

BUILDING A WORLD OF DIFFERENCE

ECONOMICS OF WIND

MON-FEN HONG

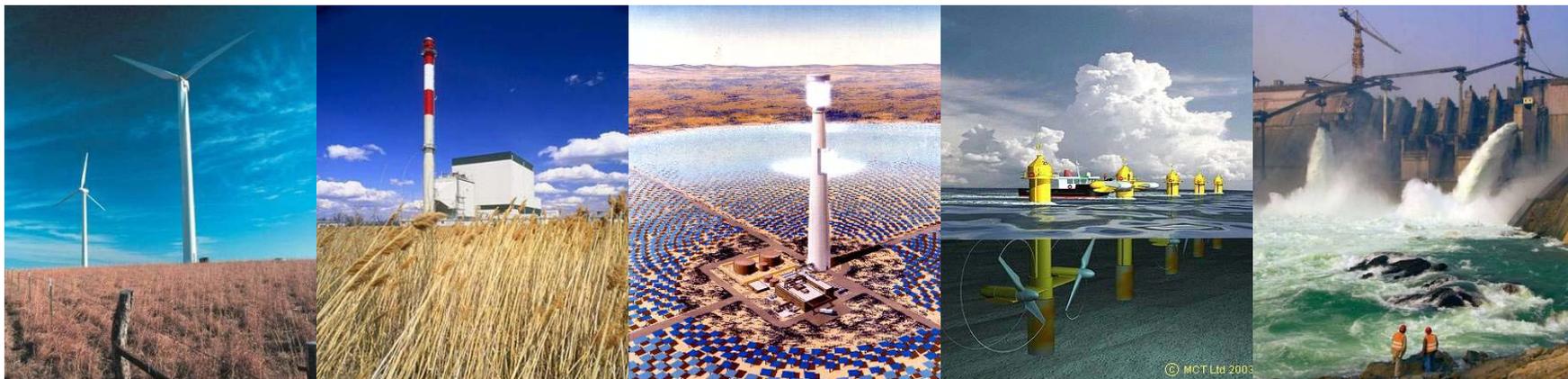
PRINCIPAL CONSULTANT
RENEWABLE ENERGY AND ENERGY EFFICIENCY

07 June 2011



BLACK & VEATCH
Building a world of difference.

BLACK & VEATCH OFFERS A WIDE RANGE OF RENEWABLE ENERGY DEVELOPMENT AND IMPLEMENTATION SOLUTIONS



GLOBAL RENEWABLE ENERGY CAPABILITIES COVERING ALL TECHNOLOGIES

- Multidisciplinary group of more than 250 staff across company
- Services from R&D to turnkey EPC projects
- Experienced in all energy sources:
 - Wind
 - Hydro
 - Solar Thermal
 - Biomass
 - Landfill Gas
 - Anaerobic Digestion
 - Ocean
 - Solar Photovoltaic
 - Geothermal
 - Ethanol / Biodiesel



National Solar Thermal Test Facility

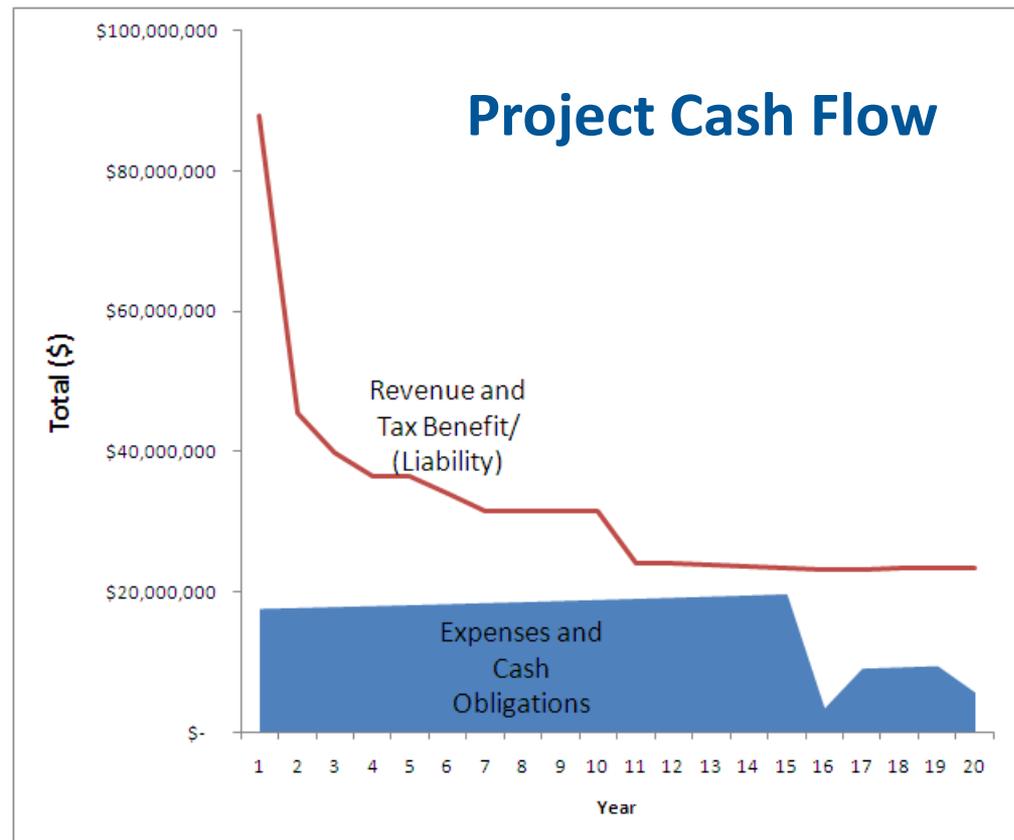
OVERVIEW

- Levelized Cost of Energy (LCOE)
- Comparing the Cost of Wind
- Renewable Energy Supply Curve for New England
- Getting to the RPS Target
- Reality Check ✓ for Real World Projects



TYPICAL COMPONENTS OF COST OF A PROJECT

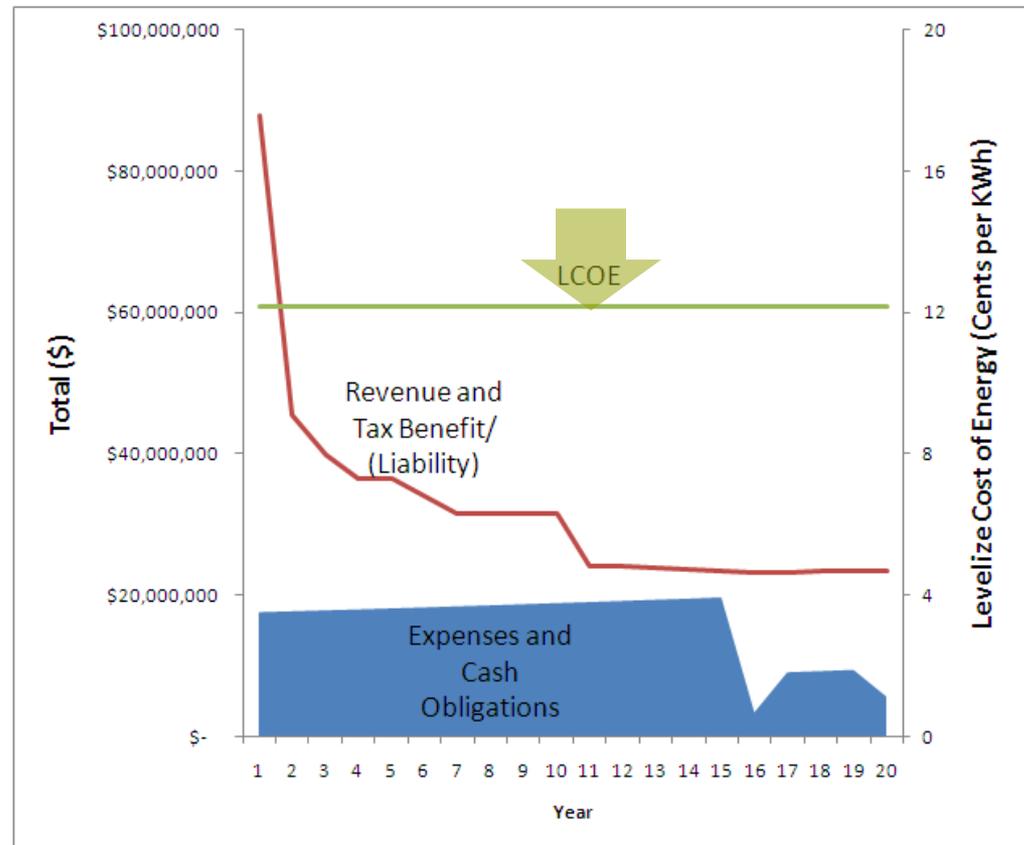
- Capital cost
- Operating cost
- Financing cost
- Taxes
- Incentives
- Performance characteristics
- Transmission and Integration*



Net cash flow over life of project is variable due to tax benefits and makes comparisons difficult

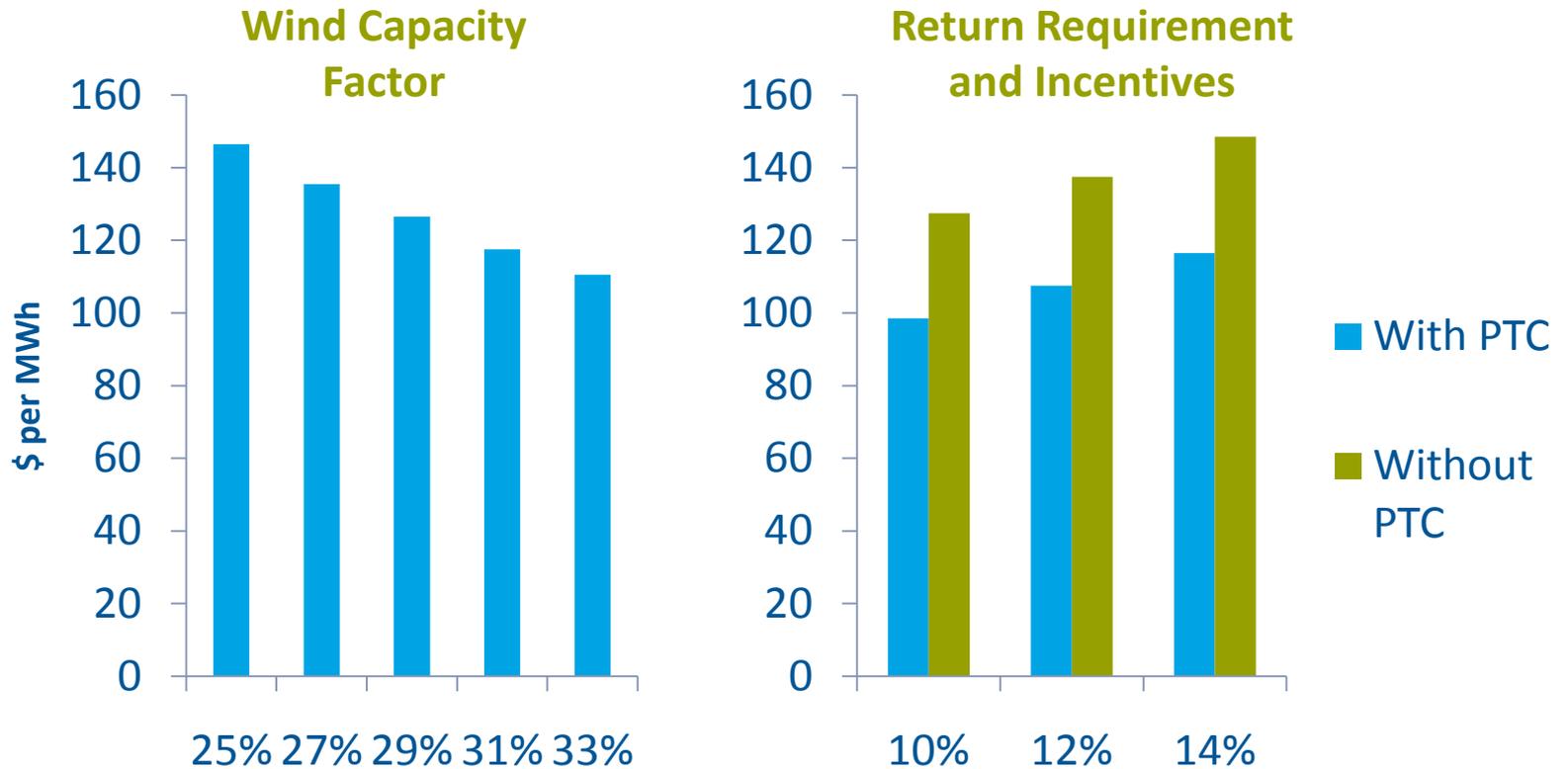
LEVELIZED COST OF ENERGY

- Convert stream of annual costs/benefits to a fixed unit cost or equivalent revenue requirement (kWh or MWh)



Unit costs allow comparison of different types of resources

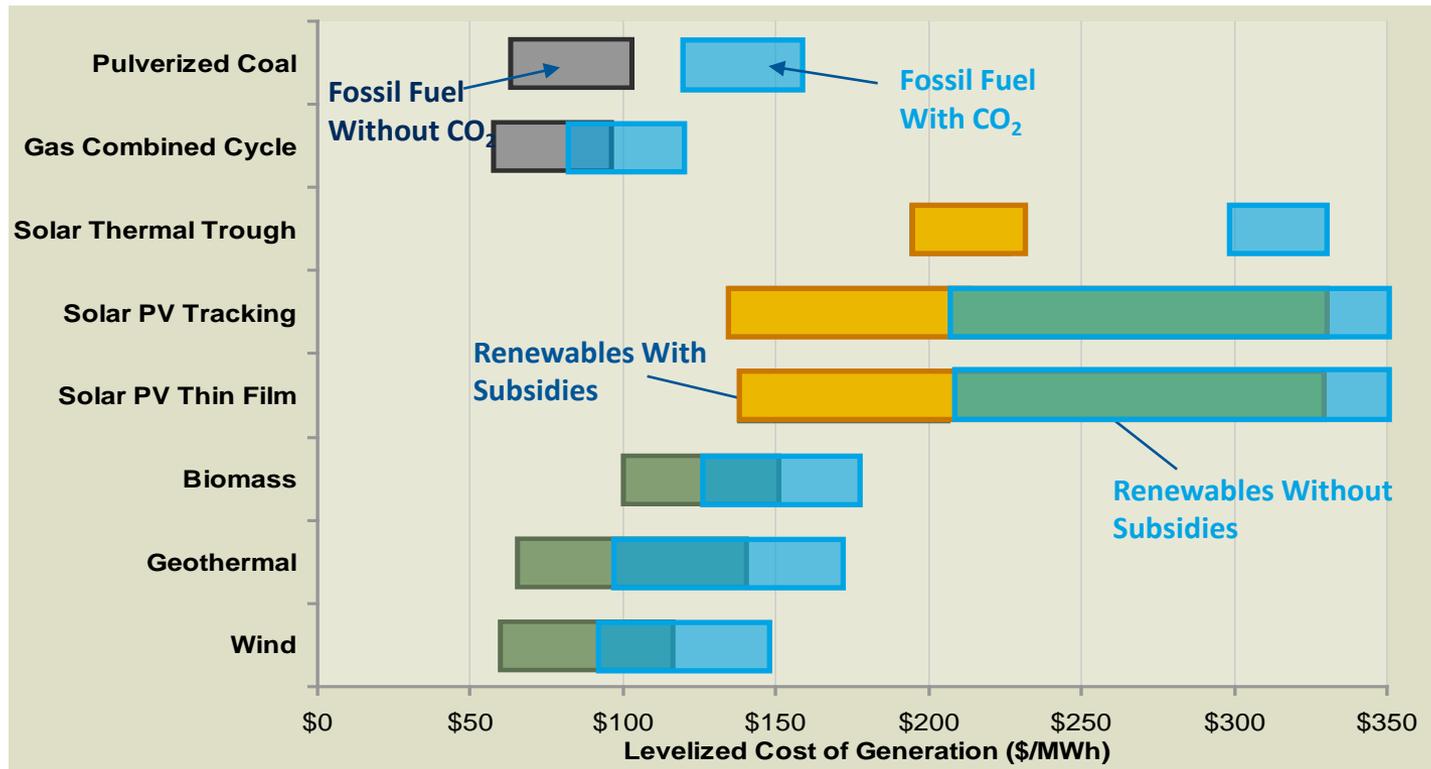
HOW LCOE CHANGES WITH PROJECT INPUTS



LCOE is highly dependent on project characteristics



LCOE OF RENEWABLE ENERGY RESOURCES AND CONVENTIONAL

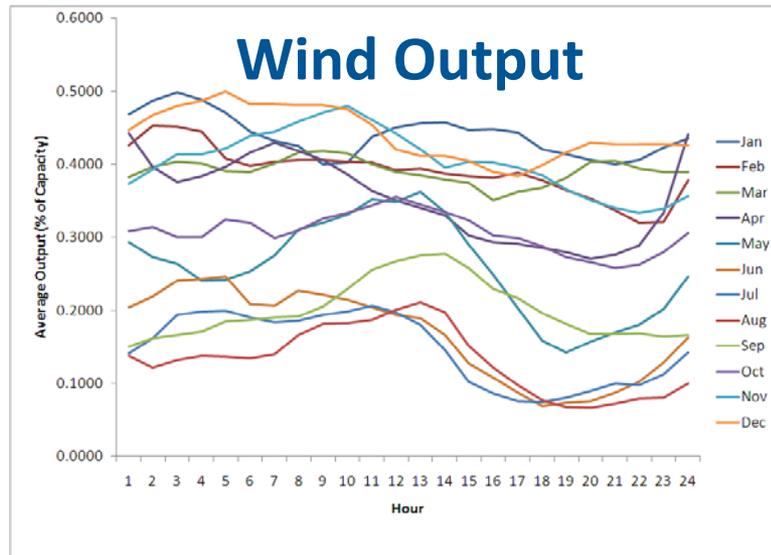


Low values for fossil cost estimates. Natural Gas = \$5/MBtu; Coal = \$2/MBtu. Higher values for fossil cost estimate. Natural Gas = \$8/MBtu; Coal = \$2/MBtu. CO2 assumes \$60/ton.

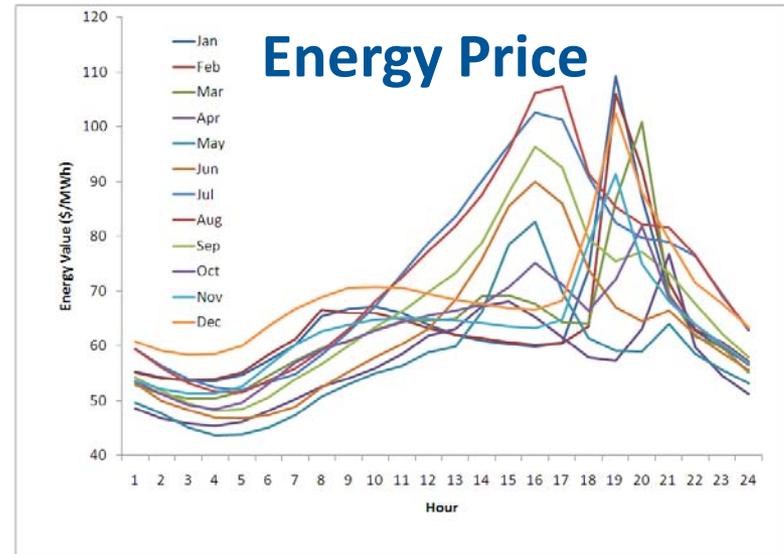
Range in LCOE of generation due to variations in cost components



UNDERLYING ENERGY VALUE



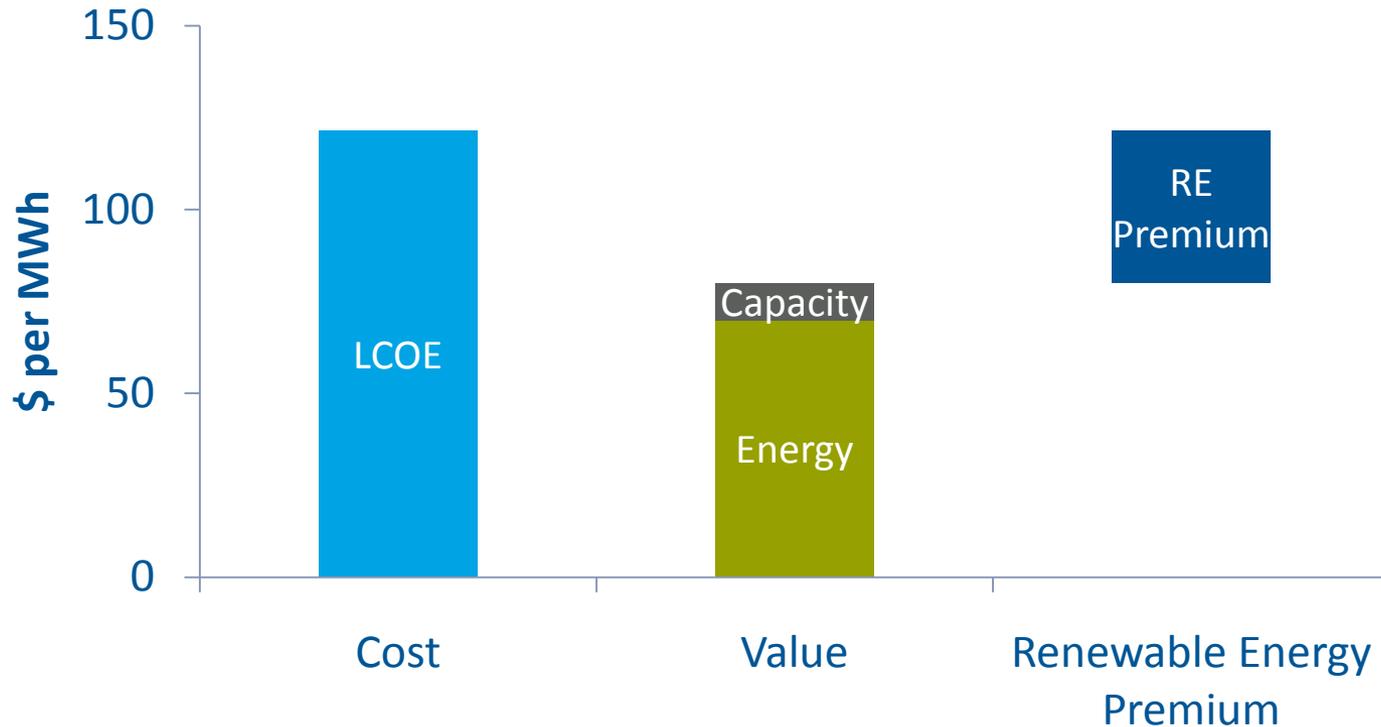
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Output Weighted Energy Value

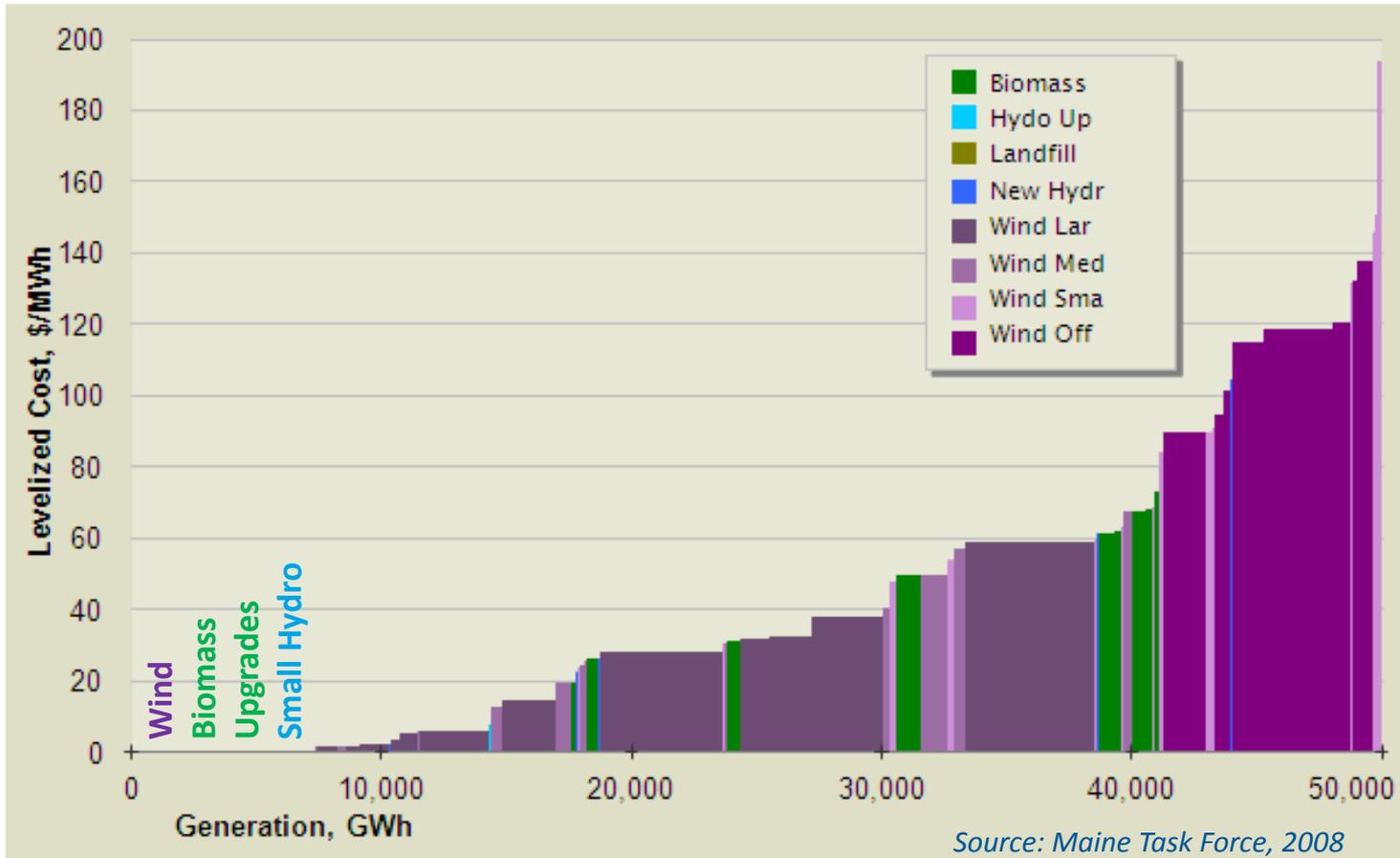
Capacity value is another value component that is also calculated based on time of output

RENEWABLE ENERGY PREMIUM



Renewable Energy Premium is the difference between LCOE and underlying energy/capacity value

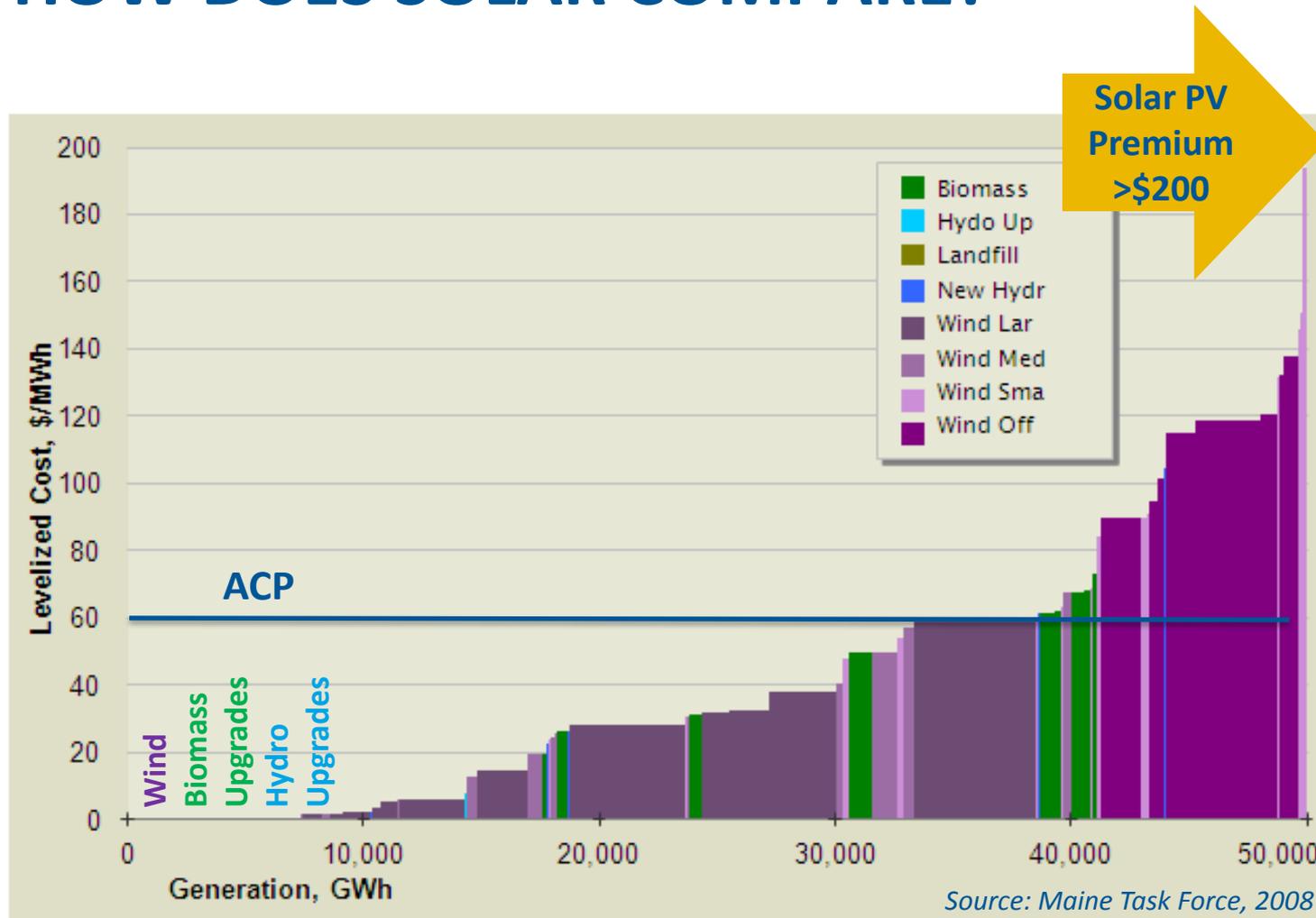
RENEWABLE ENERGY PREMIUM SUPPLY CURVE WITH PTC IN NEW ENGLAND



Supply curve is predominantly wind

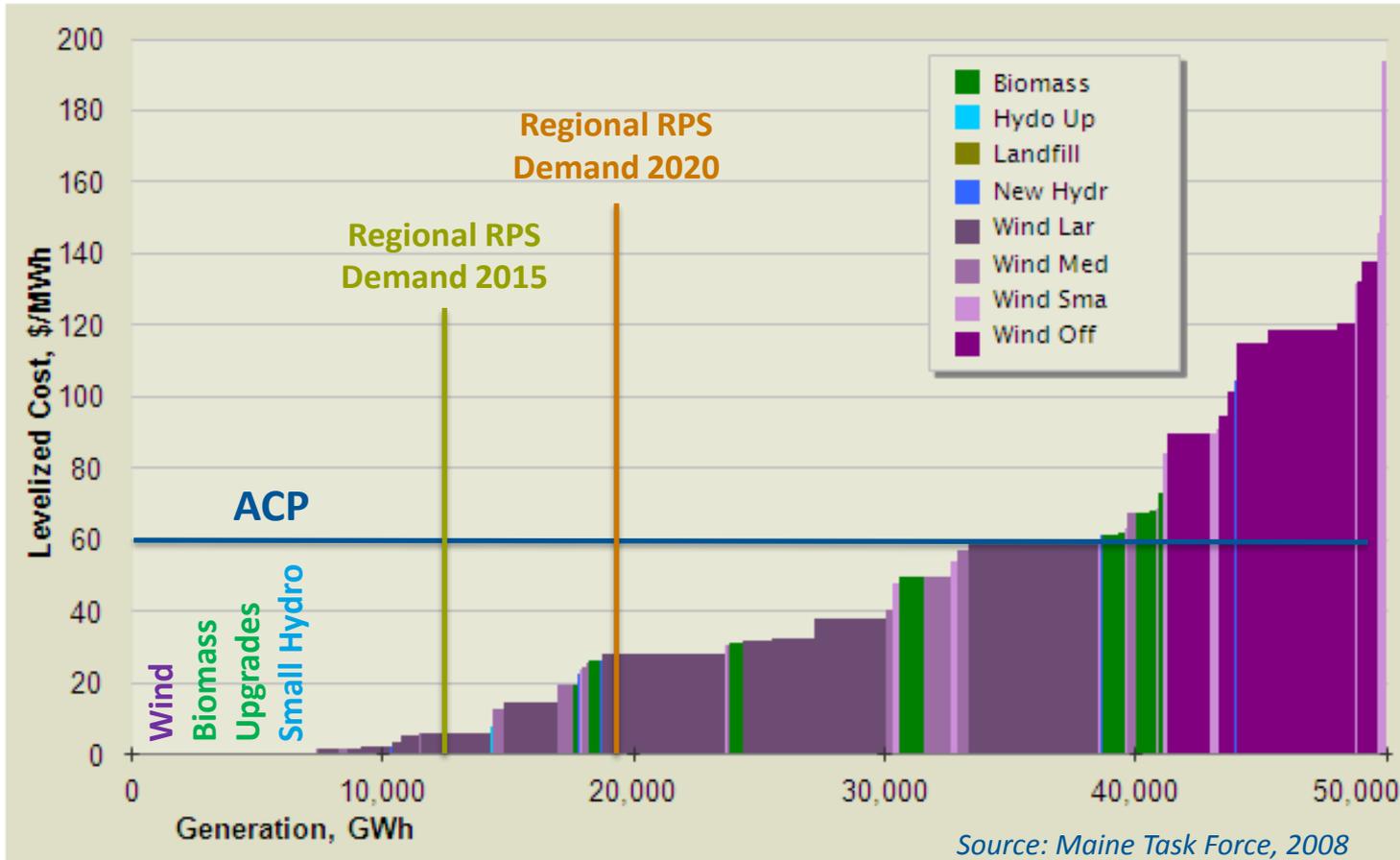


HOW DOES SOLAR COMPARE?



Range depends on behind the meter or large-utility scale, but premium still higher than offshore wind

GETTING TO THE RPS TARGET



Much of onshore wind is needed to meet future RPS demand

REALITY CHECK FOR REAL WORLD PROJECTS

- Supply curve used a set of common assumptions for similar resources.
- In reality, LCOE can vary depending on the specifics of a project...
 - Energy production is highly site specific
 - Capital costs benefit from scale economies
 - Fixed costs benefit from scale economies
 - Federal tax incentives set to expire
 - Financing costs (debt and equity) depends on availability
 - Access to transmission

All of these factors drive projects to optimize for performance, size, and timing.

THANK YOU!

MON-FEN HONG
HONGM@BV.COM



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Together



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