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High Level Overview of Data Needs for RE Analysis

Anthony Lopez | December 22, 2016

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Priority RE analysis topics for countries in the Lower Mekong

- Understanding RE Potential
  - Technical potential
  - Economic potential
  - RE Zones
  - Grid integration studies
  - Distributed solar PV
- Understanding Other Goals
  - Resilience/risk
  - Electrification

- We welcome your input on whether these are the right priorities on which to focus our efforts, and which are most important

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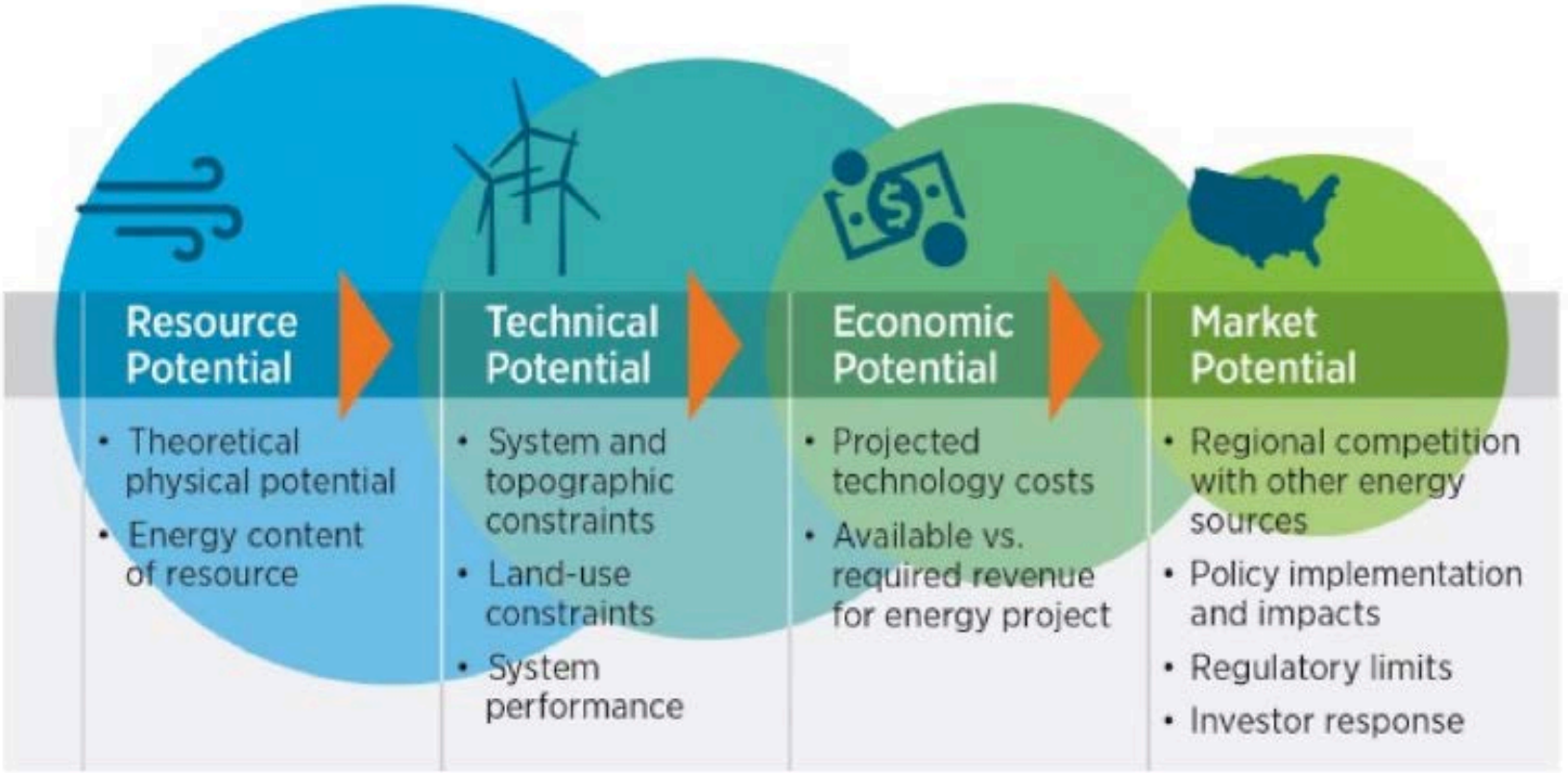
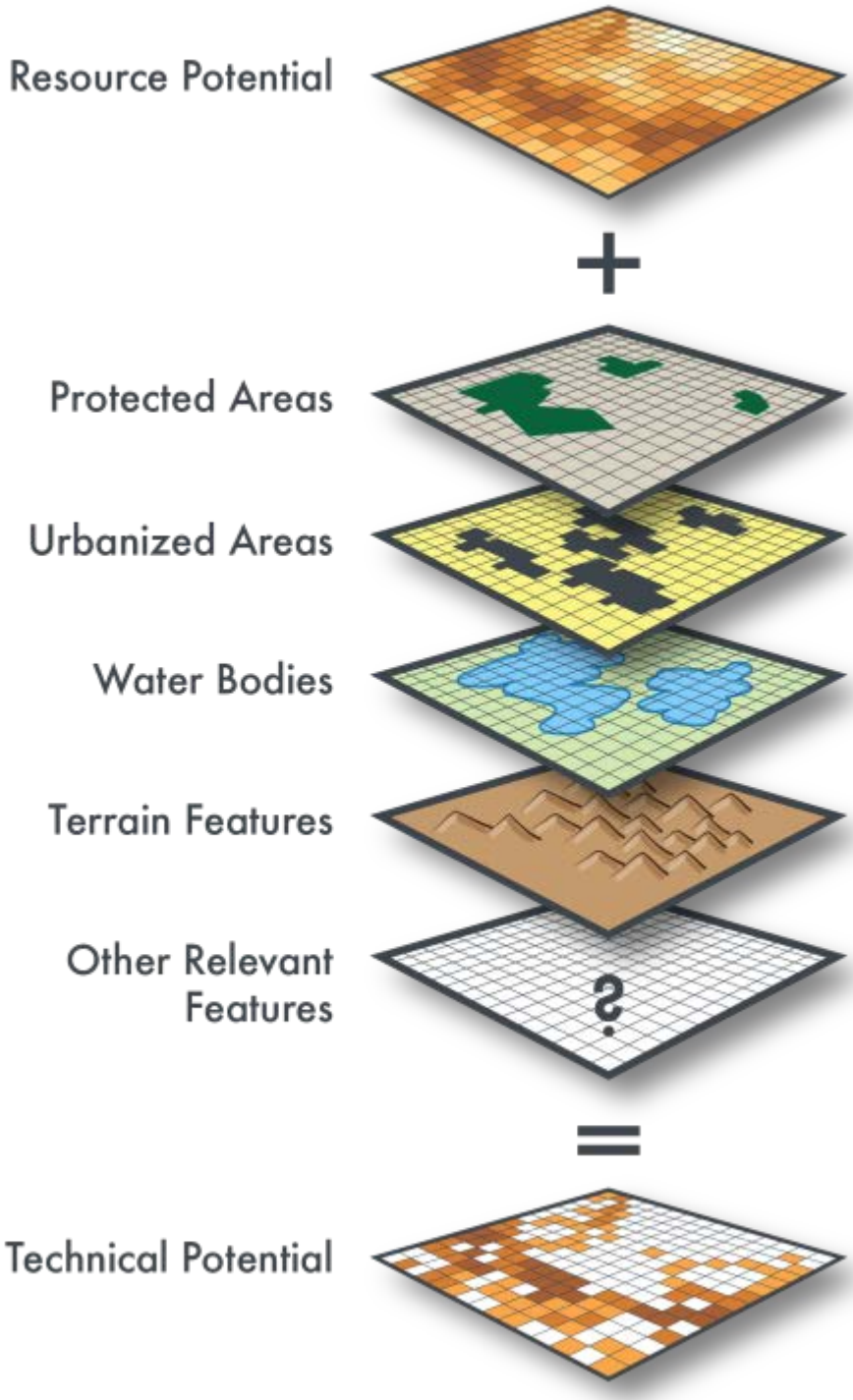
Understanding RE Potential

RE Potential…



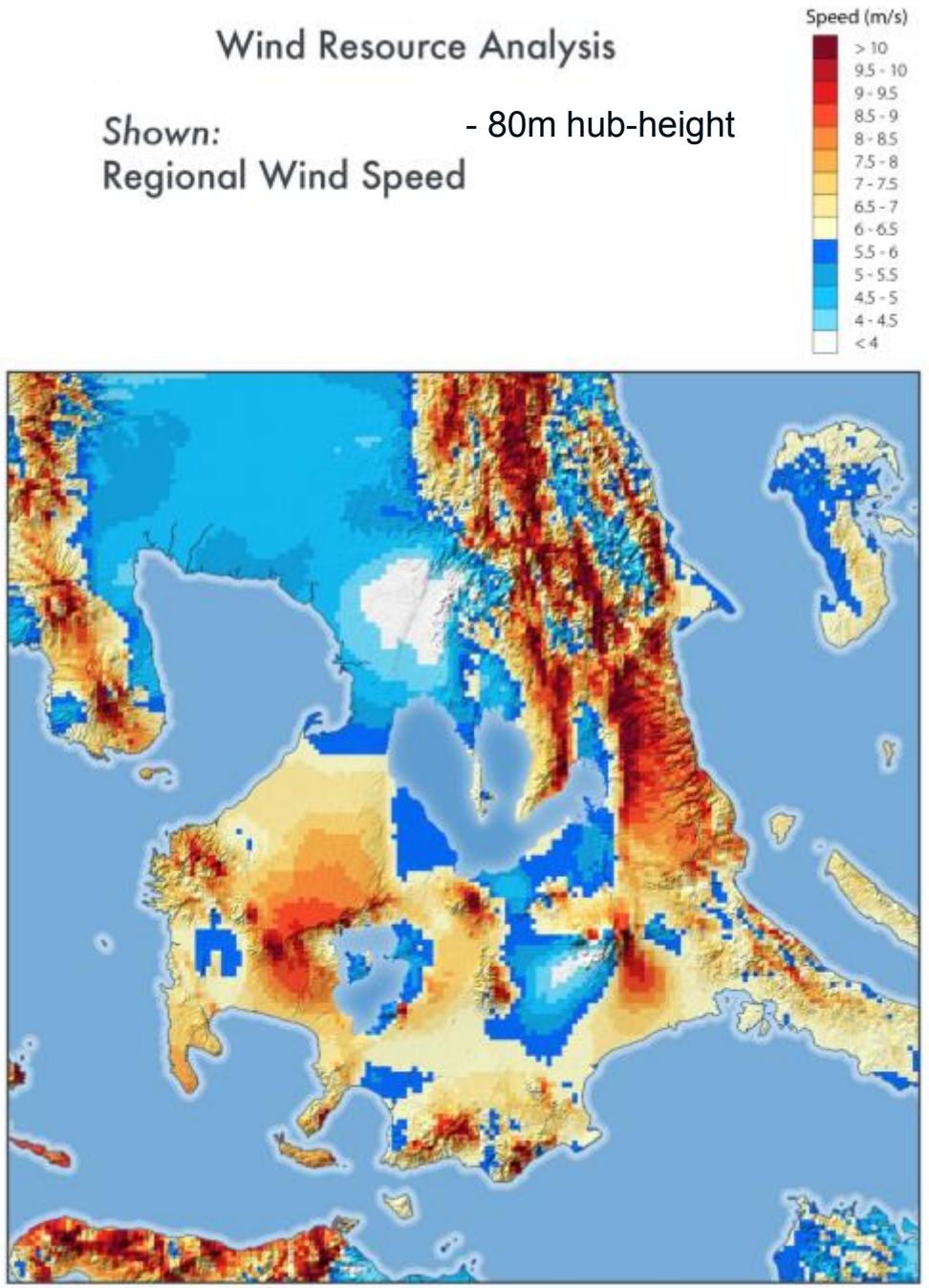
Technical Potential

- Renewable energy technical potential represents the achievable energy capacity and generation of a particular technology given system performance, topographic limitations, environmental, and land-use constraints
  - Does not consider technology costs



Technical Potential

This example illustrates the process of narrowing wind resource potential to technical wind potential, using data from the Philippines



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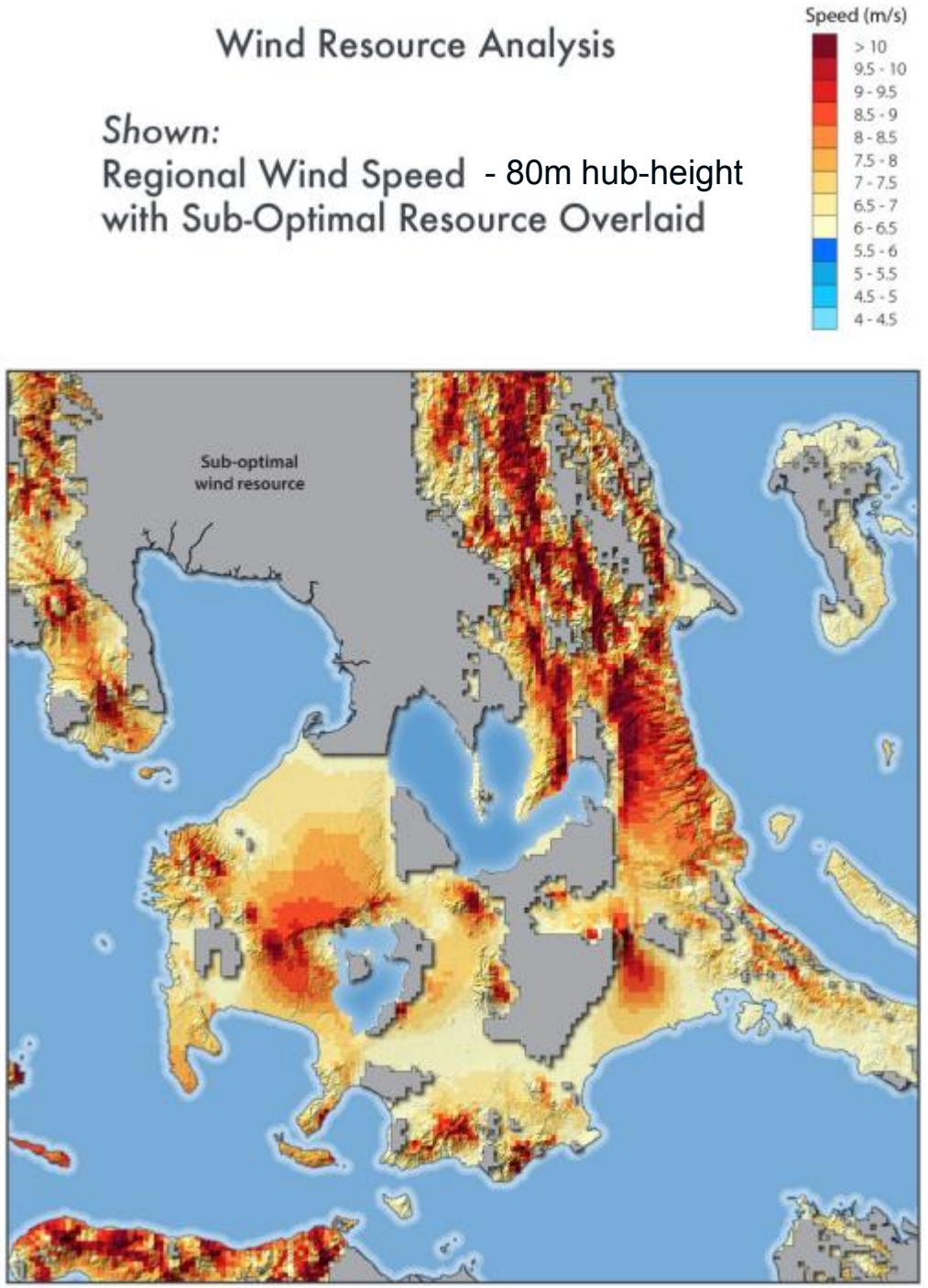
Technical Potential

- *In this case, we have defined "sub-optimal" resource as annual average wind speed <6m/s*



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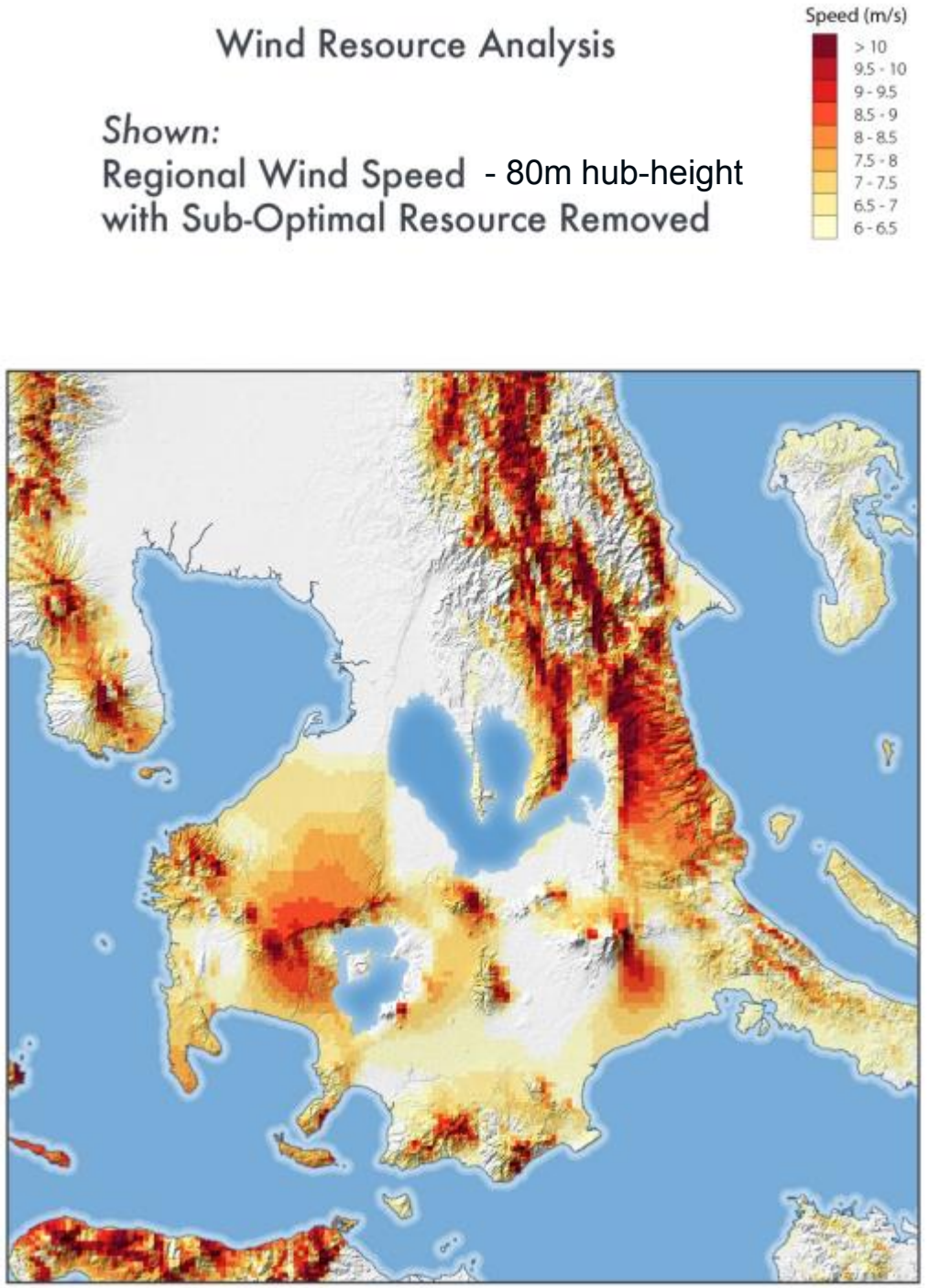

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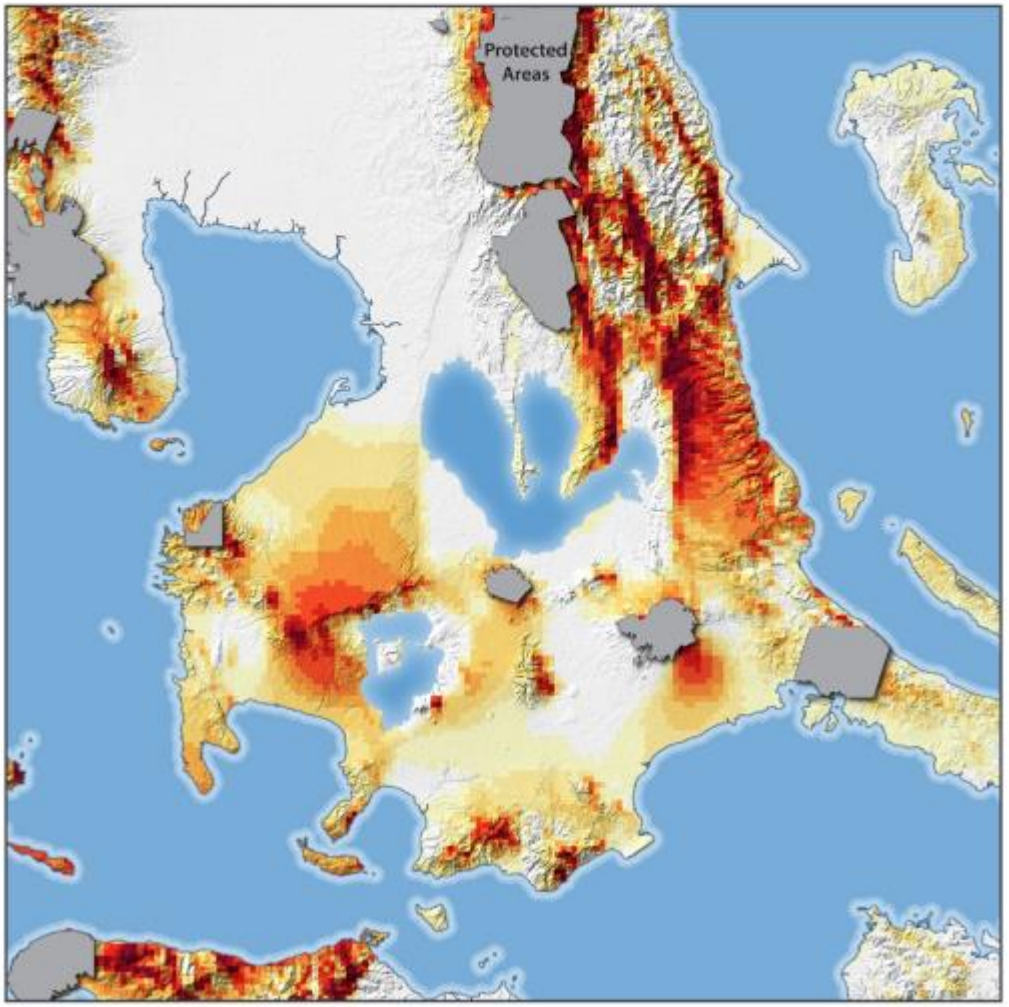
Technical Potential

Wind Resource Analysis

Shown:
Regional Wind Speed - 80m hub-height
with Protected Areas Overlaid



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Technical Potential

Wind Resource Analysis

Shown:
Regional Wind Speed - 80m hub-height
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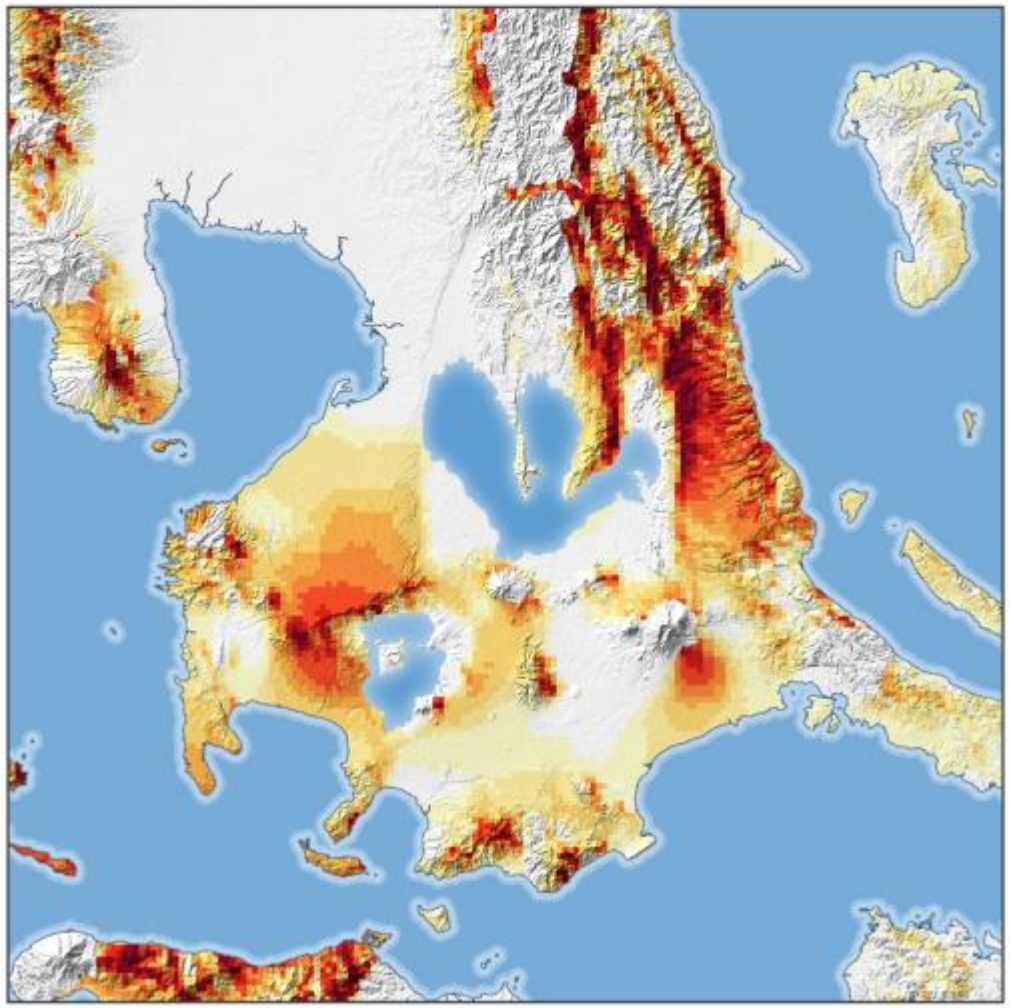

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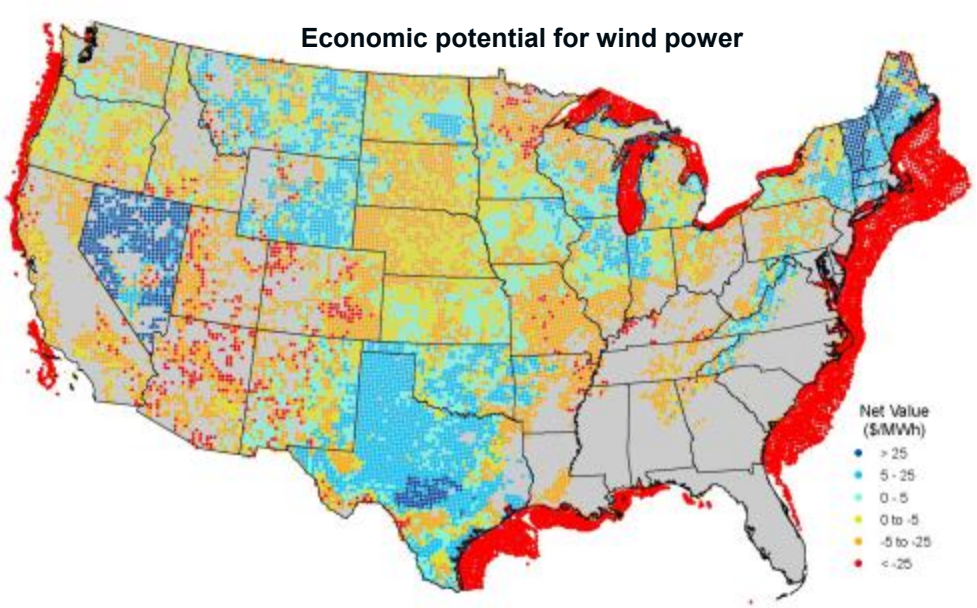
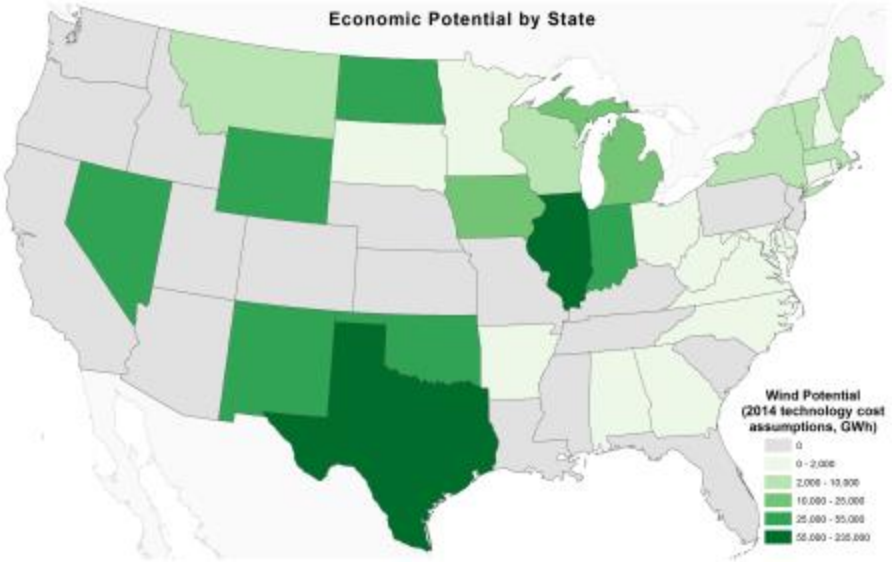
Technical Potential – Data Requirements

- **Resource (*annual average temporal resolution sufficient**)**
  - Solar (~10km), wind (<2km*), biomass, marine hydrokinetic (MHK), geothermal, hydro, etc.
- **Environmental**
  - Land-use, land-cover, protected areas, sensitive flora and fauna, rivers, lakes, topography, elevation
- **Other**
  - Population, land ownership, technology assumptions

Economic Potential

- Economic potential is defined as the subset of the available resource technical potential where the cost required to generate the electricity is below the revenue available in terms of displaced energy and displaced capacity





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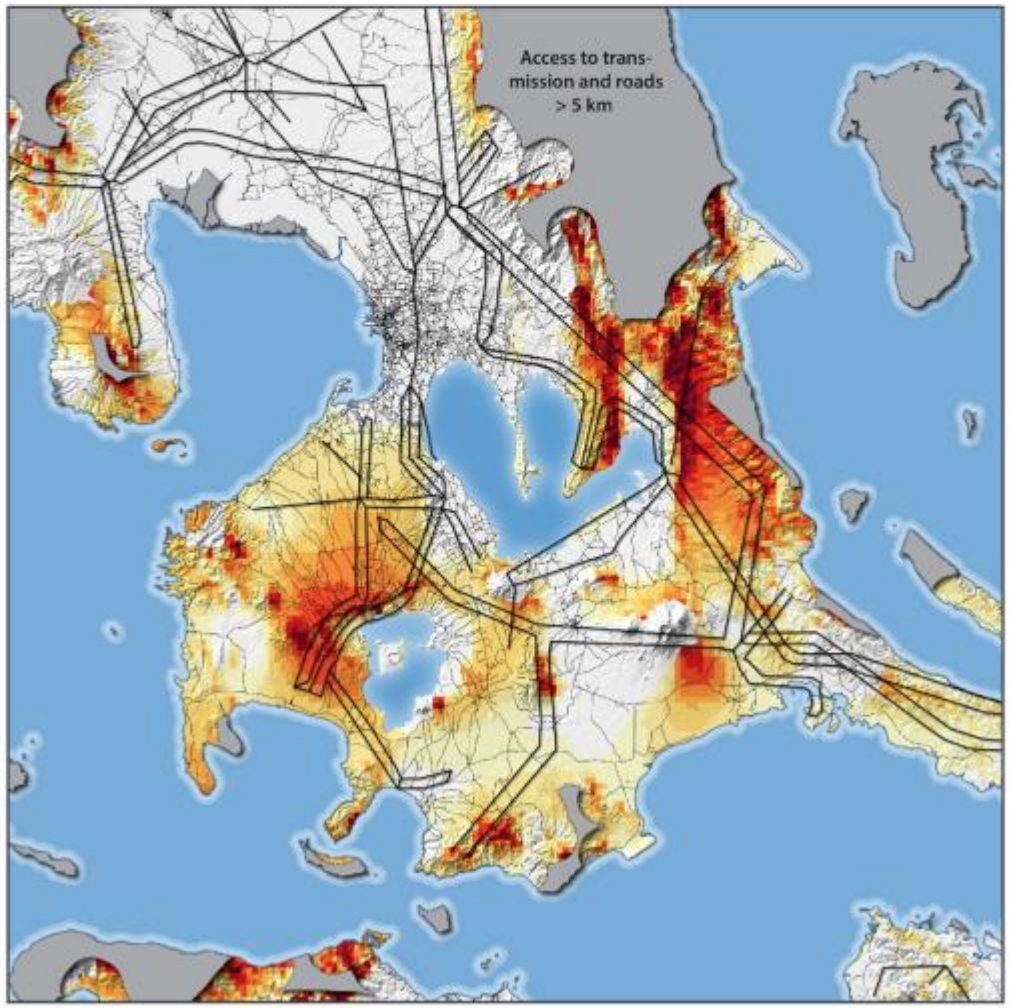
Economic Potential

- *In this case, we are assuming that resources further than 5km from transmission and transportation networks are not cost-effective to develop*

Wind Resource Analysis

Shown:
Regional Wind Speed - 80m hub-height
with Transmission and Roads Overlaid
and Remote Areas Overlaid



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Economic Potential

Wind Resource Analysis

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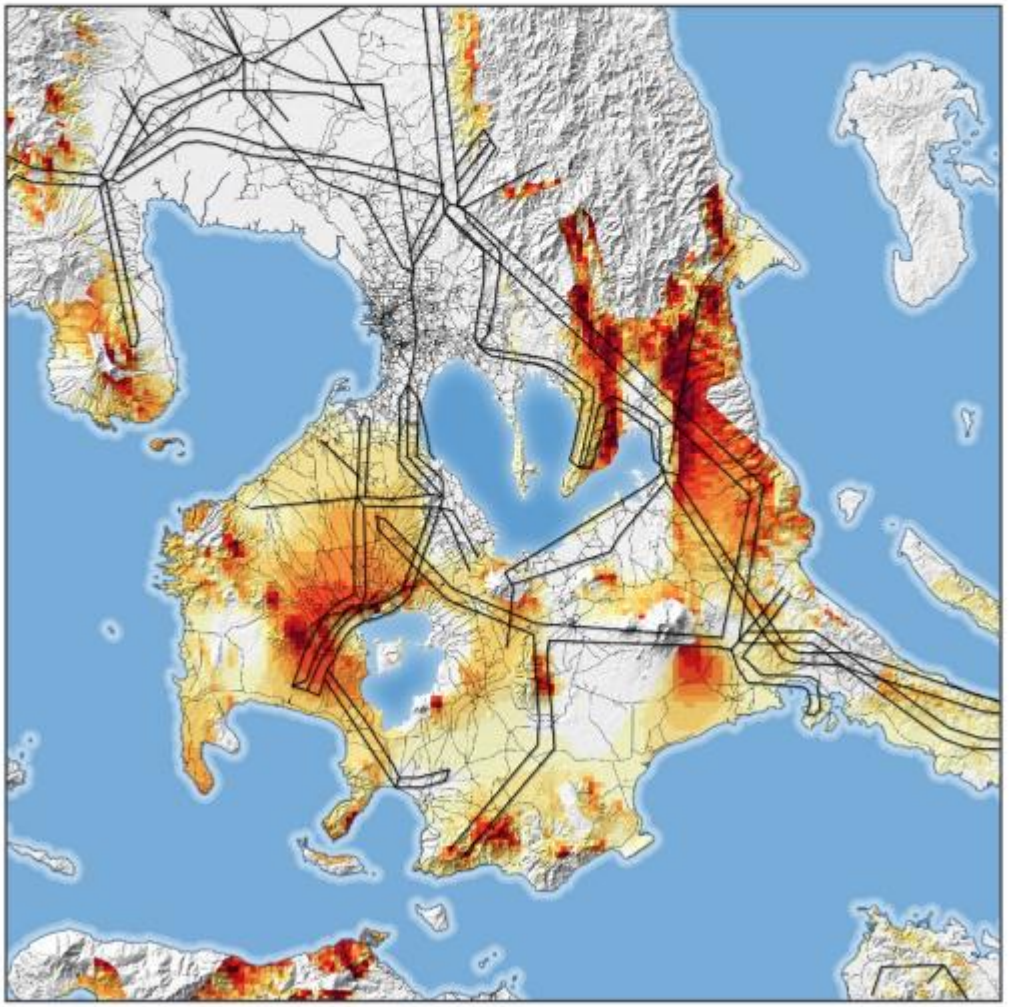

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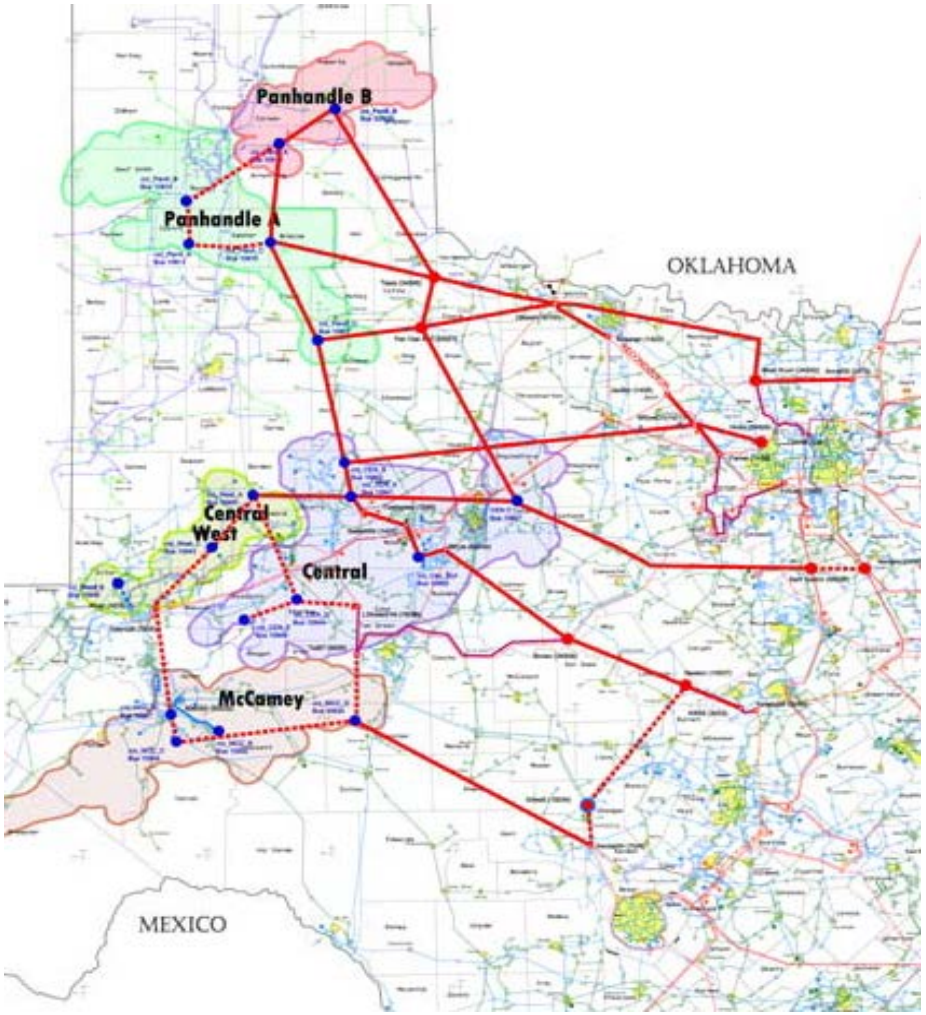
Economic Potential – Data Requirements

- **Same requirements as technical potential, plus*:***
  - **Hourly solar and wind resource**
  - **Levelized Cost of Energy (LCOE) *for each technology***
    - Plant construction cost
    - Operations and maintenance cost
    - Fixed operating cost
    - Variable operating cost
    - Fixed charge rate
    - Intra-regional transmission cost
  - **Levelized Avoided Cost of Energy (LACE)**
    - Marginal generation or wholesale energy market price
    - Projected energy price

RE Zones

- What are RE Zones?
  - Areas with a high concentration of high-quality, easily-developable renewable energy potential
  - A tool for transmission planning



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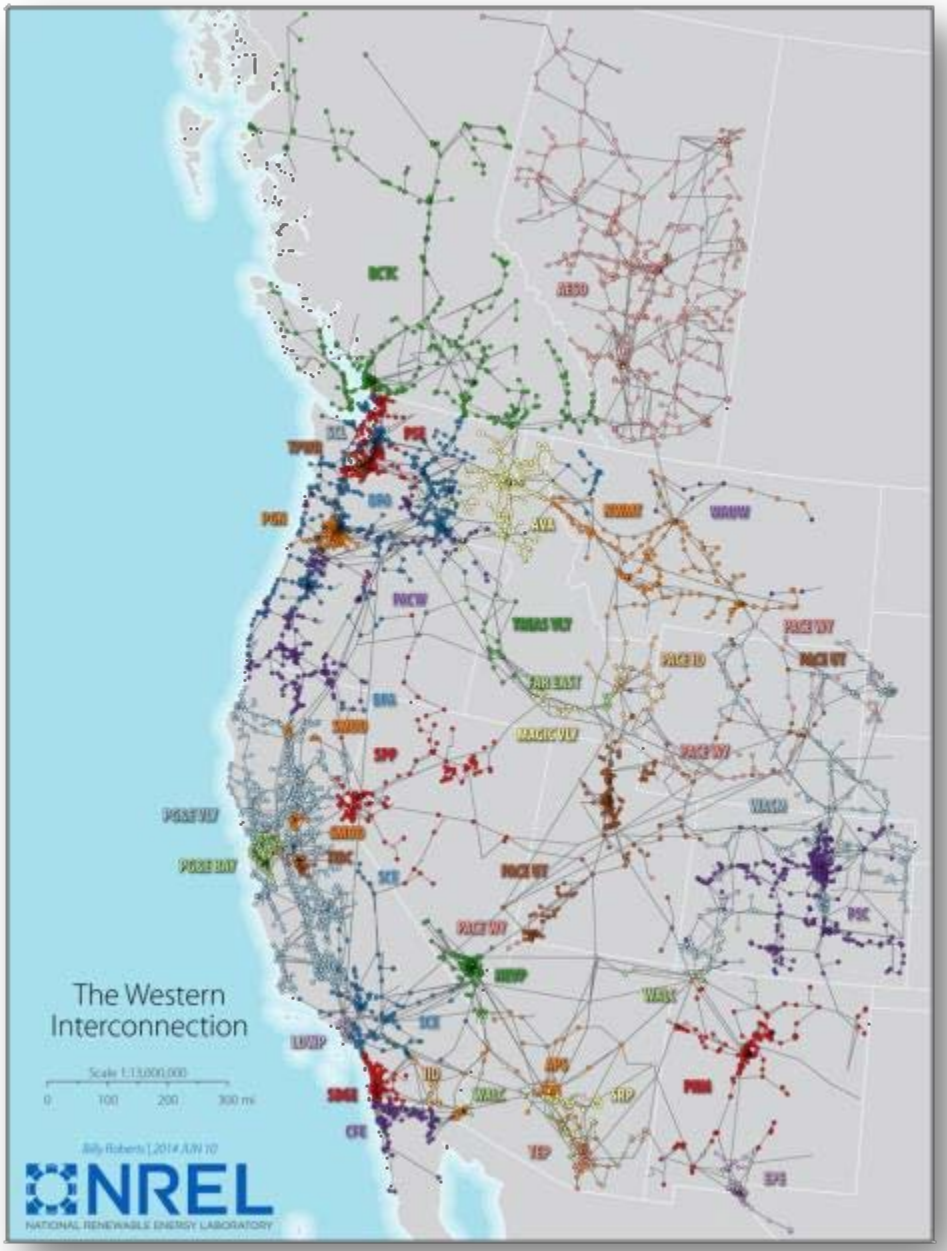
Renewable Energy Zones – Data Requirements

- Same requirements as technical potential, plus:
  - Infrastructure
    - Electric transmission lines [detailed, non-hypothetical]
    - Electric substations [detailed, non-hypothetical]
    - Roads
- Economic potential requirements are helpful (not necessarily required*)

Grid Integration Studies

- A grid integration study is an analytical framework for evaluating how a power system can be planned/operated with high levels of variable RE.
  - Simulates operation of the power system under different future scenarios.
  - Identifies reliability constraints.
  - Determines relative costs of actions to help integrate RE.
  - Addresses system operator concerns that the system can work reliably and cost-effectively.

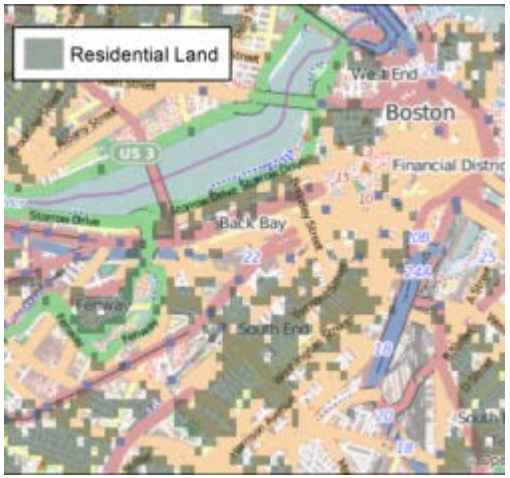


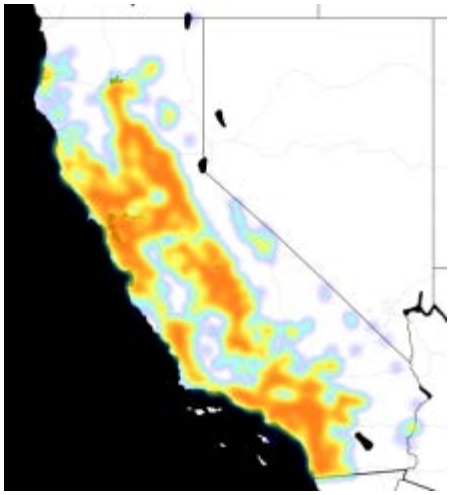
Grid Integration – Data Requirements

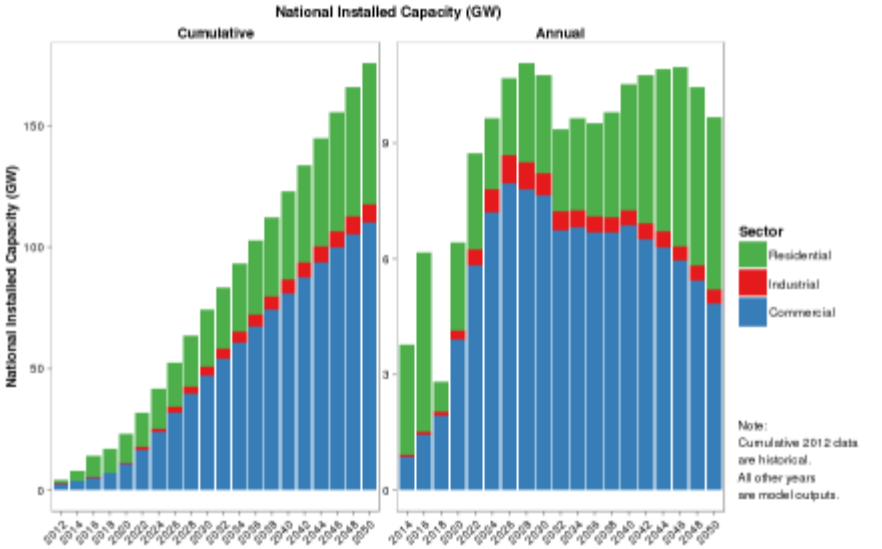
- Same requirements as technical potential, plus:
  - Hourly (or sub-hourly) solar and wind resource
  - Hourly (or sub-hourly) load
    - If the focus is on capacity expansion, need load and RE resource profiles for a typical year*
    - If the focus is on operations, need load data and RE resource data that are time-synchronous (same year and time-steps)
  - Existing and planned electric infrastructure
    - Transmission lines and nodes
    - Generator locations and operating characteristics (e.g., capacity, minimum stable level, ramp rate, heat rates, outage rates, fuel costs…)

Distributed solar photovoltaic (DGPV)

- Connected to the distribution network of a utility system
- Connected “behind-the-meter”
- Smaller scale in nature
- In most cases, not owned or operated by distribution utility







(Top Left): Evaluate adoption potential for each 200m^2 cell; (Top Right): Spatial focus permits regional predictions; (Bottom): Results from BAU-Mid Costs Scenario in ITC Extension analysis

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DGPV – Data Requirements

- If we want to gain a basic understanding of the technical potential…
  - Hourly solar resource
  - Building Inventory microdata
    - Representation of current and future building stock (counts, building type/area, occupancy rates, roof area, roof suitability)
- If we want to model DGPV diffusion… (in addition to above)
  - Hourly current and future Load
  - Representation of end-uses
    - Sectors, applications for DG
  - Current and future retail rate prices
  - Current and future incentives, net metering
  - Financing assumptions
  - Technology cost and performance assumptions
  - Current adoption levels
    - Where, how much

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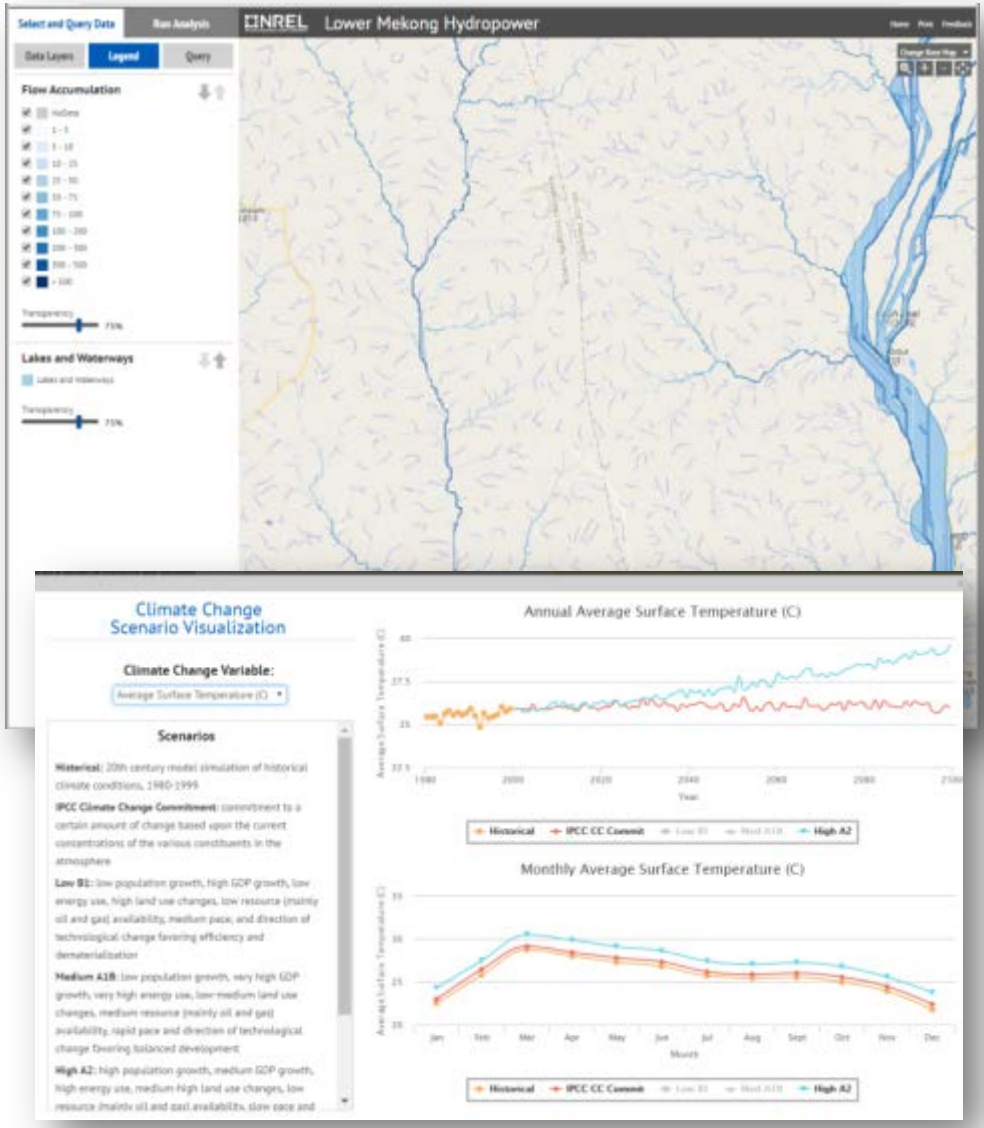
Understanding Other Goals

Risk and Resiliency

- How does energy resource availability vary (e.g., by season or hour)?
- How vulnerable are future generation and infrastructure investments to natural disasters?
- Where can RE deployment potentially contribute to energy reliability, e.g., by providing backup to critical loads?
- How might energy development impact food and water security?



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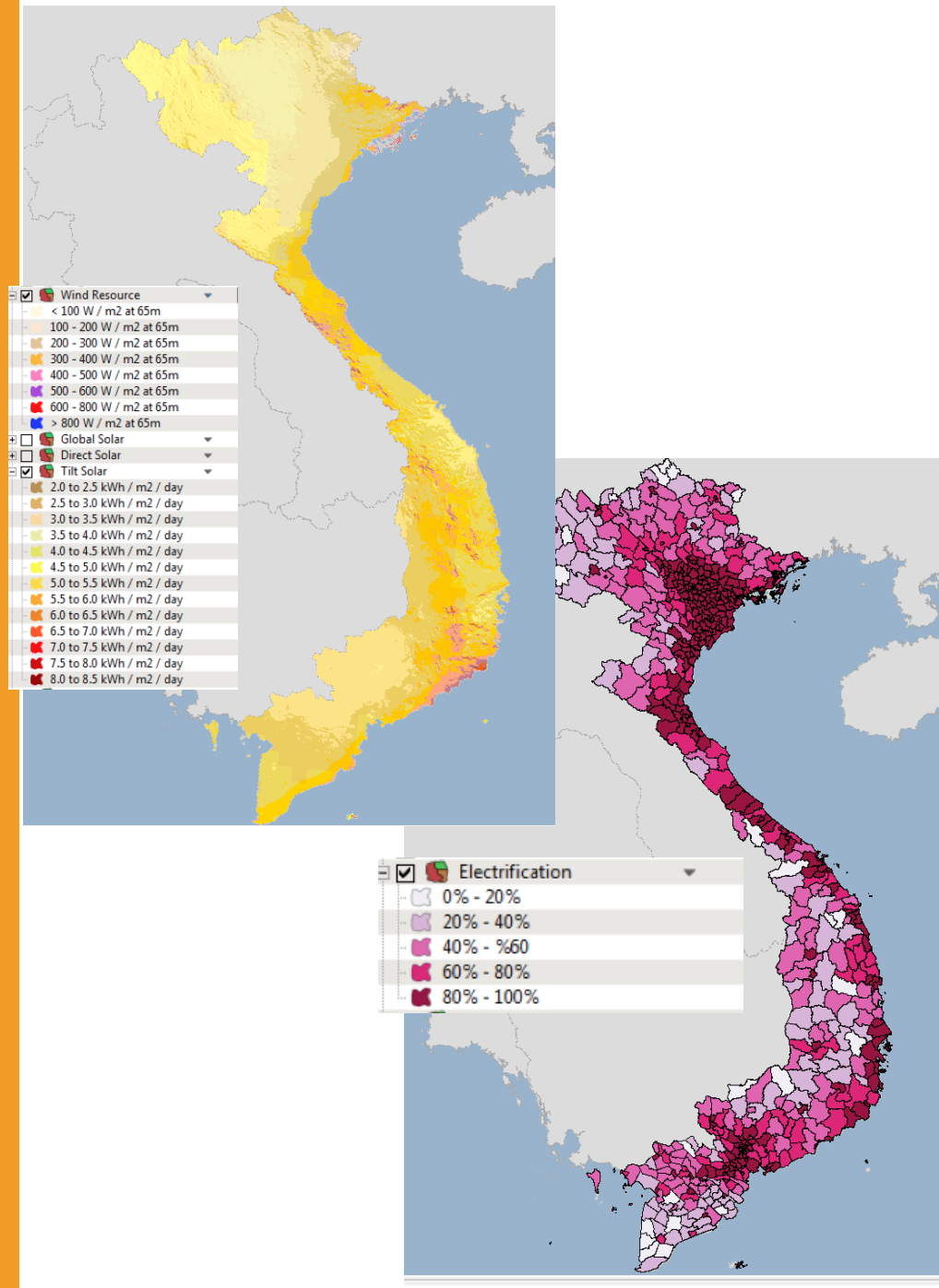
Risk and Resiliency

- **Energy resource availability**
  - E.g., annual, monthly (and hourly*) availability of hydro, biomass, wind, solar, etc.
- **Natural Hazards and Severe Weather**
  - Tsunami frequency, landslide frequency, fire risk, earthquake frequency, drought events, flood risk, heatwave risk, tornadoes risk, etc.
- **Infrastructure**
  - Electric transmission lines, substations, natural gas pipelines, roads, power plants, critical loads, etc.
- **Food and water security**
  - Productivity of croplands, distribution of population relying on subsistence farming, energy technology footprint, …

Electrification

- Where might renewables support the electrification of off-grid communities?



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Electrification data requirements

- **Same requirements as technical potential, plus:**
  - Population distribution
  - Poverty rates [district-level or higher resolution]
  - Electrification rates [district-level or higher resolution]
  - Existing and planned transmission lines and substations (***not required if high-resolution electrification rates are available****)

Thank You

Anthony Lopez
National Renewable Energy Laboratory
Tel: +1-303-275-3654
Email: anthony.lopez@nrel.gov

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