Location, Location, Location
Does it still matter???

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CEERISK
Bridging the Gap

Fukushima, Japan 2011

- Following a major earthquake, a 15-metre tsunami disabled the power supply and cooling of three Fukushima Daiichi reactors, causing a nuclear accident on 11 March 2011. All three cores largely melted in the first three days.

LPG Condensate Plant
Hassi Messaoud, Algeria

- EPC contract between owner and contractor to build an LPG/condensate plant
- During commissioning and warranty period, damages in relation to defects and failures of certain equipment occurred causing a 12 month-delay in the construction of the plant.
- Owner claimed damages for additional costs allegedly incurred in connection with the delays.
- Majority of the damages were attributed to equipment design incompatibility with conditions on the ground

Zongo River - Bolivia

- The Bolivian Power Company (Cobee) decided to suspend operations at its four plants Valley Miguillas, for lack of guarantees on their work, after 10 days of blocking access roads and virtual kidnapping company officials, by of community members in the area, said company spokesman Jose Gualberto Villarroel.

Kathmandu, Nepal - 2015

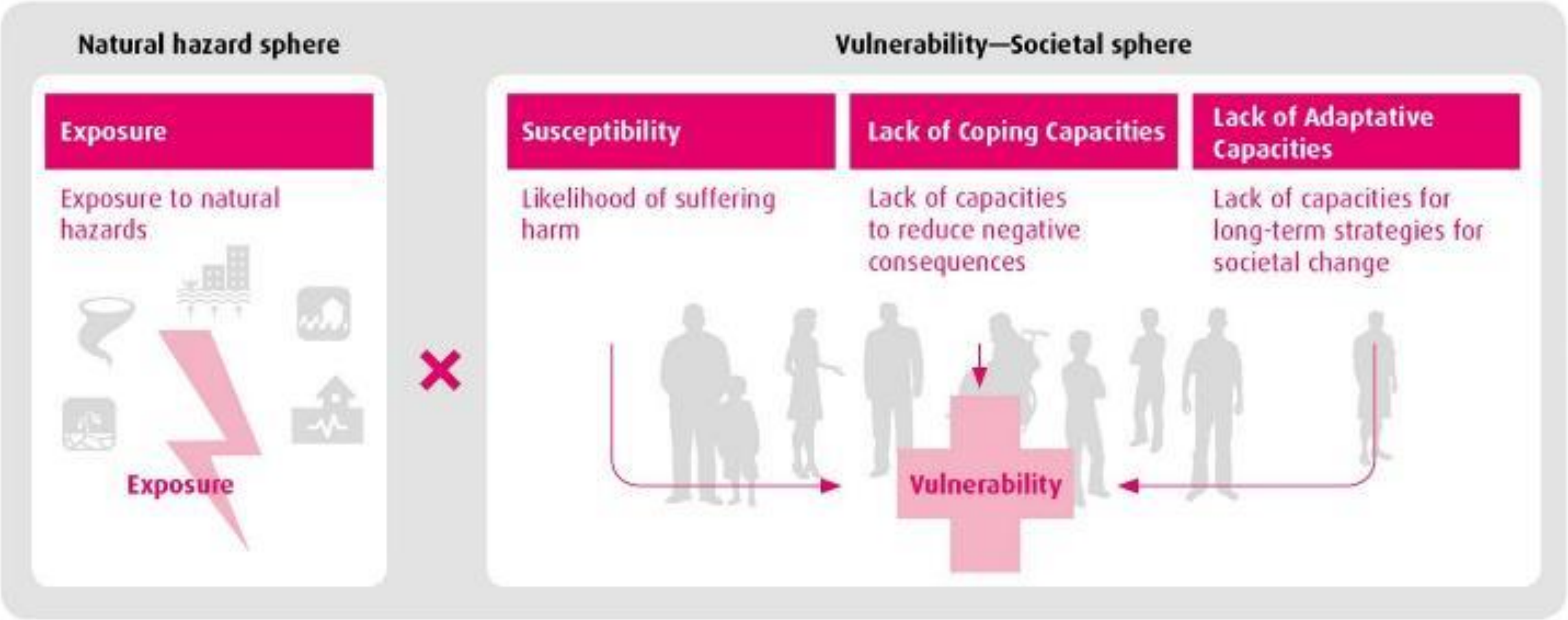
- Earthquakes, aftershocks and quake-induced landslides damaged up to 15 hydropower plants.
- Reducing power generation by 120.22 MW.
- This is 15 percent of the total installed capacity at the 49 power plants in the country.

Status of hydropower plants affected by earthquake	
Upper Bhotekoshi (45MW)	Yet to be resto
Hewa Khola (14.9 MW)	Yet to be fully restored
Baramchi (4.2 MW)	Yet to be resto
Charnawati (3.52 MW)	Restored
Jiri khola (2.4 MW)	Restored
Mailung (5 MW)	Yet to be resto
Siurikhola (5 MW)	Restored
Sipring Khola (10MW)	Yet to be resto
Lower Modi 1 (10MW)	Restored
Sunkoshi Small (2.6)	Restored
Chhotekhola (1 MW)	Not known
Lower Chaku Khola (1.8 MW)	Restored

A year later …

- Eight of the projects, including the 45 MW Upper Bhotekoshi Hydropower, have not yet been restored
- Energy loss amounts to millions of rupees in total.
  - Loss of energy generation at Upper Bhotekoshi alone has amounted to 236 GWh, or US $ 30 million in monetary terms.
- Project officials say it might take another six months for the restoration work to be completed.

Risk Assessment



Siting Power Plants

- The siting criteria are intended as a “common language” for power plant site characteristics.

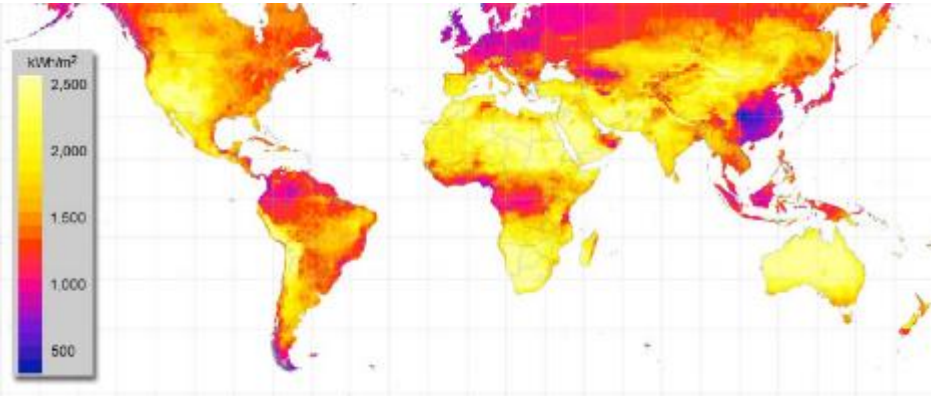
  - Access
  - Air quality
  - Air space restrictions
  - Buffering
  - Floodplain
  - Fuel delivery
  - Need

What does Siting Criteria Mean?

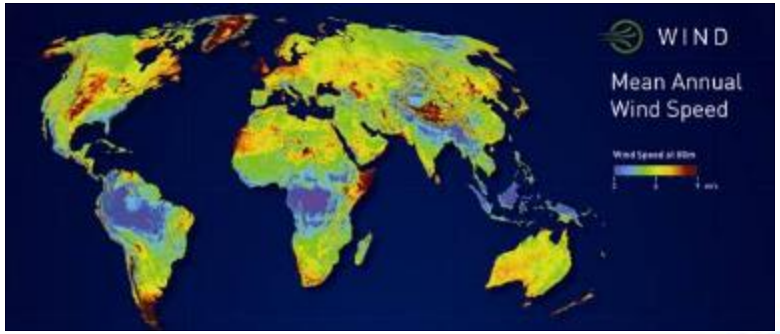
- They do not create a “cookbook” for finding sites.
  - Developers can use the criteria as a checklist for public and agency interests and as a guide for clear communication to area residents.
  - Government agencies can use the criteria to review the developer’s choice of site and ensure the project meets regulatory requirements.
  - The general public can use the siting criteria to:
    - Compare sites.
    - Understand why particular sites were chosen.
    - Determine which factors of importance to them were considered.
    - Influence siting or other project decisions.

Siting Criteria – Performance Considerations

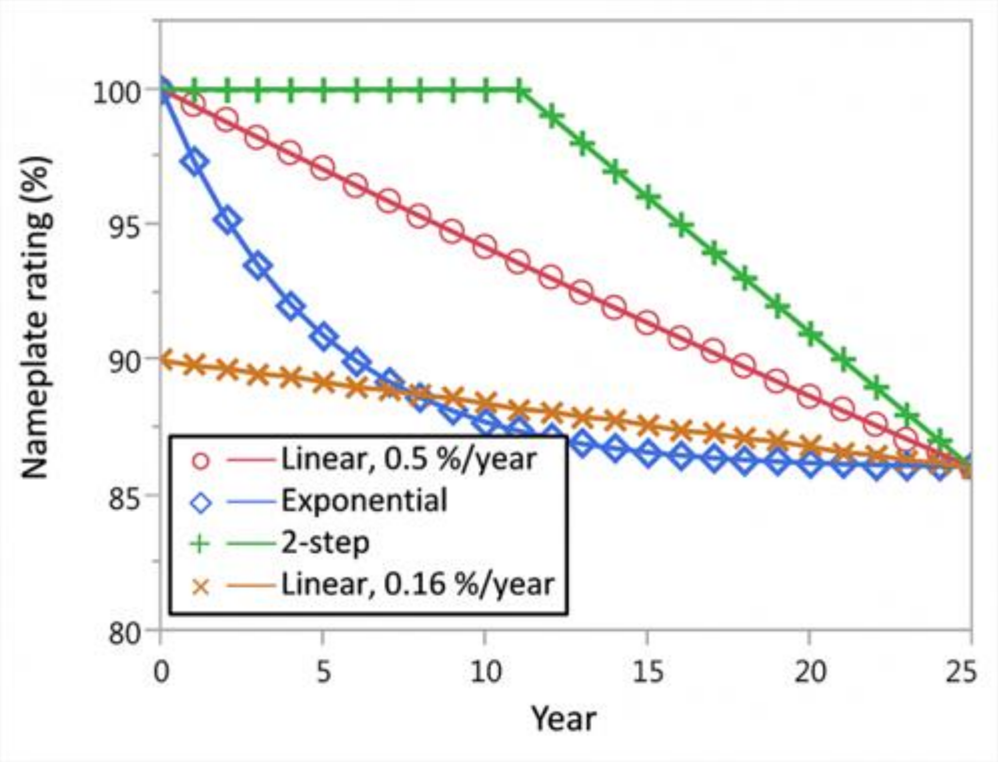
- Solar PV
  - Solar radiation is the most important data to acquire and can be one of the highest risks to the business case for a solar power facility.



- Wind Energy
  - Availability
    - Assumptions align with experience
    - Resource assessment and wind flow modelling
    - Wake losses: AWST "deep-array" wake model (DAWM) aligns with available data (onshore and offshore)



Output / Extended Yield Cover



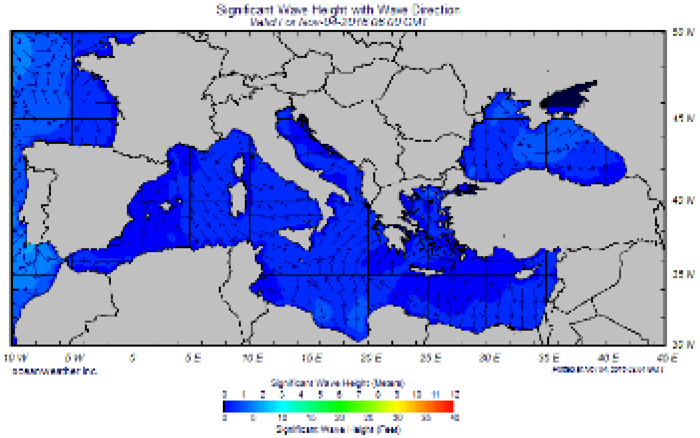
Different degradation rate input curves as a function of time.

- Linear degradation at a rate of 0.5%/year (red circles),
- Exponential decline (blue diamonds),
- Two-step profile (green crosses)
- Linear decline (orange crosses) starting at 90% of nameplate rating are shown.

- Plant Output (kWh) x Electricity Tariff
- Triggers:
  - Lack of sunshine
    - Weather conditions
  - Unexpected degradation of modules
    - Root Cause
  - Deterioration, delamination, equipment defects
    - Manufacturer Warranty
    - Root Cause
  - Any revenue loss when business interruption does not apply

Siting Criteria – Design Considerations

- Availability of location information
  - Wind Speed maps
    - Global maps, as well as feelings and hearsay, cannot anymore be the only sources of information for decision makers to define investment policy.
  - Sea Conditions



- Changing Patterns

- Averages vs. Peaks

Siting Criteria – Construction Considerations

- Power plant construction and operation can require road, rail, or barge access to the site.
  - The number and location of site entrances
  - Nearby roads and rail lines.
  - Heavily travelled roads vs. less travelled routes.
  - Closeness to major highways
  - Ease of access to the site without causing traffic congestion or safety problems.

Siting Criteria – Fuel Delivery

- Information is needed on access and distance to:
  - Existing fuel transport systems,
  - Competing fuel transporters,
  - Alternate fuel delivery systems.
    - On-site space may be needed for fuel storage.
    - Generally, sites with access to competing fuel transporters and alternate fuels are preferable to sites without this access.

Siting Criteria - Geography

- Site geography can affect construction costs and environmental impacts. The features of most interest are:
- General site topography (ground slope)
- Soil types and depths
- Depth to groundwater.

Siting Criteria - Transmission

- New transmission line can be a significant cost of plant siting and a major cause of community concern.
  - Shorter new power lines are preferred to longer new lines,
  - Lower-voltage lines are preferred to higher-voltage lines.
  - Upgrading or rebuilding existing lines is sometimes preferred to installing new lines.
  - Transmission connections that increase system reliability and stability and decrease system losses are desirable.

Siting Criteria – Water Supply

- Many power plant technologies use water from lakes, rivers, municipal water utilities, or groundwater.
- Surface water is used for plant cooling and groundwater is used for plant processes.
  - Presence of adequate and usable water resources at or near a site is preferred over sites with remote, inadequate, or low-quality water resources.
  - Sites with no competing water uses are generally preferred to sites with many uses.

Siting Criteria – Water Discharge

- Many power plant technologies discharge wastewater into rivers, lakes, or municipal treatment systems.
  - Local water resources must be able to absorb additional water that is hot or acidic.
  - More discharge capacity available nearby with fewer restrictions on it are more desirable.
  - Sites with access to municipal treatment systems with adequate capacity may also be desirable.
  - Sites where the receiving water has ample physical and chemical assimilative capacity may be more desirable, as may sites with no existing legal waste load allocation and no competing or complicating discharges.

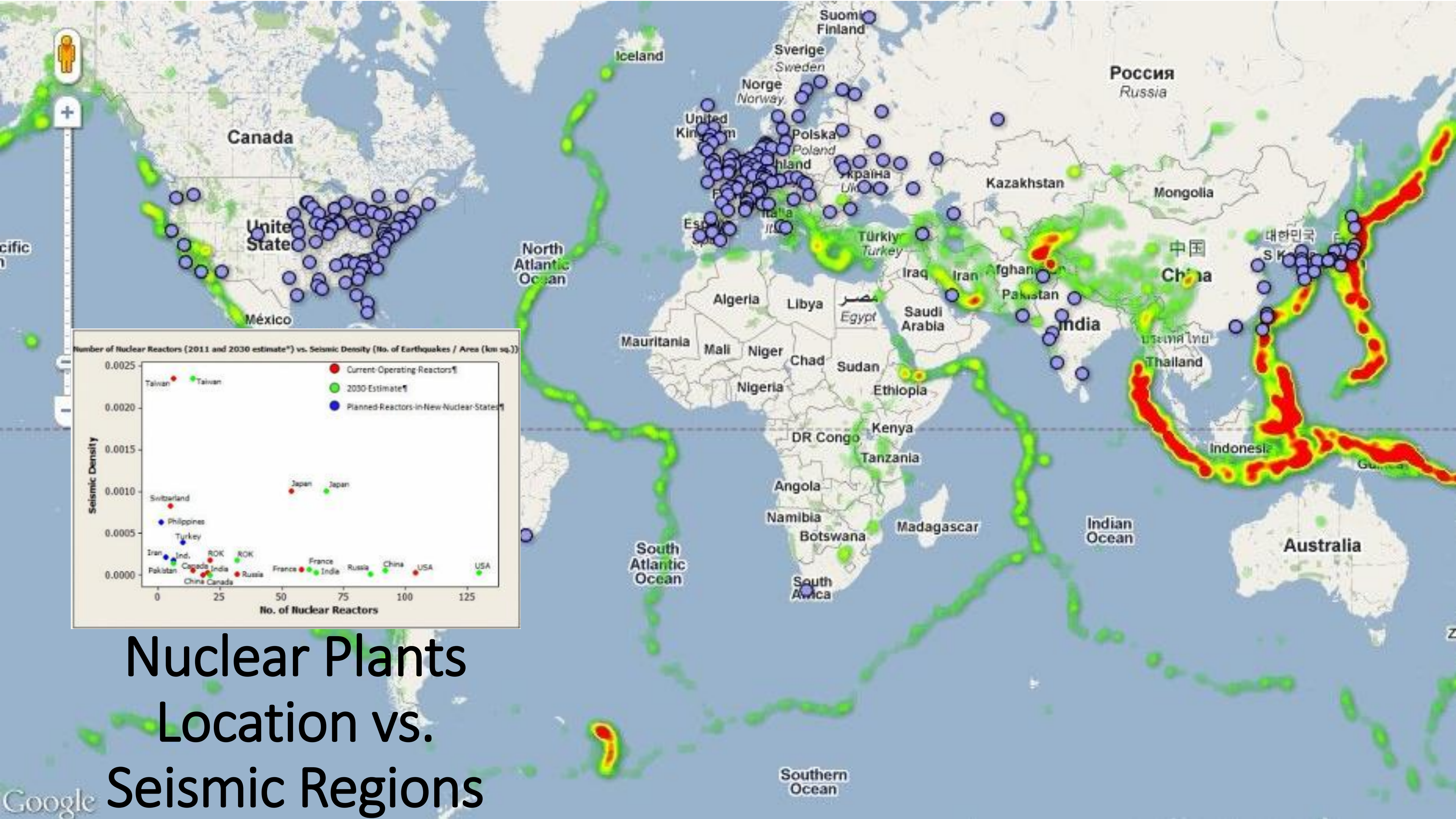
Siting Criteria – Impact on People

- Community Impact
  - Aesthetics
  - Archaeology-historic sites
  - Community service costs
  - Effects on wells
  - Labour availability
  - Number of relocations
  - Public attitude
- Public Health & Safety
  - Degradation of local air quality
  - Dust
  - EMF
  - Noise
  - Operational odours
  - Traffic safety
  - Water treatment

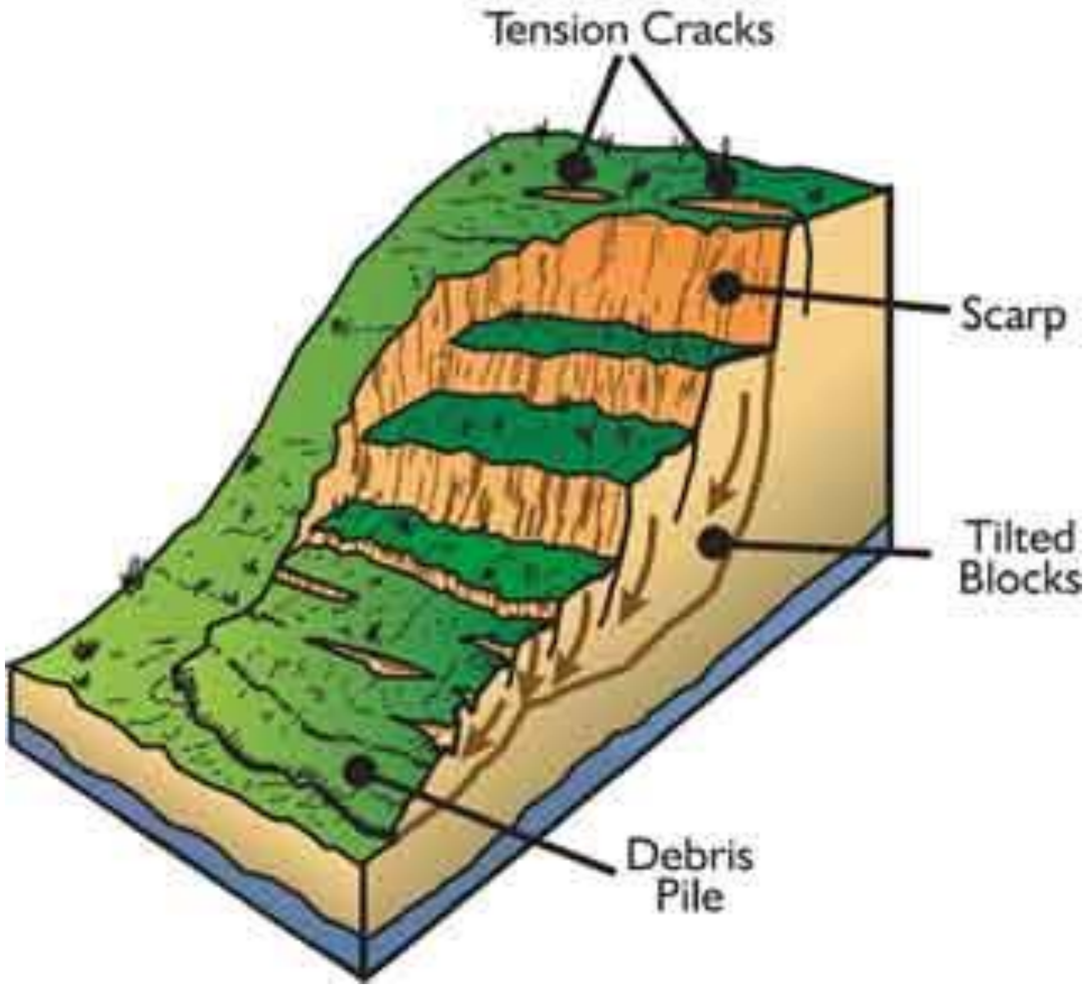
Insurance Specific Location Considerations

Insurance Risk Factors

- Seismic Activity
  - Earthquakes
  - Quake induced landslides
- Climate:
  - Temperature
  - Rain fall
  - Wind speed
  - Natural disasters
    - Hurricanes
    - Tornados
    - Tsunami
    - Monsoon
- Access
  - Transportation
  - Grid connectivity
- People
  - Manpower
  - Expertise
  - Community relations



Nuclear Plants Location vs. Seismic Regions



Landslides

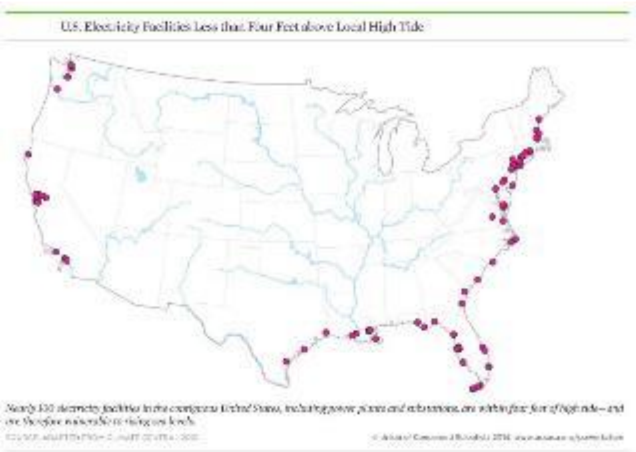
- Landslides occur in most regions containing slopes, and create **LANDSLIDE HAZARDS** to roads, utility lines, and buildings.
- Most landslides move slowly enough that people are not directly threatened, but some are so rapid people are trapped in their houses.

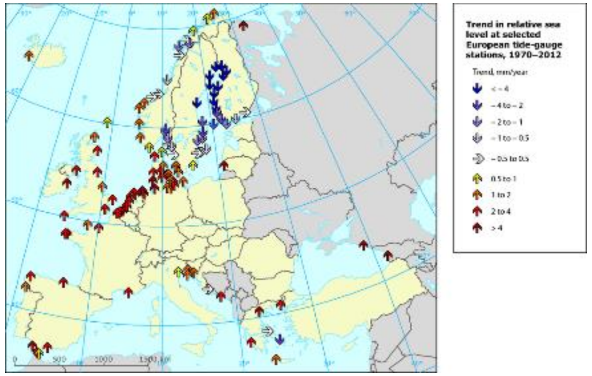
Climate Risk

Extreme Weather & Power Plants

- In 2011 and 2012 alone, 25 extreme weather events caused $188 billion in damages and 1,100 fatalities.
- In 2012, eight million people across 21 states lost power as a result of Hurricane Sandy.

Climate Change Risk

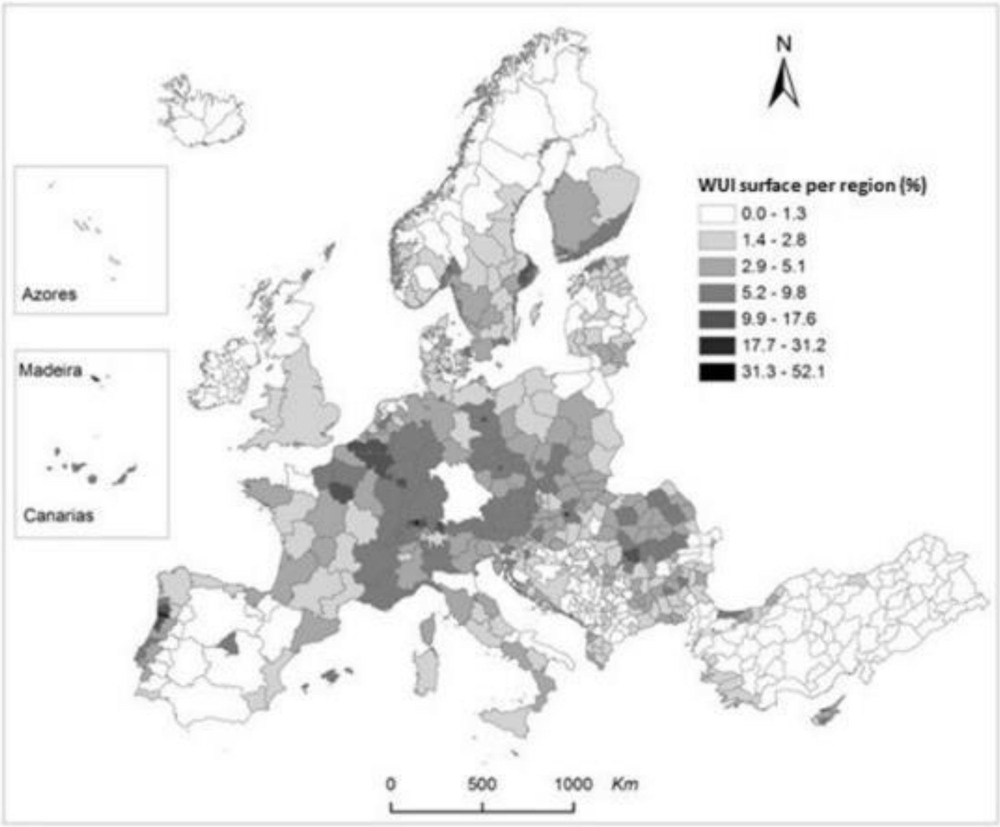




- **Accelerating sea level rise:**
  - In the USA, 100 electric facilities in the contiguous U.S., including power plants and substations, are sited within four feet of local high tide.
  - Global average sea level is projected to rise up to an additional 6.6 feet over the course of this century, greatly increasing coastal flooding risks.
  - Pipelines in coast of many areas will experience intensifying flooding and winds which could result in infrastructure damage and severely disrupt oil distribution.

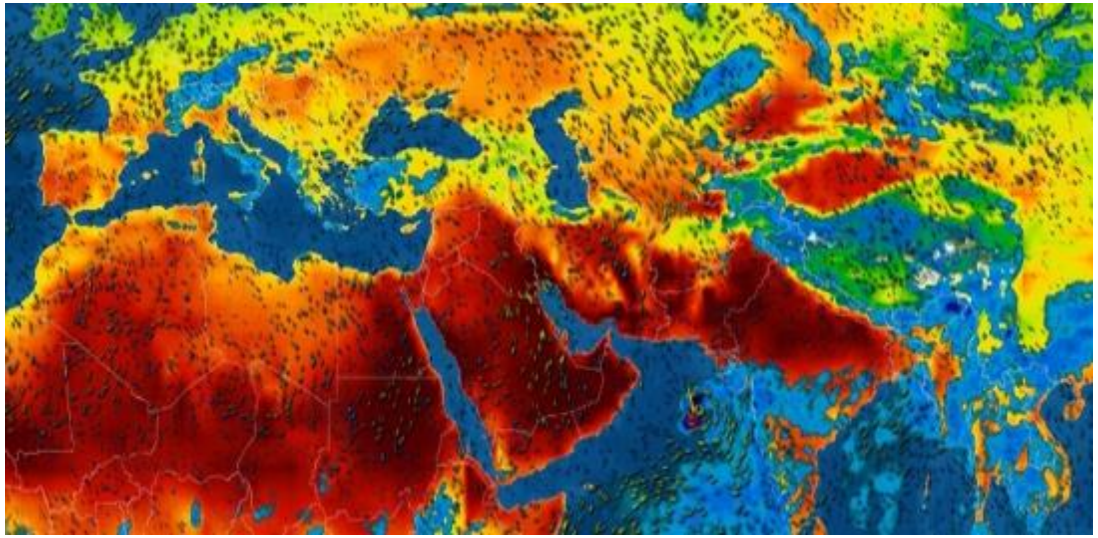
Climate Change Risks

- **Increasing wildfires:**
  - Wildfires can directly damage transmission poles and other electricity infrastructure,
  - The greatest risk comes from smoke and particulate matter, which can ionize the air, create an electrical pathway away from transmission lines, and shut down the lines.



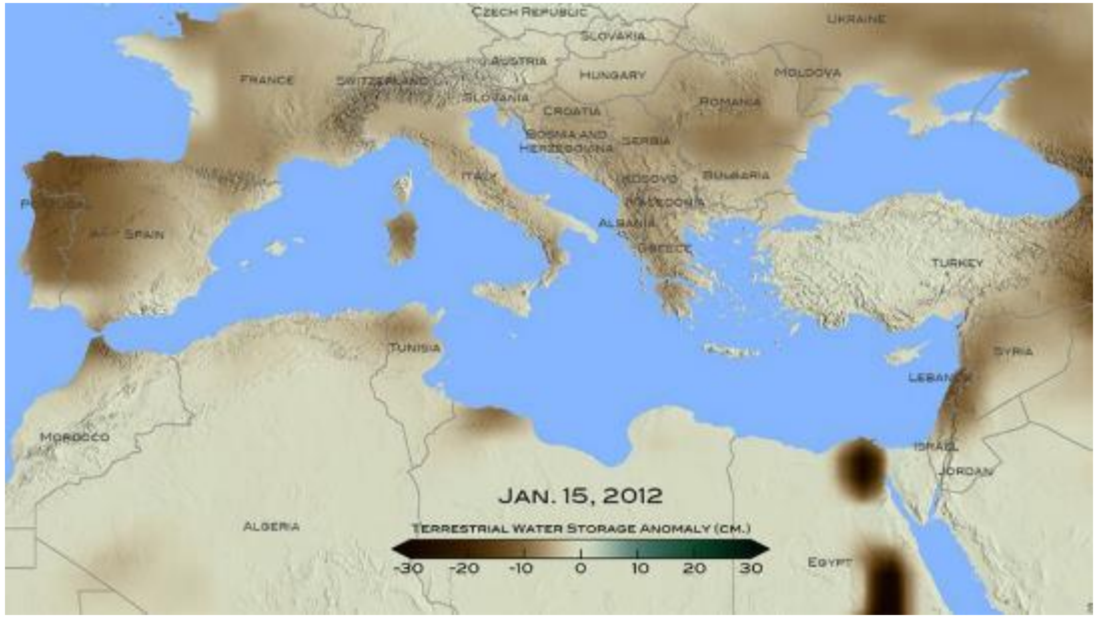
Climate Change Risks

- **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.
- Increasing temperatures means the number of days above 95 degrees Fahrenheit will increase from the past 30-year average of 39 days to 60 days by mid-century.
- By 2100, that number is expected to grow to 114 days. The increase in harsh conditions will impact oil & gas production at onshore rigs due to constraints that need to be imposed on workers.



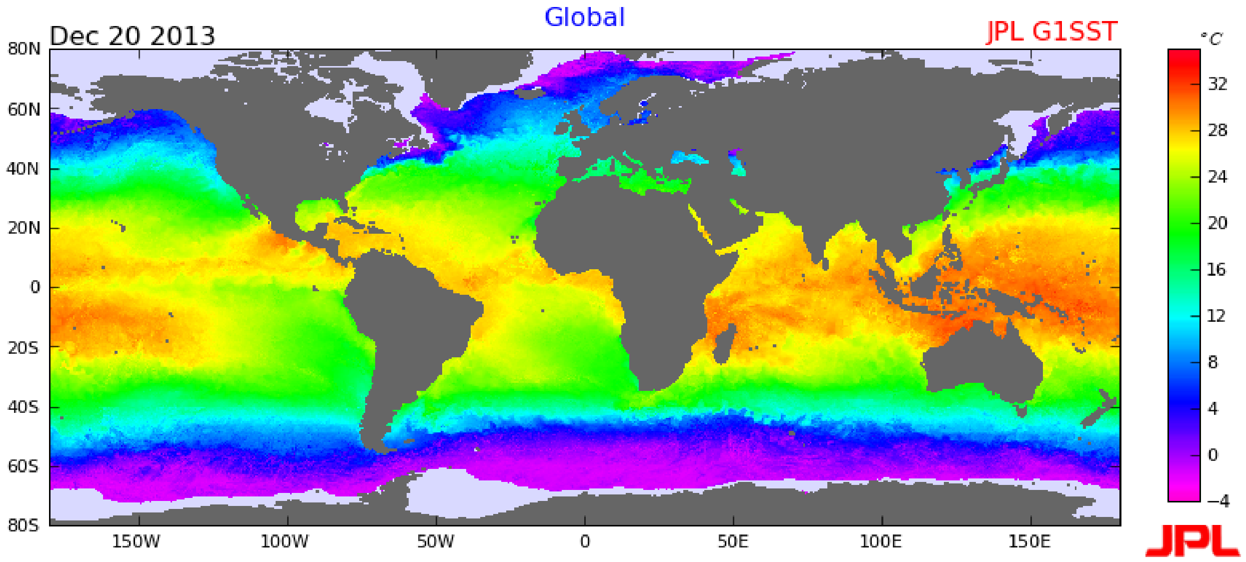
Climate Change Risks

- **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.



Climate Change Risks

- **Elevated water temperatures:**
  - Higher air temperatures warm the water in rivers and reservoirs used by power plants for their cooling needs.
- If the temperature of incoming water is too hot, or if the temperature of the discharge water is too high, power plants must dial back production or shut down temporarily, as has occurred at numerous coal and nuclear power plants over the past decade.



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

Regulatory Risks

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

- Rabigh-2 comprise three 686.5MW combined-cycle power blocks designed as multi-shaft configurations.
- Each block features two SGT6-5000F series gas turbines, three SGen6-1000A-series electrical generators, and a SST6-5000 series HI-L steam turbine.

Rabigh-2, KSA

Qurayyah Combined Cycle Power Plant
Qurayyah, Saudi Arabia

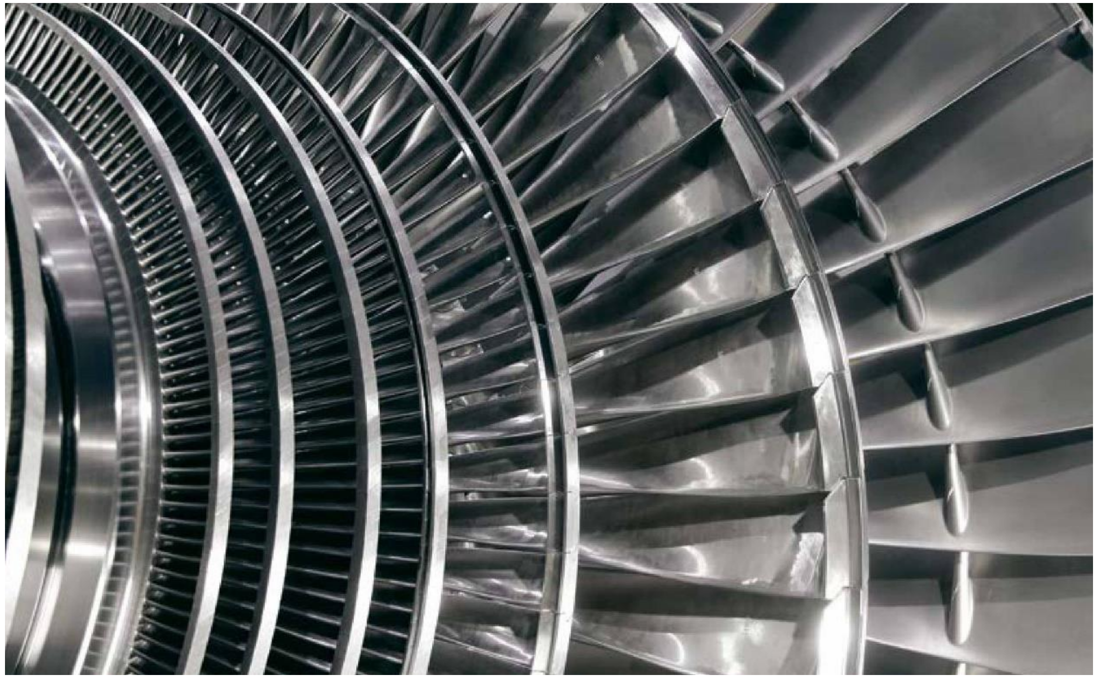
- Take one of the largest gas-fired plants in the world. Add 50C (122F)–degree heat and frequent heavy sand storms. Then slot it into a three-year construction schedule. What you get is a combined cycle behemoth with some unique technology and a multi-faceted team that pulled off a massive job.

Location Considerations

- The site was chosen to leverage several advantages.
  - First, it was in the center of an industrial hub, with much of the demand fairly close by.
  - It was also close to natural gas supplies, meaning relatively little new fuelling infrastructure would be needed.
  - Finally, the location along the coast meant seawater could be used for cooling. That was an advantage, as the hot climate in Saudi Arabia makes air-cooled condensers much less efficient.

Technology

- One of the largest combined cycle plants in the world. The facility is composed of six separate power blocks, each comprising:
  - Two Siemens SGT6-5000F gas turbines feeding two BHI heat recovery steam generators and
  - Single SST6-4000 steam turbine.
  - Each turbine drives a Siemens SGEN6-1000A generator.



Location Challenges

- The project faced several major challenges.
  - Ambient conditions, where summer temperatures can top 50C while falling below 10C in the winter.
  - Heavy sand storms that can wreak considerable havoc with normal operations are also common.

Sand Storms

- To deal with the constant sand and dust, all the major equipment is located inside dedicated buildings or climactic enclosures.
- The gas turbines, meanwhile, are equipped with automatic pulse air cleaning of the inlet filter elements.

Temperature Challenges

- The extreme heat required special measures.
- A specially designed inlet chilling system supplied by Stellar Energy was added to reduce inlet temperatures and keep efficiency high.
- While gas turbine inlet chillers are nothing new, this one came with some added bells and whistles because of the extra demands it would face.
  - **Cooling Capacity:** 92,000 TR
  - **TES Tank:** 180,150 Ton-Hr Thermal Energy Storage (TES) tank

Things to remember

- Location risks are varied and significant
- Due to climate change, risks are becoming more prevalent
- Must try and think outside the box
- Multiple types of losses
- YES Location matters

Thank you for your attention

- For questions or additional information please visit our website at

www.CEERISK.com

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