HVDC Transmission and the Future of Clean Energy

Presented to
Southern States Energy Board

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CLEAN LINE
ENERGY PARTNERS

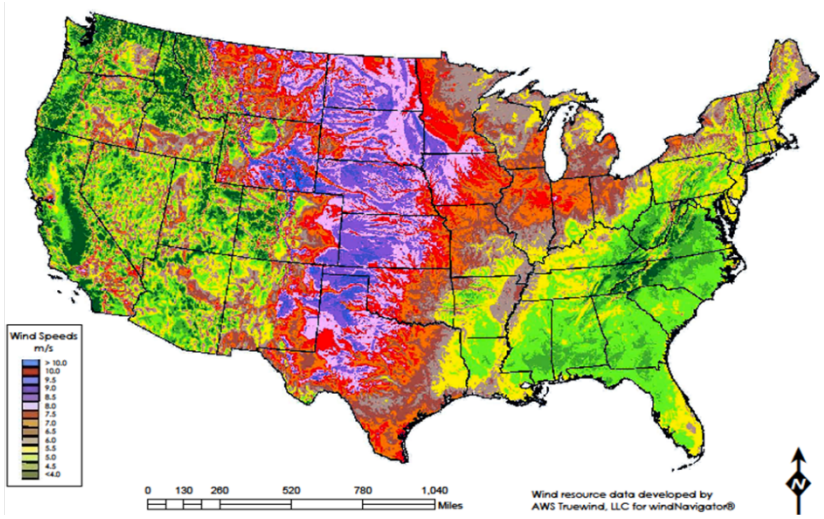
Who is Clean Line Energy?

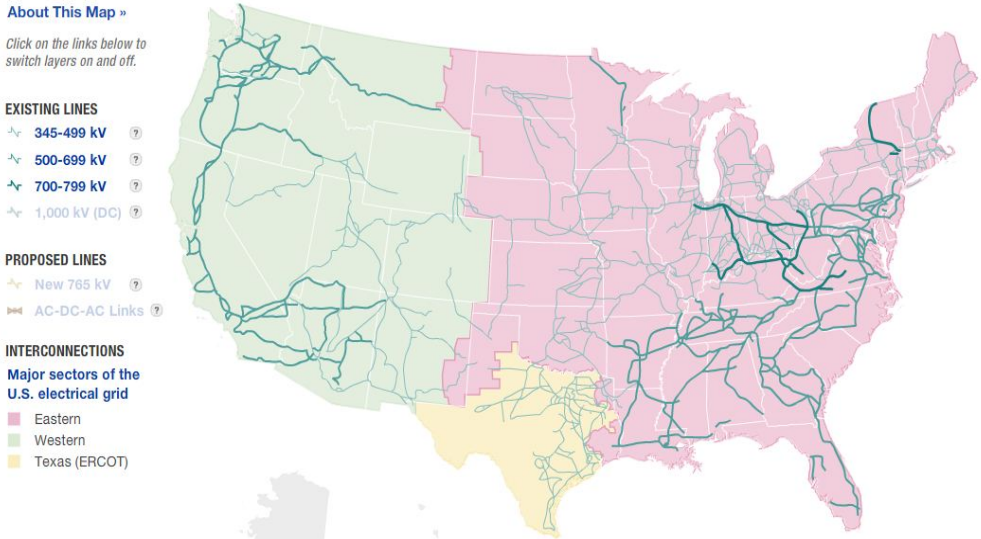
Clean Line develops **high voltage**, **long-haul transmission lines** to connect the **best renewable energy** resources in North America to communities and cities that lack access to new, **low-cost renewable power**.

Integrating large clean energy sources with demand centers

Why do we need HVDC transmission?

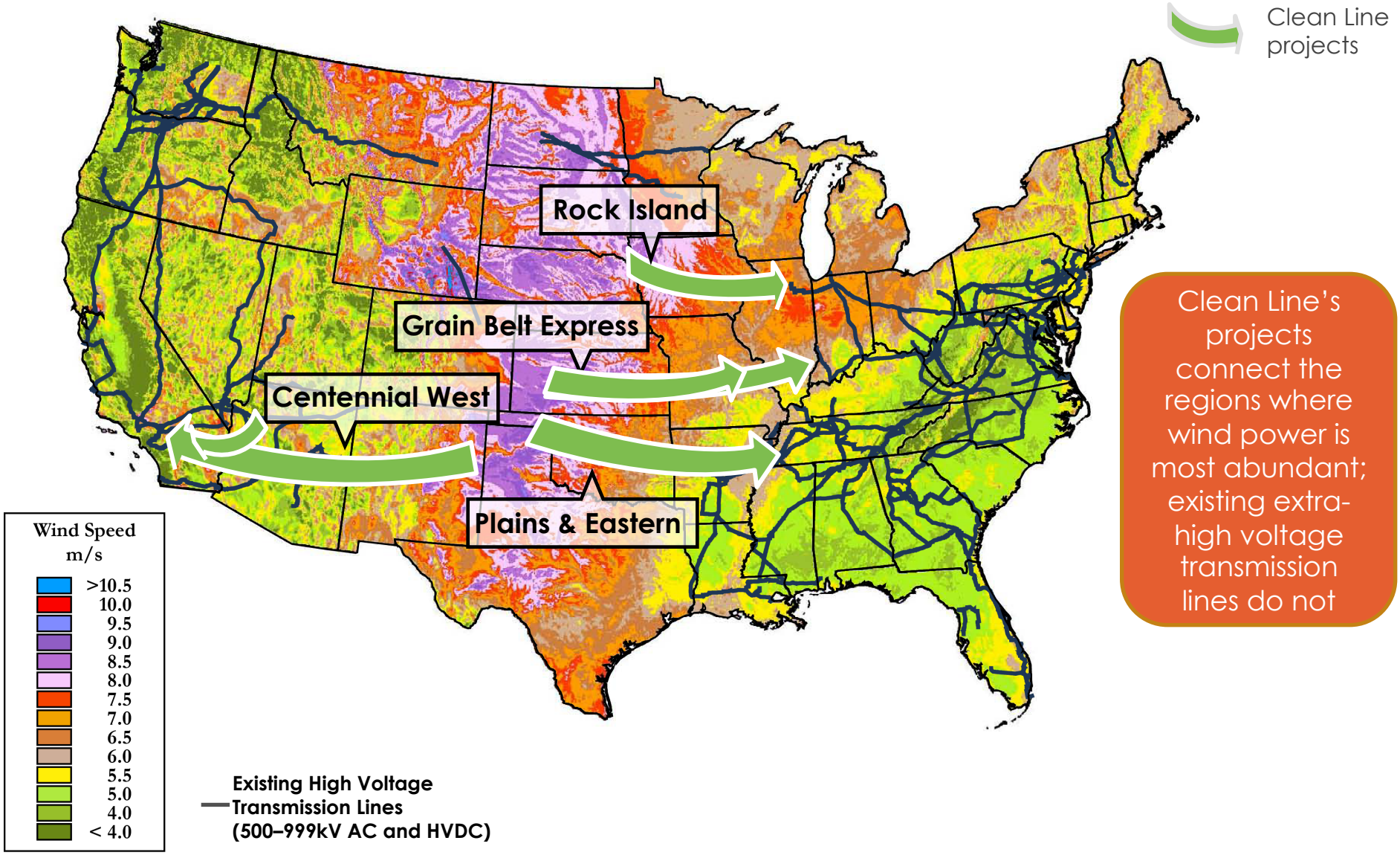
Best wind resources are in central spine of the United States away from distant population centers





...with limited access to robust transmission systems

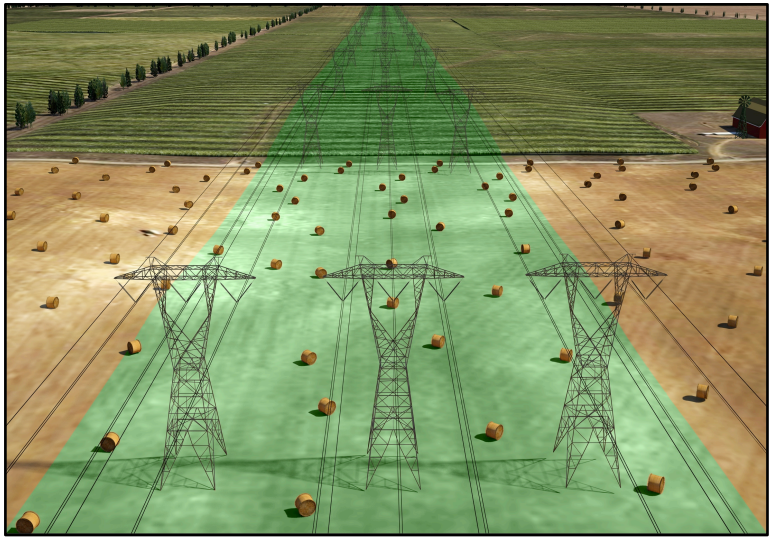
Clean Line's projects connect the best wind resources to load centers



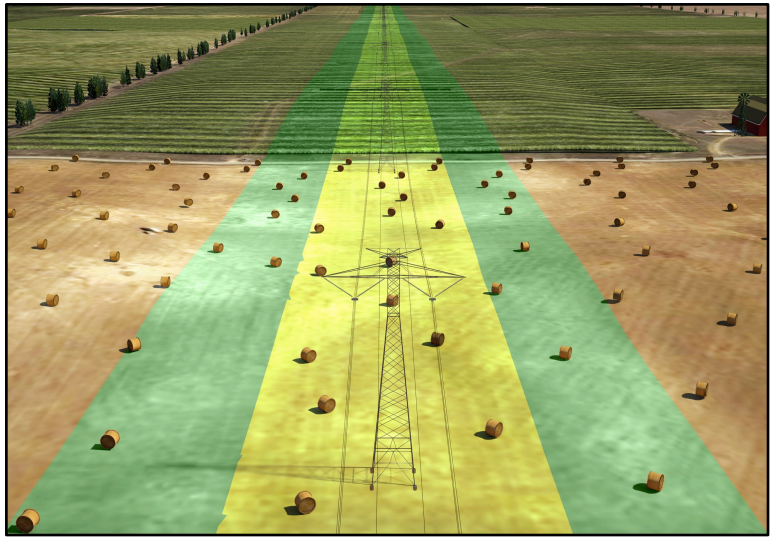
Clean Line's projects connect the regions where wind power is most abundant; existing extra-high voltage transmission lines do not

HVDC is the most efficient method to transmit large amounts of electricity over long distances

- More efficient — Lower line losses
- Lower cost — Requires less infrastructure, results in lower costs and lower prices for delivered renewable energy
- Improved reliability — Control of power flow enhances system stability and lowers cost of integrating wind
- Smaller footprint — Use narrower right-of-way than equivalent Alternating Current (AC)



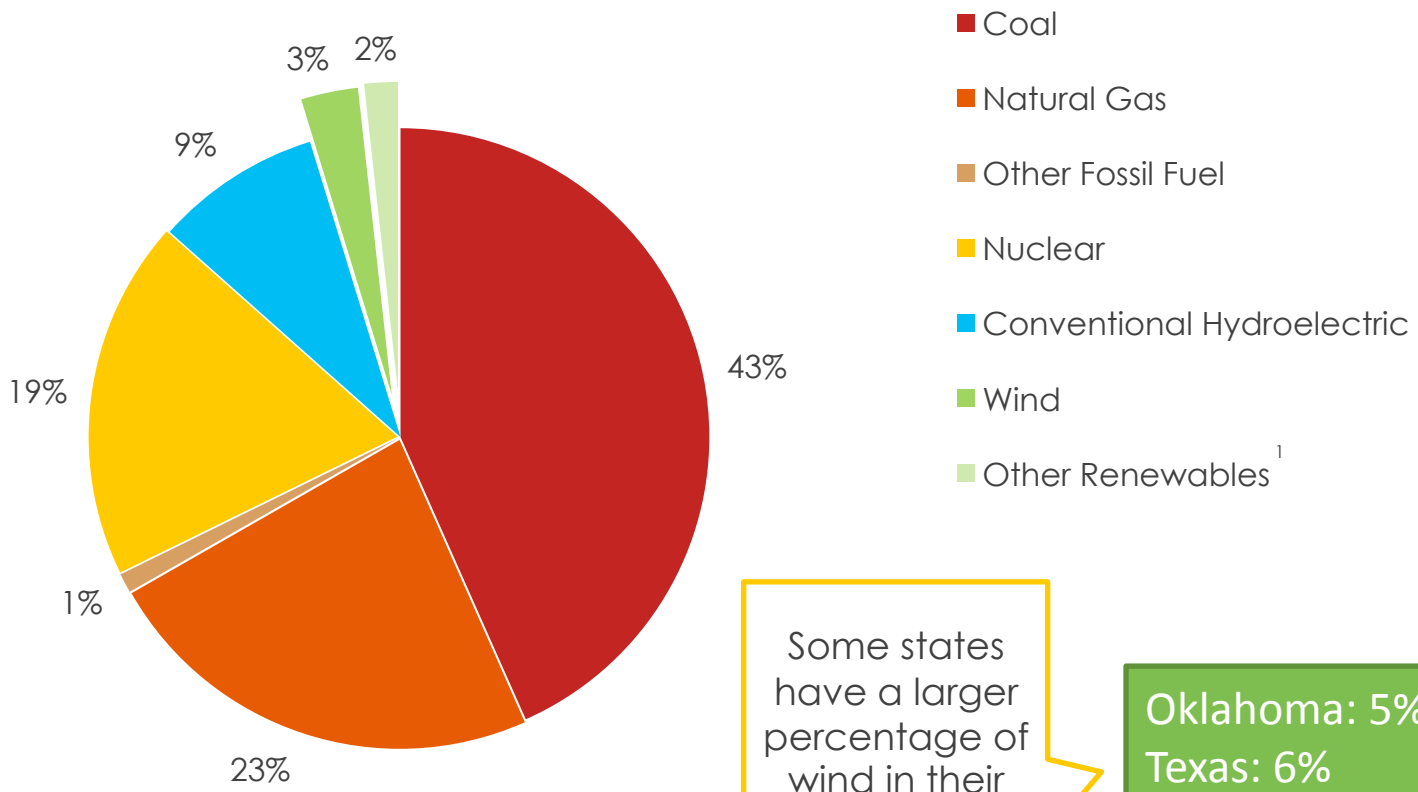
AC Footprint



DC Footprint

Renewables currently constitute a relatively small portion of the U.S.'s electricity generation mix…

U.S. Net Electricity Generation By Fuel Type
2011 Year-To-Date



Some states have a larger percentage of wind in their energy mix

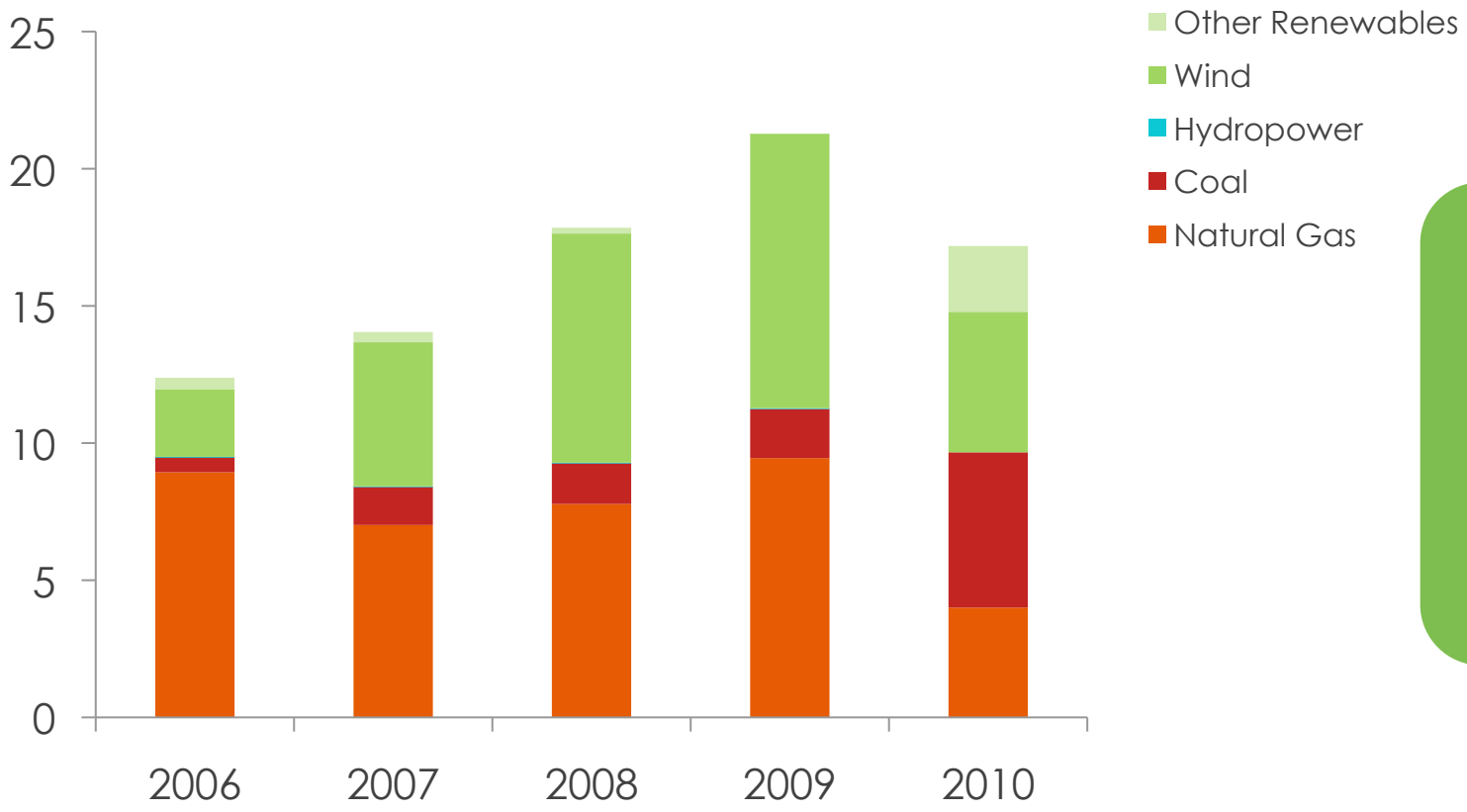
Oklahoma: 5%
Texas: 6%
Iowa: 16%

1. Includes generation from Wood, Waste, Geothermal, and Solar

Source: EIA

…but are an increasingly large proportion of new generating capacity

U.S. New Generation Capacity Additions
Gigawatt

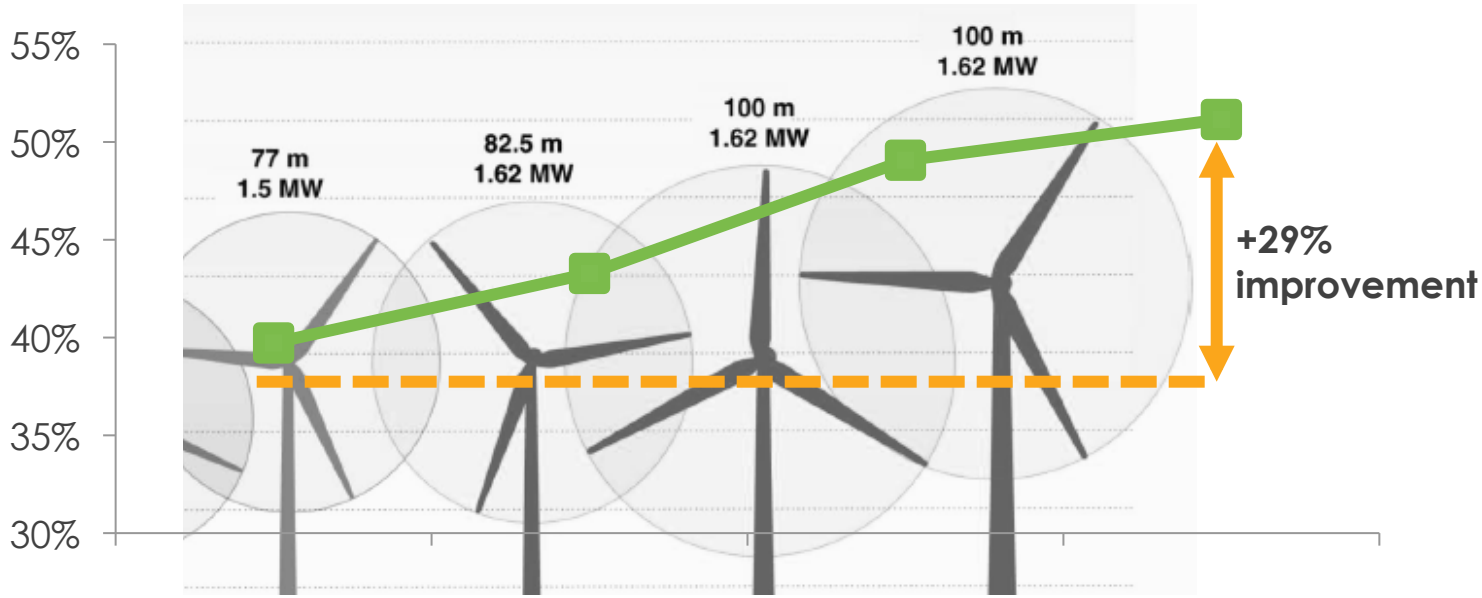


Wind power alone has constituted ~40% of new generation capacity additions over the past 5 years

Source: EIA; AWEA

Improving wind turbine technology is increasing capacity factors and reducing generation costs…

Net Capacity Factor[1]
At 8.5 meters per second wind speed

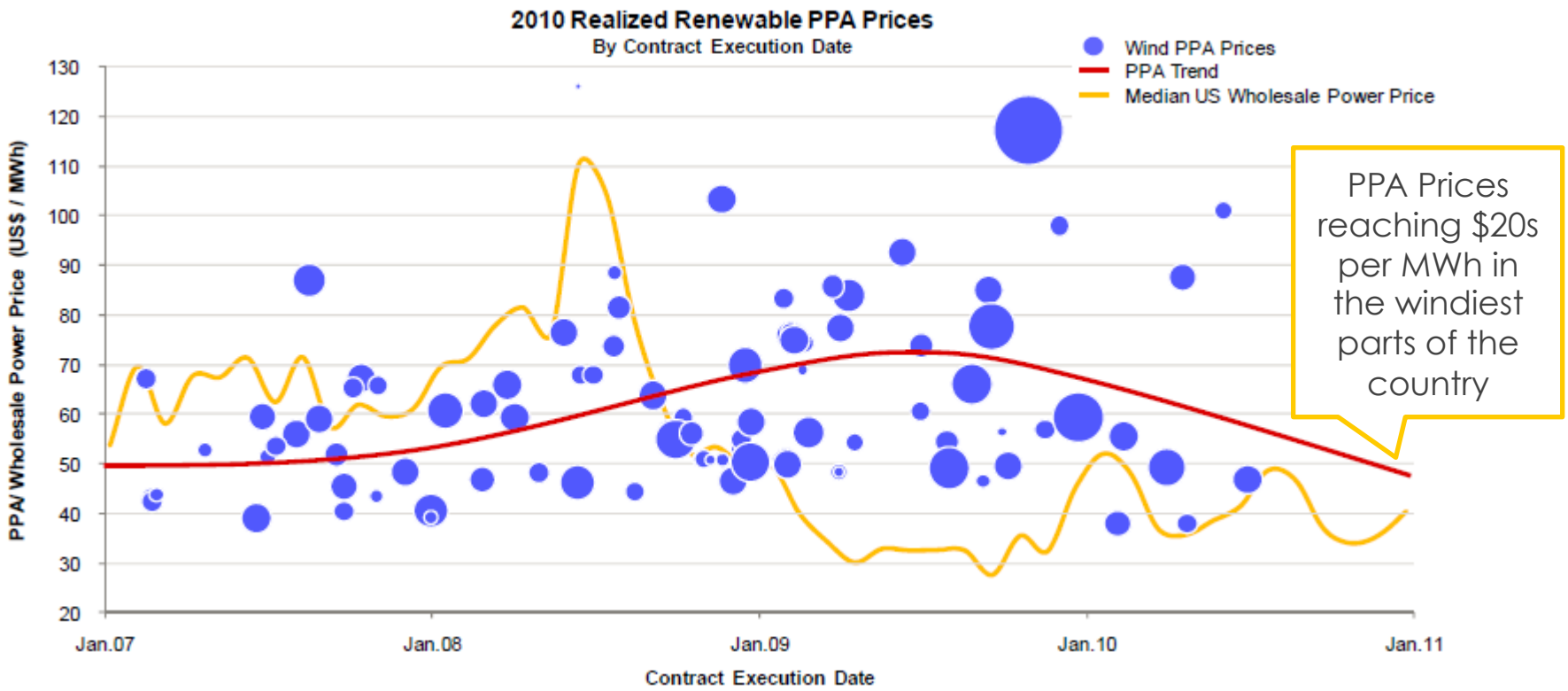


Improving GE 1.5-1.6 MW Turbine from 2005 - 2010 →

In meters				
Rotor Diameter	77	82.5	100	100
Hub Height	80	80	80	100

1. Assumptions: shear alpha = 0.2, Rayleigh distribution, 17% losses from GCF to NCF

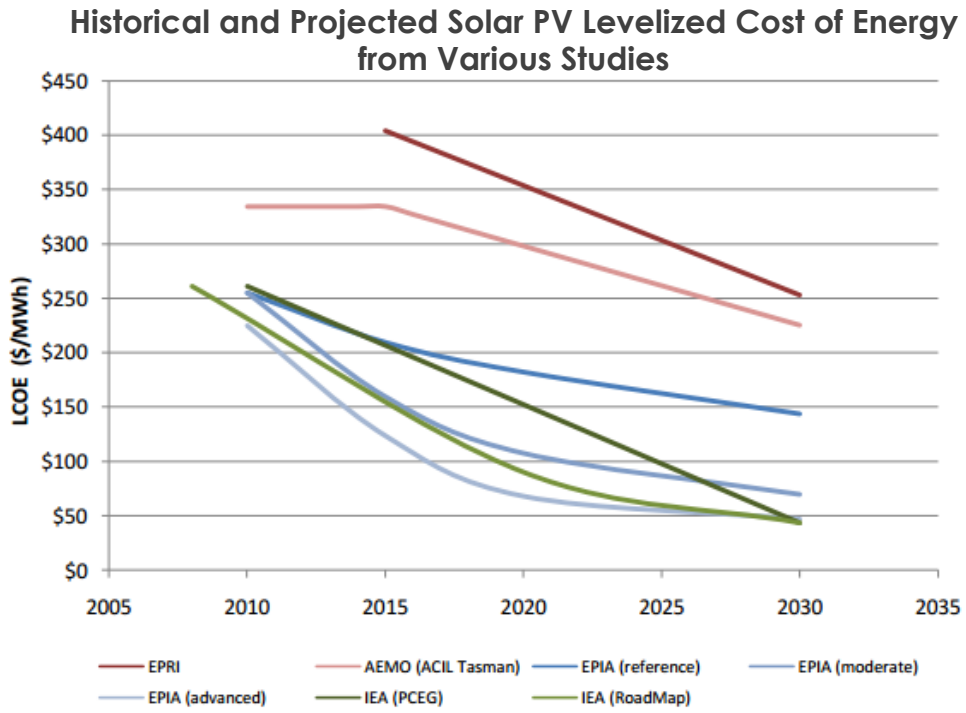
…resulting in cheap wind power purchase agreements ("PPAs")



Note: Represents projects online between 2007 and 2010 with contracts executed between January 2007 and June 2010. Projects online during the same period but with earlier contract execution dates are omitted. Prices represent realized price for full year 2010, where available, excluding test energy or other pre-COD arrangements. Wholesale power price taken as monthly median of representative sample of US hubs
Source: FERC, Intercontinental Exchange, EIA, IHS Emerging Energy Research

Source: IHS "US Wind Power Markets and Strategies: 2011–2025" Market Study Excerpt

Solar PV has also been experiencing declining costs



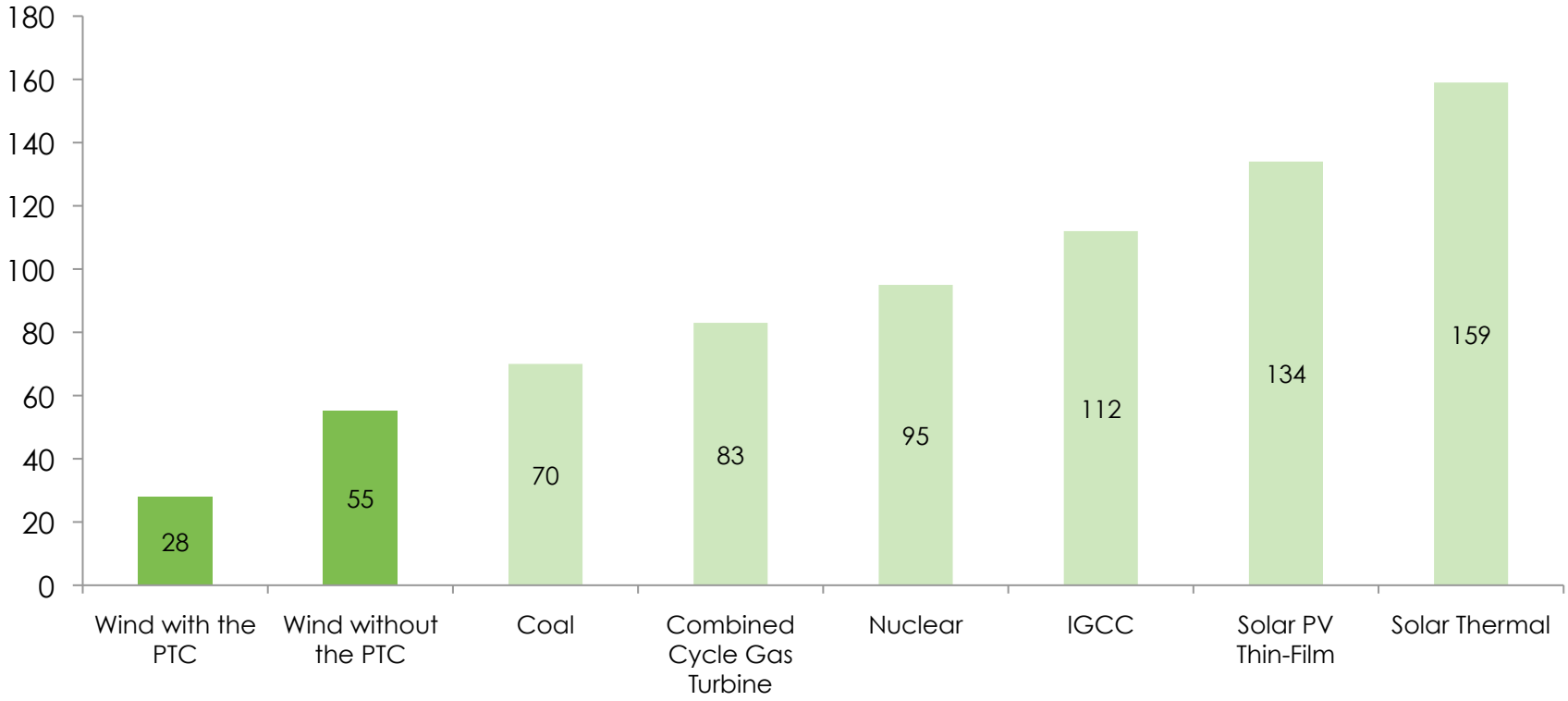
- PV module prices have dropped due to both a decline in polysilicon prices & improvements in technology
- Polysilicon prices have dropped 93% to $33/kg from $475/kg three years ago, due to oversupply
- Reduced PV prices are forcing other solar technologies, such as concentrated solar and Solyndra's tube technology, out of the market

Source: University of Melbourne

High capacity factor wind is competitive with other sources of new generation

Levelized Cost of Energy[1]

$ / MWh



1. Cost of other sources of generation based on mid-point of Lazard's LCOE estimates in 2011$, except for lower-end for coal (no carbon capture)
2. Wind costs assume 50% capacity factor, capex costs of $1700/KW, O&M costs of $10/MWh
3. Assumes $5.50/MMBtu gas price. With ±25% variation in the fuel price, the Combined Cycle Gas Turbine LCOE ranges from $58 - $109/MWh and the IGCC LCOE ranges from $90 - $135/MWh.

Source: Lazard; Clean Line Energy

Imported wind can provide tremendous value to delivered market

Analysis of historical data shows that imported wind provides substantial amount of power when it is needed most, displacing gas peaking plants and saving customers on fuel costs.

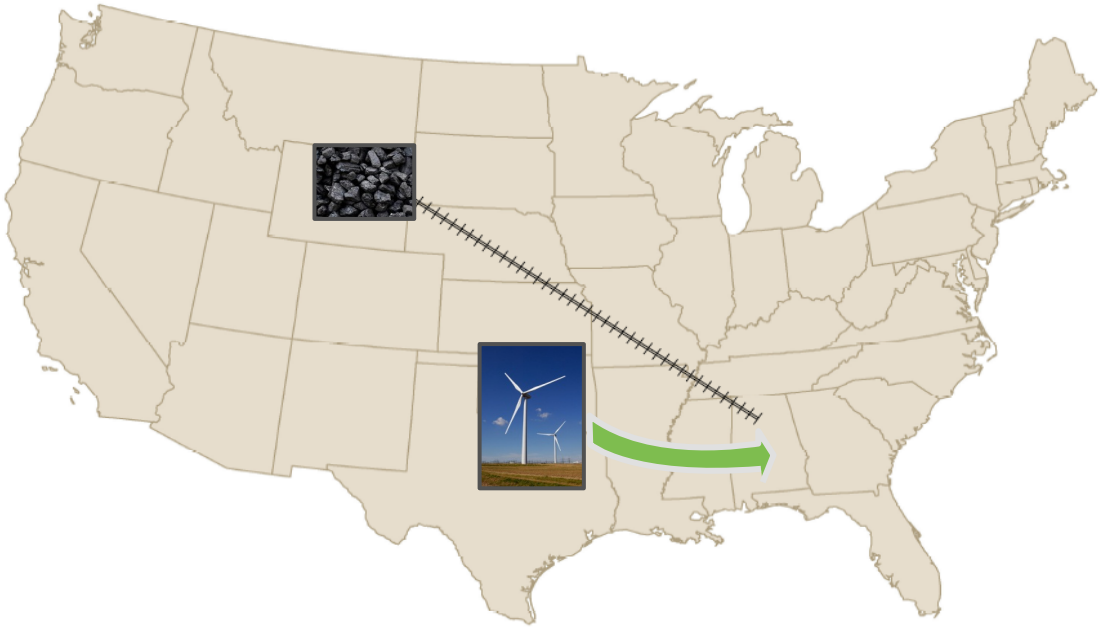
Case Study: Summer 2011

Using a modeled **1000 MW** wind farm located in the Oklahoma panhandle with actual wind data and temperature data from Atlanta, GA as a load proxy for the Southeast, this table shows the average power output of the wind farm from Jun 1st – Sep 29th for various temperatures in Atlanta at the same hour. (2900 hours of data)

Temperature in Atlanta	Average Power Output
Greater than 80°F	493 MW
Greater than 85°F	486 MW
Greater than 90°F	479 MW
Greater than 95°F	307 MW

Source: MAP Royalty

Local wind and gas make sense for the Southeast



Imported Coal

- Imported energy source
- Less investment in the Southeast
- Exposure to transport cost and global price pressure with coal exports to China

Local Wind and Gas

- 100% investment in Southeast
  - Natural gas drilling
  - Wind manufacturing
  - Transmission
  - More jobs for the Southeast
- The combination reduces exposure to fuel price volatility

Source: MAP Royalty

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