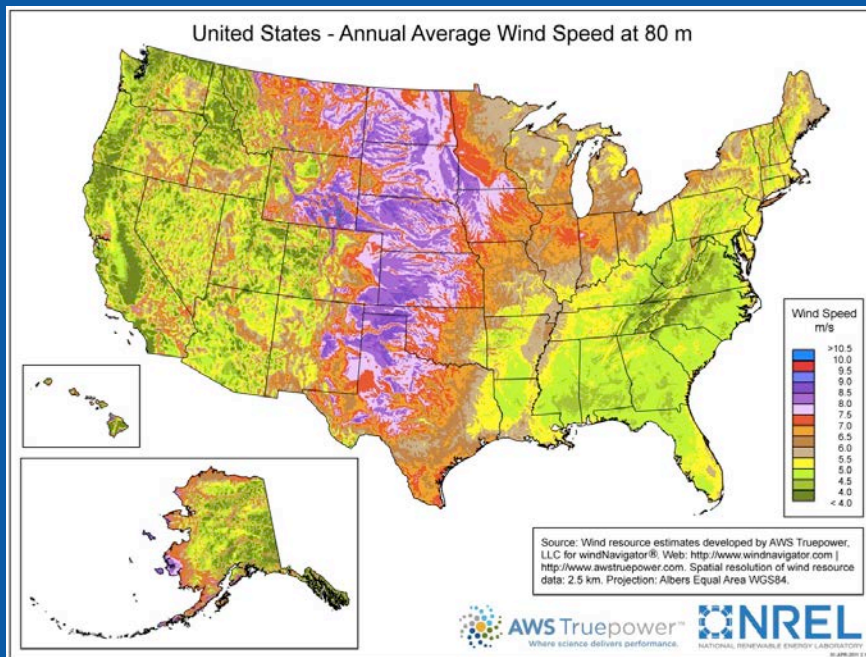


# National-Scale Wind Resource Assessment for Power Generation



**Modern Approaches to Support the Development of a Nation's Wind Energy Potential**

**E. Ian Baring-Gould**

**Asia Clean Energy Forum 2013**

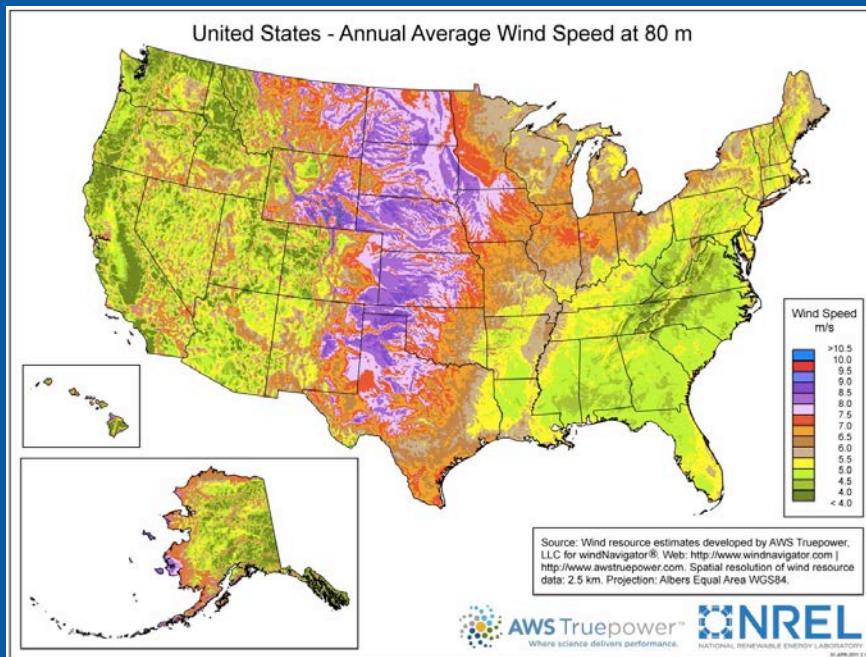
**June 28, 2013**

**Manila, Philippines**

**NREL/PR-7A20-59115**

Supported by the U.S. Department of Energy

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# Energy Development Conundrum

Energy development is a balance of resource availability, cost, impact assessment, demand, and a heavy dose of politics.

The energy sector is risk averse and dependent on limited capital markets with a low risk tolerance.



RISK matters:

- Power production
- Structural engineering
- Grid integration.

Especially since RE technologies already are associated with a risk premium.

# Resource Assessment is Driven by the Question

Question: Will it be windy on my hike today?

Which instrument is better?



Boy Scout with a wet finger

RESULT: WINDY +/- ? m/s

VS.



Anemometer

RESULT: 8 m/s +/- 0.1 m/s

What is at risk? An uncomfortable hike

A Boy Scout might work for this scenario.

# Resource Assessment is Driven by the Question

Question: How windy will it be at my wind farm?

Which instrument is better?



Boy Scout with a wet finger

RESULT: WINDY +/- ? m/s

VS.



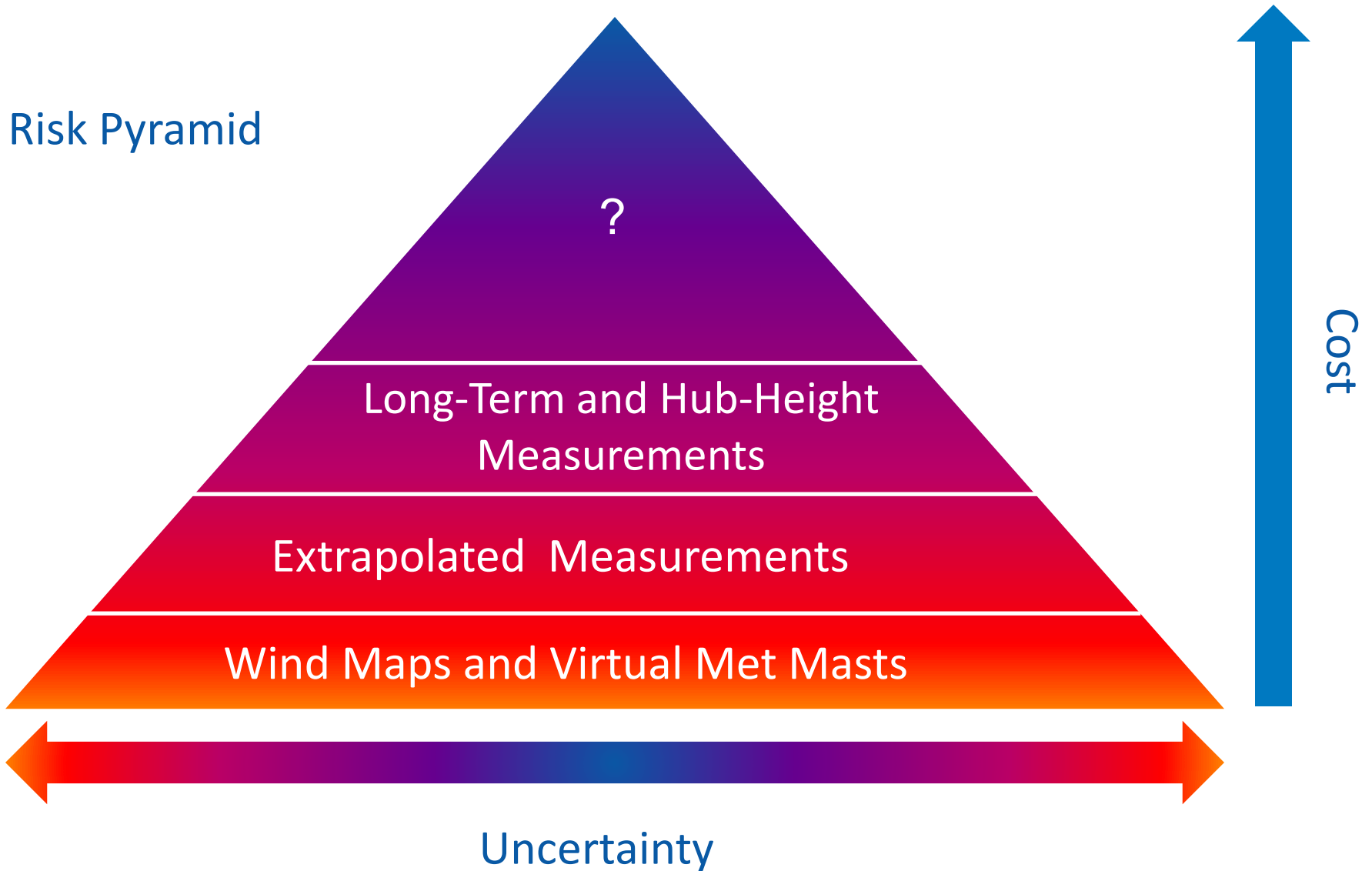
Anemometer

RESULT: 8 m/s +/- 0.1 m/s

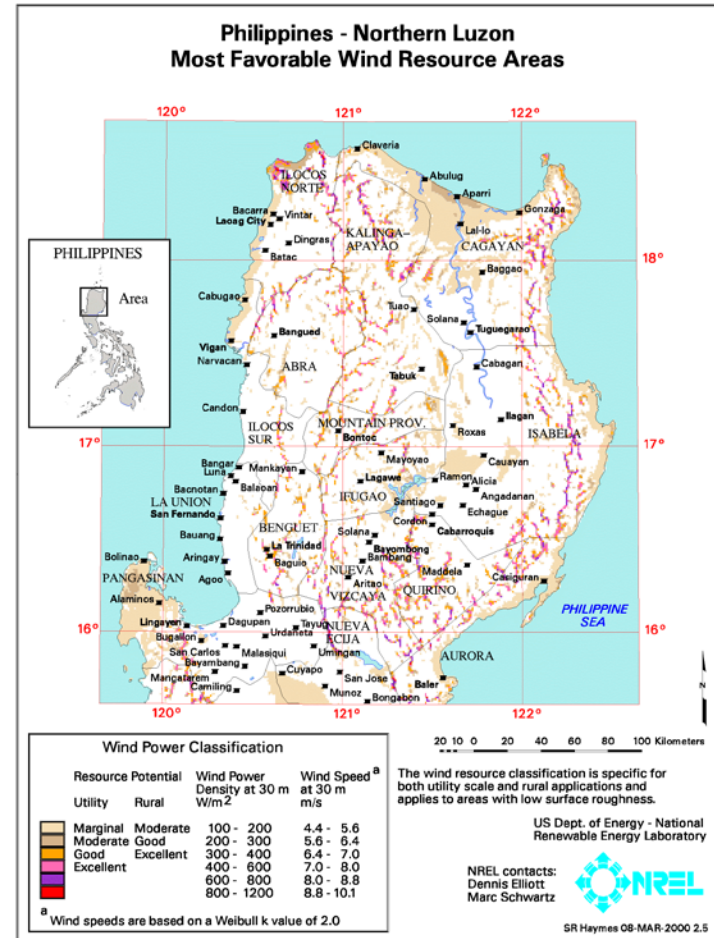
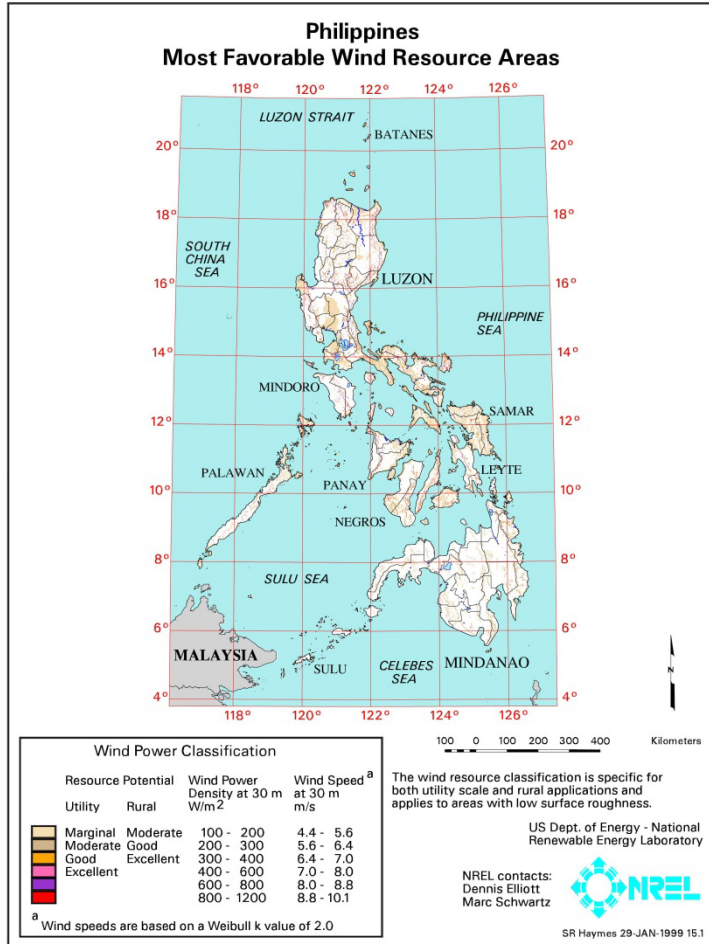
What is at risk? Champagne or bankruptcy

Anemometer is the way to go with so much at stake!

# Cost and Risk Trade-Off



# Philippines Wind Resource Assessment



The NREL 2001 study estimated a 70-GW wind development potential for the Philippines, but many constraints have limited development.

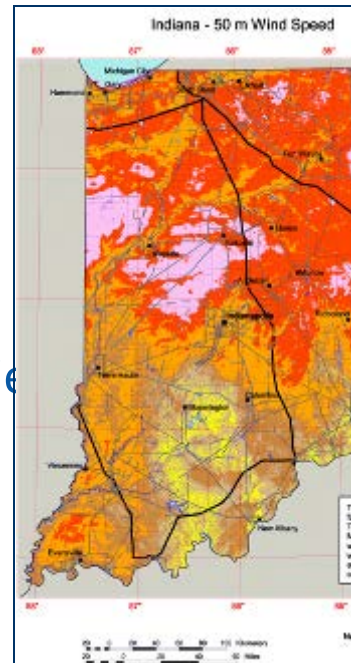
# Wind Resource Assessment Considerations

## Important wind characteristics:

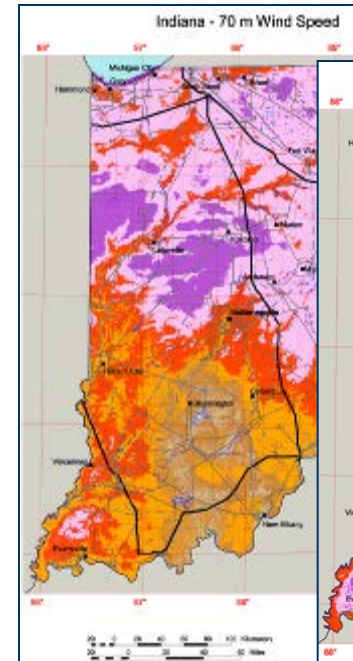
- Wind shear, spatial and temporal variations, terrain influences
- Seasonal and diurnal wind patterns
- Wind direction and speed frequency
- Turbulence and complex terrain influences
- Extreme weather events.

## New wind resource tools:

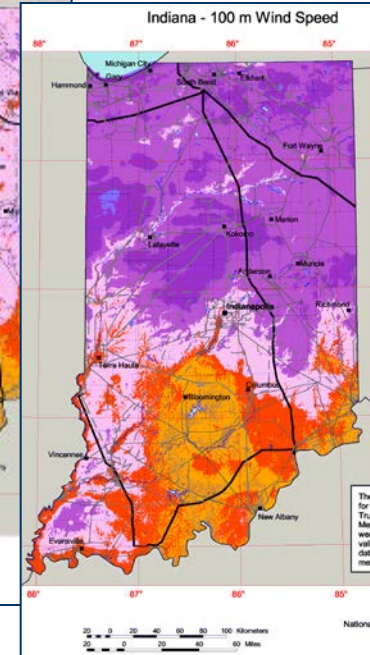
- Greatly improved wind modeling
- Computational-based worldwide wind data sets
- Validation of regional modeled wind speeds with tower-based measurement sites
- Better understanding of wind changes with height
- For some locations, virtual measurement can be obtained, which can help spur wind development.



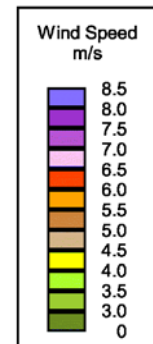
Best areas 6.5-7 m/s  
Capacity factors 30%-35%



Best areas 7-7.5 m/s  
Capacity factors 35%-40%



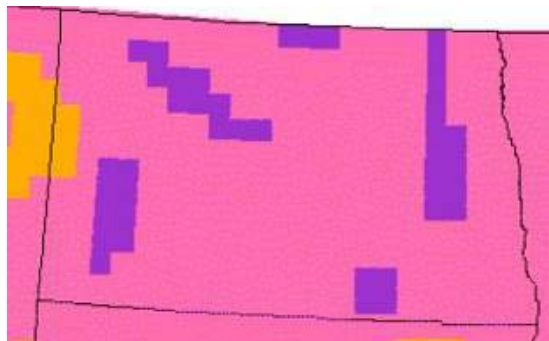
Best areas 7.5-8.2 m/s  
Capacity factors 40%-45%





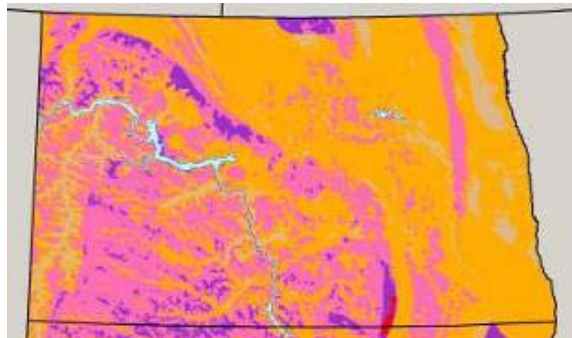
# High-Resolution Wind Mapping

## North Dakota's "Changing" Wind



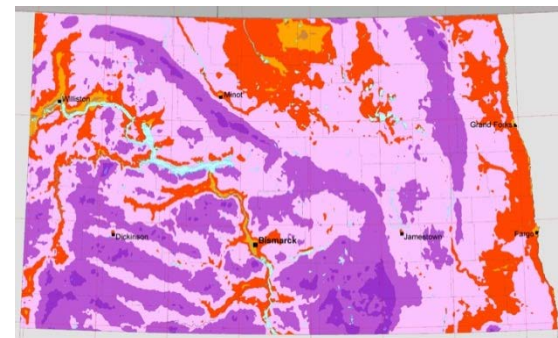
1987

20-km resolution  
30-m height  
No ground cover  
Minimal terrain data



2000

1-km resolution  
50-m height  
Basic ground cover  
Good terrain data



2010

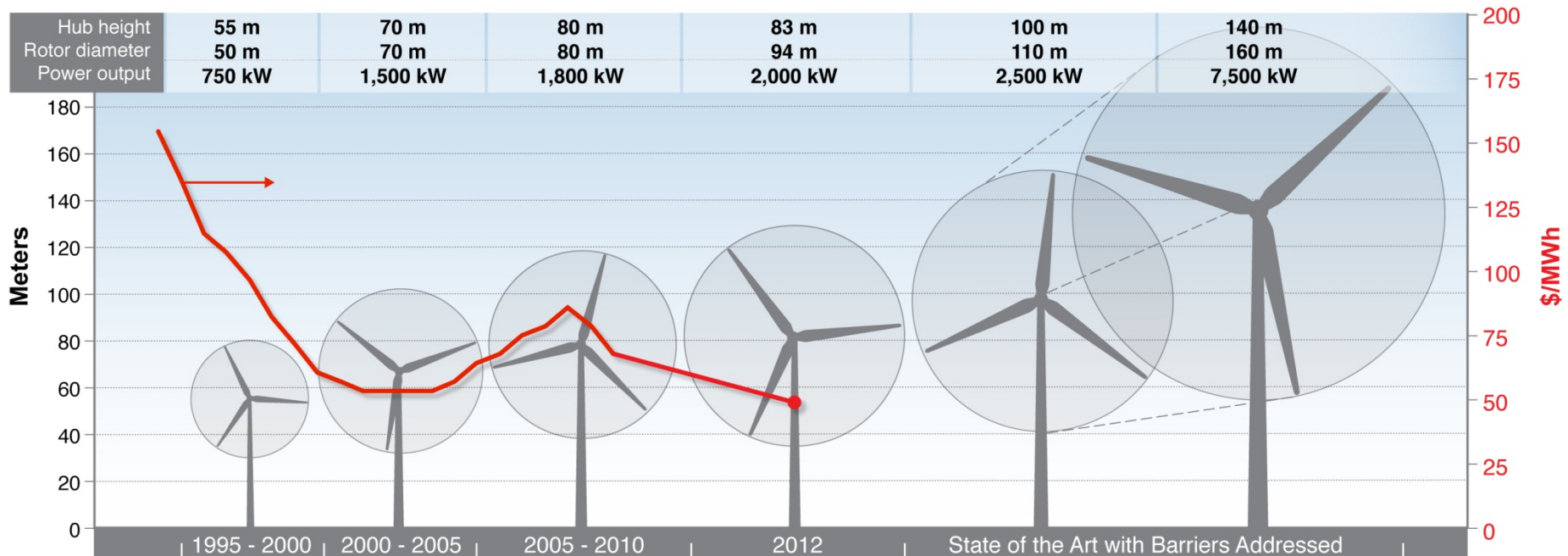
200-m resolution  
Multiple heights (80 m)  
Good ground cover  
Excellent terrain data

With the new and expanded availability of data, increasing computational power, and better prediction models, the ability to conduct national wind assessments has increased almost exponentially.

This allows developers and policy makers to better assess potential.

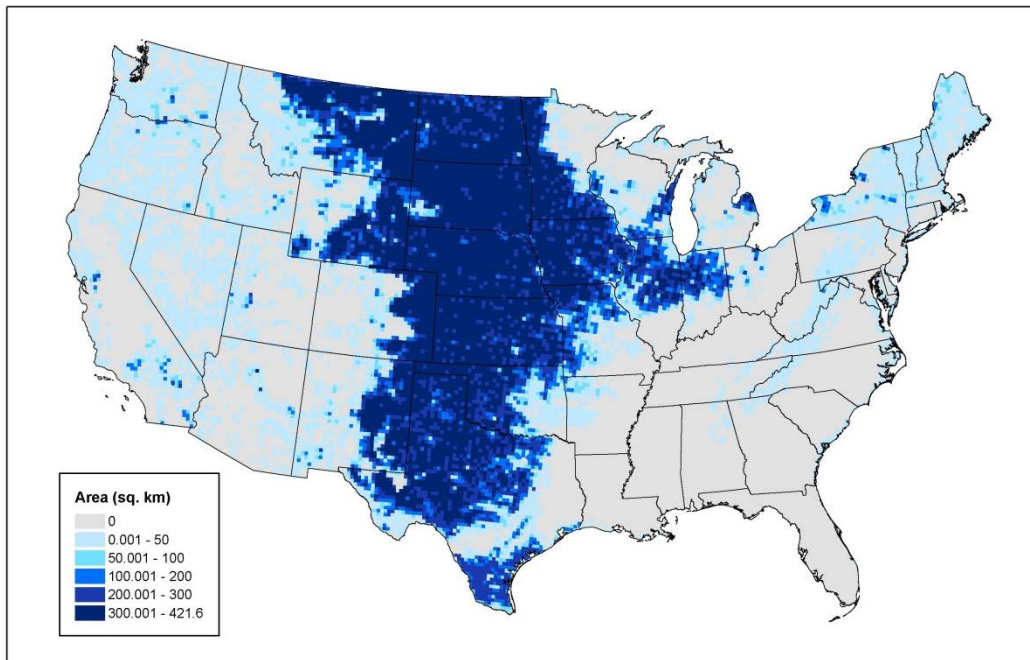
# Changes in Turbine Technology

Rapidly changing turbine technology focused on taller turbine towers and larger turbine rotors (longer blades) is changing the landscape of wind development.



# Changes in Viable Wind Deployment

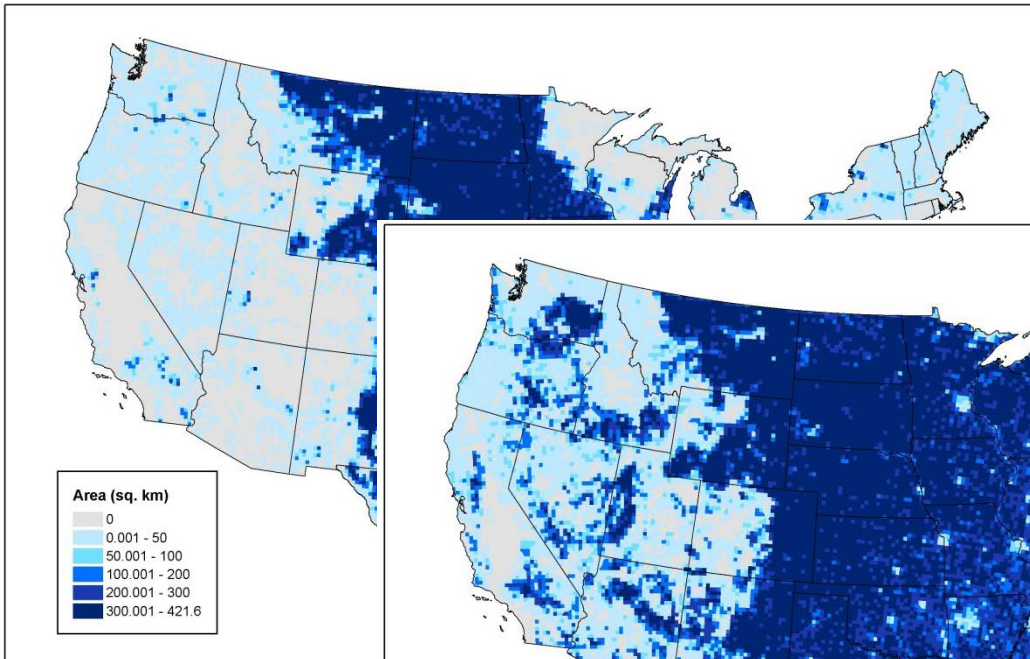
Area of the United States with viable (30% capacity factor) wind development



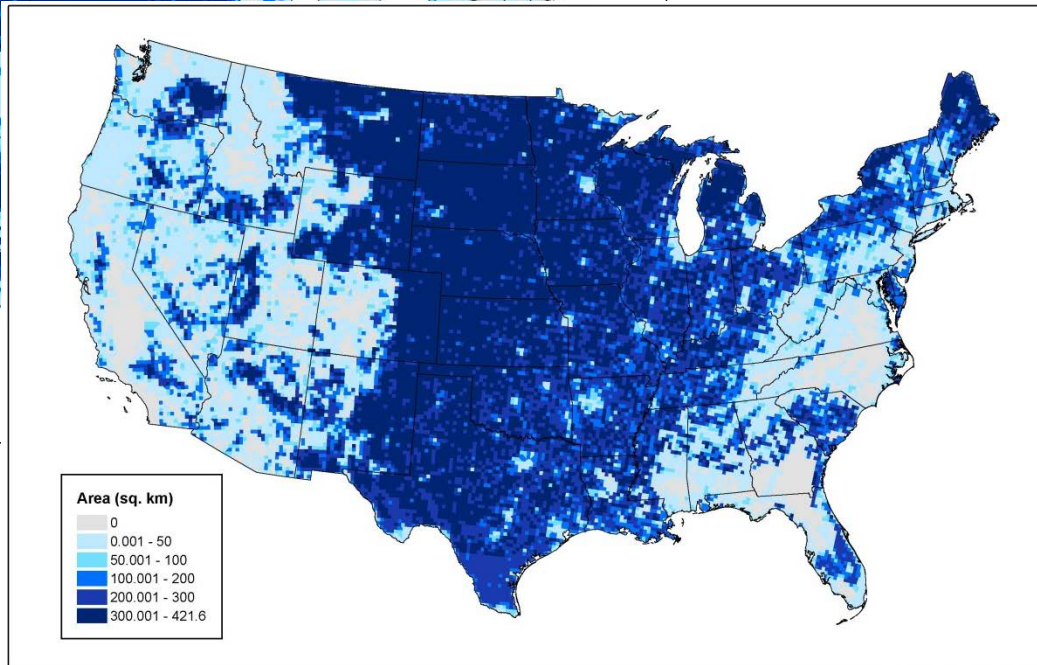
Class II  
turbine, 77-m  
rotor on an  
80-m tower

# Changes in Viable Wind Deployment

Area of the United States with viable (30% capacity factor) wind development



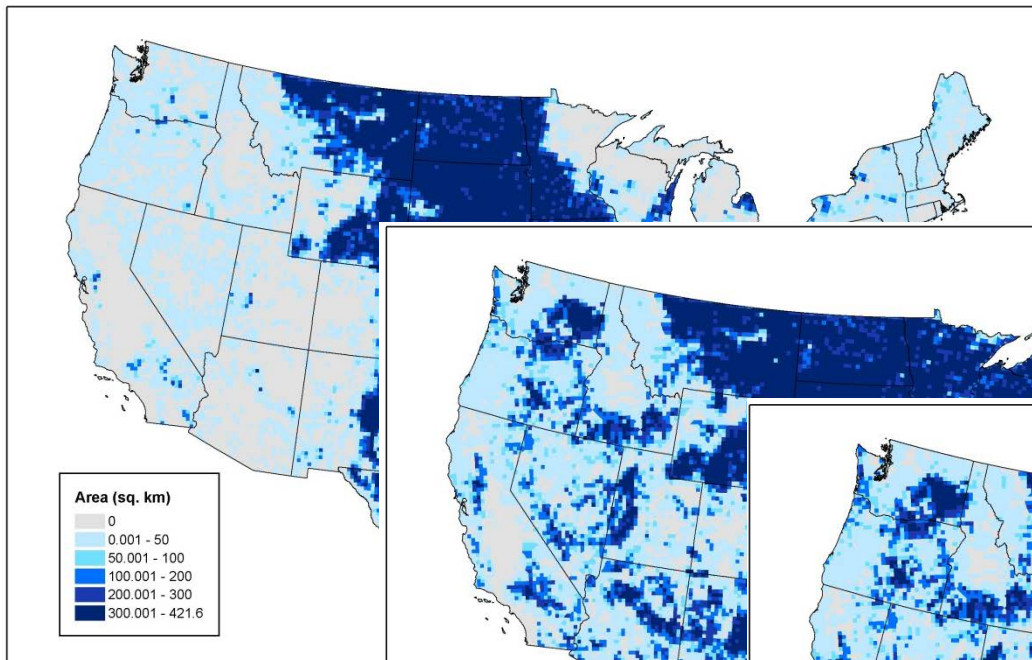
Class II  
turbine, 77-m  
rotor on an  
80-m tower



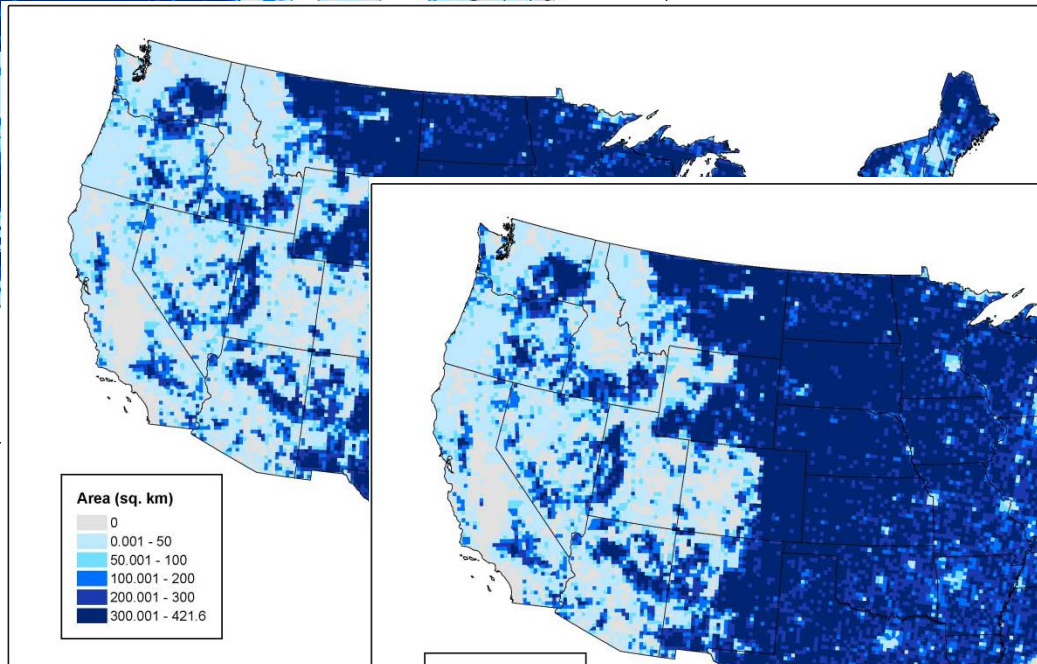
Class III  
turbine, 100-m  
rotor on a 110-  
m tower

# Changes in Viable Wind Deployment

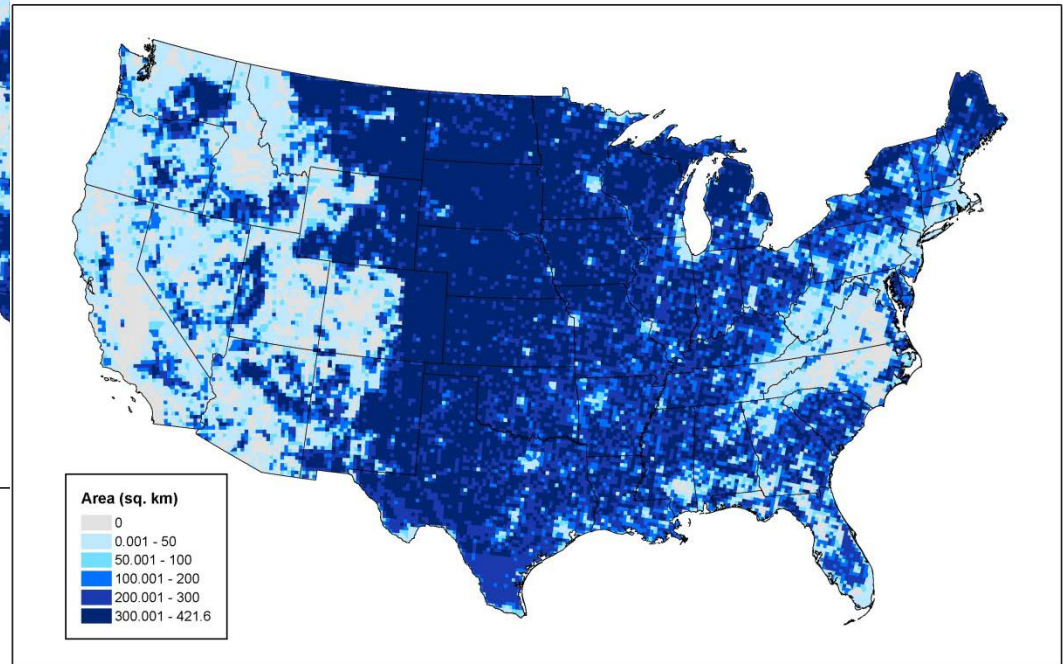
Area of the United States with viable (30% capacity factor) wind development



Class II turbine, 77-m rotor on an 80-m tower



Class III turbine, 100-m rotor on a 110-m tower

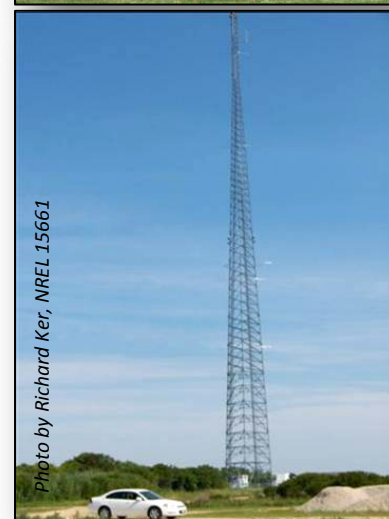


Class III turbine, 117-m rotor on a 140-m tower

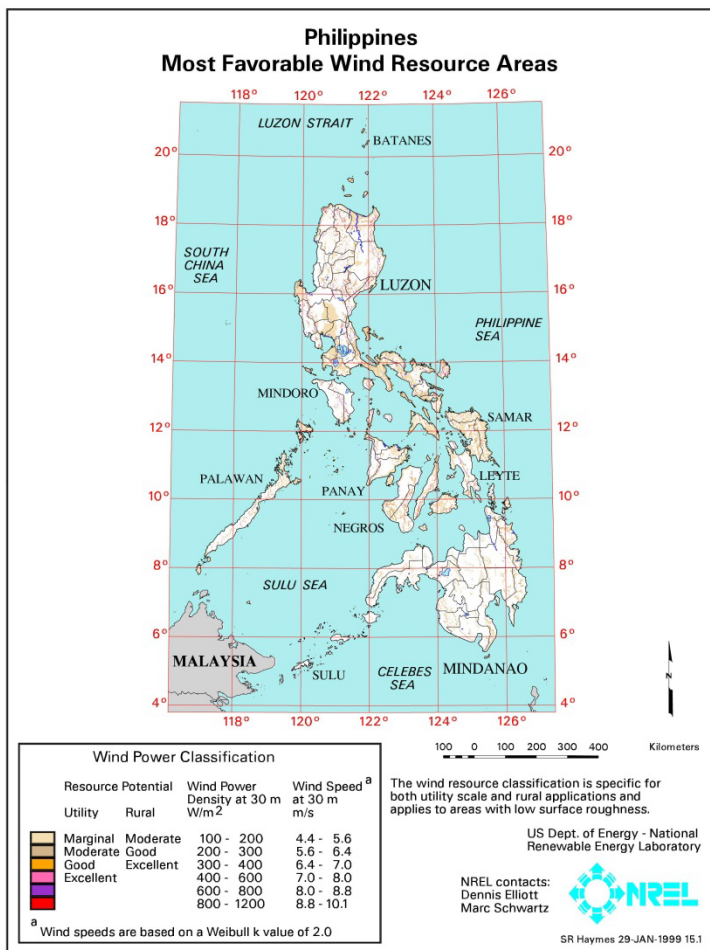
# Resource Assessment to Development

Although static national wind maps can help identify development potential, they have not provided a clear path to developed projects.

- Basic maps cannot be substituted for measurement data.
- Implementation of simple assessment tools (Geospatial Toolkit) allows viable comparisons for policy decisions.
- National wind resource measurement programs are needed to provide data to support project assessment.
- Modern meso-scale computational models using validated data can allow expanded development by making initial resource assessments available to a wide pool of potential developers at lower cost (i.e., better risk/return).



# Updated Philippines Wind Resource Assessment



Given the changes in resource modeling and turbine technology over the past decade, what will a new national assessment look like?

It would include more economically viable wind potential closer to loads and infrastructure.

But will this be enough to expand wind development in the Philippines?

Maybe, but it's back to an assessment of the risk/reward premium.

More efforts will likely be needed to reduce the risks associated with large-scale wind development on behalf of regulators, utility providers, developers, and financiers.



*Photo by David Parsons, NREL 07389*

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