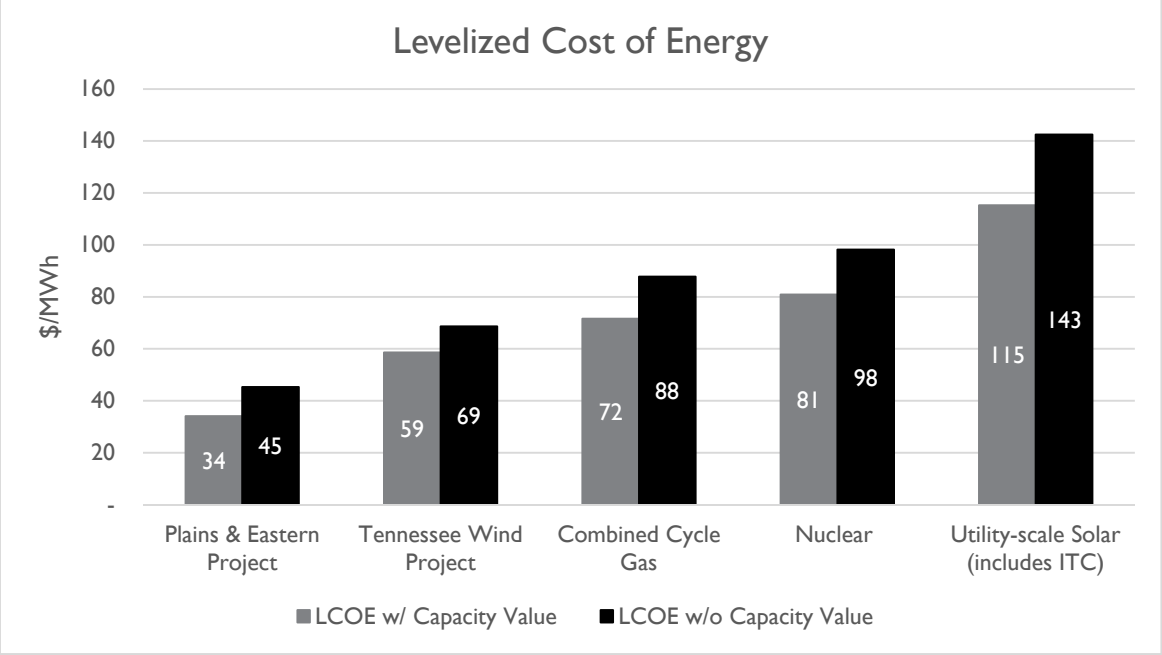
Summary

The levelized cost of energy ("LCOE") calculation is used in the electric power industry to rigorously compare different ways of sourcing electricity. It takes into account all costs of generating electricity, including capital costs, operating expenses, taxes, the cost of debt, the return on equity, any available subsidies, and necessary transmission additions. The LCOE analysis produces a levelized cost per unit of energy that is a proxy for a power purchase agreement that a utility would sign. The price of the power purchase agreement, as estimated by the LCOE model, is sufficient for the owner of generation and transmission facilities to recover all the costs associated with the facilities and earn a market rate of return.

The LCOE analysis indicates that wind energy delivered by the Project is the lowest-cost way to provide new energy to sources to the region. The base case results are shown in the graph below:



Two different levelized cost calculations are shown above. The black bars reflect just the cost of generating energy. They do not account for the differing capacity value of generation technologies, that is, their ability to run reliably to meet peak demand, which will be a significant component of their value to the bulk electric system. The gray bars, on the other hand show the results for each kind of generator incorporating an appropriate capacity value. Even when capacity value is included in the model, the wind energy delivered over the Project remains the lowest cost option even considering this effect.

In addition to the base case results, Clean Line has conducted a sensitivity analysis varying five of the base case input assumptions. The sensitivities calculate the LCOE 1) with or without the PTC; 2) varying the carbon price (a scenario considering no future carbon price, a base and a high carbon price scenario); 3) varying the natural gas price projection; 4) varying the Oklahoma wind capacity factor; and 5) varying the Tennessee wind capacity factor. 162 different scenarios were analyzed. The Plains & Eastern Project's delivered cost is the lowest of all alternatives in 83% of all scenarios. It is lower than Nuclear, Solar, and Tennessee wind in every scenario and is cheaper than Gas in 83% of these scenarios. General assumptions and sensitivities are described in more detail below.

General inputs and assumptions

- Shared Inputs
  - Annual Inflation – 2.5%
  - Corporate tax rate – 35%
  - Debt – 50%
  - Cost of debt – 5.5%
  - Equity – 50%
  - Cost of equity – 12%
  - Capacity value – 95,659 $/MW-yr (Projected annual revenue requirement for combustion turbines in $/MW-yr, EIA AEO2013 forecast)
  - Regional cost adjustments for non-wind generation
    - OK in SPP South (SPSO) (EIA AEO2013)
    - TN in SERC Central (SRCE) (EIA AEO2013)
  - Property tax rate
    - OK – 6.14% (Average of counties in the Oklahoma Panhandle: http://www.tax.ok.gov/advform/2012StatBook.pdf)
    - TN – 3.196% (Average of all counties: https://www.comptroller.tn.gov/pa/LR.asp?W=13)
  - Assessment on commercial property
    - OK – 13% (Average of counties in the Oklahoma Panhandle: http://www.tax.ok.gov/advform/2012StatBook.pdf)
    - TN – 40% (https://www.comptroller.tn.gov/pa/paavt.asp)
- Input Sensitivities (base case)
  - PTC value – 23 $/MWh (IRS Section 45)
  - Carbon dioxide price – 15 $/ton in 2020 to 60 $/ton in 2040 (Synapse Report)
  - Natural gas price – 5.68 $/Mcf in 2018 to 13.82 $/Mcf in 2040 (EIA AEO2014)
  - OK wind capacity factor – 53%
  - TN wind capacity factor – 30% (High estimate from http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=tn)
  - OK wind capacity credit – 34.2% (P75 of yearly average capacity factors of top 20 peak load hours at TVA from 1998-2012, after losses)
  - TN wind capacity credit – 19.3% (Capacity credit of OK wind scaled by capacity factor ratio between OK and TN)

Assumptions on alternatives

- Plains & Eastern line
  - Electric losses – 5%
  - Transmission charge – 8.00 $/kW-mo
- Oklahoma wind
  - Utilization rate – see OK wind capacity factor above
  - Capital cost – 1.75 $mm/MW (includes regional cost adjustments according to LBL Wind Report)
  - O&M – 7.5 $/MWh (LBL Wind Report) with 1% escalation
  - Tax depreciation – 5-years MACRS

  - Useful life – 25 years
  - Property depreciation – straight line over lifetime to 20% residual value (12 years for nacelle, at 47% of capital costs: http://www.tax.ok.gov/advform/2014BusinessPersonalProperty-Final.pdf Pg. 152)
  - Property tax exemption for wind generators – first 5 years (OK Statute 68-2902-C-7: http://www.tax.ok.gov/advform/Laws%202010.pdf)
- Tennessee wind
  - Utilization rate – see TN wind capacity factor above
  - Capital cost – 2.2 $mm/MW (includes regional cost adjustments according to LBL Wind Report)
  - O&M – 7.5 $/MWh (LBL Wind Report) with 1% escalation
  - Tax depreciation – 5-years MACRS
  - Useful life – 25 years
  - Property depreciation – straight line over lifetime to 20% residual value
  - Property assessment – 33% (Tennessee House Bill 62: http://www.capitol.tn.gov/Bills/108/Bill/HB0062.pdf)
  - TOD adjustment – 106% (Tennessee EWITS data compared with OK wind, calculated from simulated hourly LMPs at P&E Shelby drop-off point and wind profile provided by DNV GL)
- Combined Cycle Gas
  - Utilization rate – 87% (EIA AEO2013)
  - Capital cost – 1.006 $mm/MW (EIA AEO2013)
  - Fixed O&M – 15.1 $/kW (EIA AEO2013)
  - Variable O&M – 3.21 $/MWh (EIA AEO2013)
  - Heat rate – 6,333 Btu/kWh (EIA AEO2013)
  - Carbon intensity – 0.053 tons/mmBtu
  - Tax depreciation – 15-years MACRS
  - Useful life – 30 years
  - Property depreciation – straight line over lifetime to 20% residual value
  - Capacity credit – 76% [0-100 MW], 87% [100-200 MW], 91% [200-300 MW], 93% [300-400 MW] (1-EFOR, or Equivalent Forced Outage Rate: Generating Availability Data System)
  - TOD adjustment – 112% (Assumed constant generation compared with OK wind, calculated from simulated hourly LMPs at P&E Shelby drop-off point and wind profile provided by DNV GL)
- Nuclear
  - Utilization rate – 90% (EIA AEO2013)
  - Capital cost – 5.429 $mm/MW (EIA AEO2013)
  - Fixed O&M – 91.65 $/kW (EIA AEO2013)
  - Variable O&M – 2.1 $/MWh (EIA AEO2013)
  - Average fuel cost (including waste management) – 7.5 $/MWh (NEI: http://www.nei.org/Knowledge-Center/Nuclear-Statistics/Costs-Fuel,-Operation,-Waste-Disposal-Life-Cycle)
  - Tax depreciation – 15-years MACRS
  - Useful life – 40 years
  - Property depreciation – straight line over lifetime to 20% residual value

  - Capacity credit – 98% [<800 MW] (1-EFOR, or Equivalent Forced Outage Rate: Generating Availability Data System)
  - Nuclear PTC value – 18 $/MWh (Energy Policy Act of 2005, Section 45J: http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf)
  - TOD adjustment – 112% (Assumed constant generation compared with OK wind, calculated from simulated hourly LMPs at P&E Shelby drop-off point and wind profile provided by DNV GL)
- Utility-scale Solar
  - Utilization rate – 19.4% (PV generation obtained using NREL PV-Watts for Memphis, TN http://rredc.nrel.gov/solar/calculators/pvwatts/version1/)
  - Capital cost – 3.805 $mm/MW (EIA AEO2013)
  - Fixed O&M – 21.37 $/kW (EIA AEO2013)
  - Variable O&M – 0 $/MWh (EIA AEO2013)
  - Investment tax credit – 30% of capital costs
  - Tax depreciation – 5-years MACRS
  - Useful life – 25 years
  - Property depreciation – straight line over lifetime to 20% residual value
  - Property assessment – 12.5% (Tennessee House Bill 62: http://www.capitol.tn.gov/Bills/108/Bill/HB0062.pdf)
  - Capacity credit – 40% (Assumed 2-axis tracking and 10% penetration levels in TN, NREL: http://www.nrel.gov/docs/fy06osti/40068.pdf)
  - TOD adjustment – 125% (PV generation obtained using NREL PV-Watts for Memphis, TN http://rredc.nrel.gov/solar/calculators/pvwatts/version1/ and is compared with OK wind, calculated from simulated hourly LMPs at P&E Shelby drop-off point and wind profile provided by DNV GL)

Input sensitivities and assumptions

- Input Sensitivities
  - PTC: [0, 23] $/MWh
  - Carbon dioxide price: [none, base, high]
    - None – no carbon costs in the future
    - Base – 15 $/ton in 2020 to 60 $/ton in 2040 and continued growth
    - High – 25 $/ton in 2020 to 90 $/ton in 2040 and continued growth
  - Natural gas price: [80, 100, 120]% of EIA AEO2014 projections
  - OK wind capacity factor: [50, 53, 56]%
  - TN wind capacity factor: [25, 30, 35]%

Variable Inputs	Low	Med	High
PTC Value ($/MWh)	0	X	23
Carbon Dioxide Price (Scenario)	None	Base	High
Natural Gas Price (% of EIA forecast)	80	100	120
OK Wind Capacity Factor (%)	50	53	56
TN Wind Capacity Factor (%)	25	30	35

$2*3^4=162$ scenarios considered

References

EIA AEO2013 – *Annual Energy Outlook 2013: Electricity Market Module.* (EIA) http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf

EIA AEO2013 forecast – *Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013*. (EIA) http://www.eia.gov/forecasts/aeo/er/pdf/electricity_generation.pdf.

EIA AEO2014 – *Annual Energy Outlook 2014 Early Release.* (EIA) http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2014).pdf

LBL Wind Report – *Wind Technologies Market Report 2012.* (LBL) http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf

Synapse Report – *2013 Carbon Dioxide Price Forecast.* (Synapse) http://www.synapse-energy.com/Downloads/SynapseReport.2013-11.0.2013-Carbon-Forecast.13-098.pdf