthquakes can cause damage to ground solar systems mounted on racks.

Flood

- Especially where systems are installed near to open water, the risk of flood and its mitigation measures on site must be checked before insurance cover is granted.

Landslide

- Location of where the plant is situated is critical consideration.
- If the facility itself is situated on a slope or at the bottom of a slope, then it may suffer considerable damage in the wake of a landslide.

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Fire

- Photovoltaic ground mounted systems are especially prone to catch fire if the undergrowth between the facilities is too strong.

Theft / vandalism

- A risk, which is quite considerable with regard to the insurance of photovoltaic systems, is the risk of theft. In some locations a large number of panels are taken off their mountings to be stolen. Moreover the price of metals being so high an increased number of theft cases has been noted in many countries for the copper.

Windstorm (hurricane, typhoon, cyclone)

- Underwriter should pay attention to the racks on which the system is mounted. How the system is fixed and fastened can also be decisive for the question of whether to insure it or not. Mover systems (with solar trackers) in particular, are prone to the risk of windstorm. Before cover is granted, an expert opinion on the ground and a statics calculation regarding the subsoil and the PV system should be submitted.

Storm Damage

- With high wind speeds and heavy rain, solar panels may be at risk of being dislodged from their spot or damaged by high volumes of water.
- However, solar panels are typically tested by manufacturers to ensure that they can survive hurricanes.
- Most solar panels are certified to withstand winds of up to 2,400 pascals, equivalent to approximately 140 mile-per-hour (MPH) winds.
- Additionally, the typical Aluminium and glass casings that hold solar cells and constitute a solar panel are highly waterproof, even during extreme rain.

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Rain

- Rain: Rain penetration associated with PV or solar thermal panels tends to come from two factors: the fixings on stand-off (traditional) and flat roof designs, and around the edges of modules on integrated designs.

Lightning

- Wind turbines are lightning magnets—and strikes on these tall, spinning structures can cause significant damage.
- Even PV plants can sustain significant damage as a result of lightning

Hail

- Extreme hailstone showers which exceed the panels' guaranteed resistance to hailstones can result in extensive damage to the photovoltaic system. Such severe weather conditions are not geographically predictable

Resistance to Hail

- Solar panel manufacturers test their products to ensure that they are capable of withstanding hail storms.
- In most cases, solar panels are tested and certified to withstand hail of up to 25 mm (one inch) falling at 23 meters per second (approximately 50 miles per hour).

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Questions

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Thank you for your attention