

## DRAFT Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions

December 8, 2014

The Center for Energy, Economic, and Environmental Policy (CEEPP) is requesting comments on the key avoided cost assumptions for the energy efficiency cost-benefit analysis discussed below. Please send any comments or questions to Frank Felder at [ffelder@ejb.rutgers.edu](mailto:ffelder@ejb.rutgers.edu) by January 8, 2015. The data sources and processes for determining these components are also discussed. All assumptions have been derived from independent and publicly available sources in order to be transparent. For previously used avoided cost assumptions please visit <http://ceeep.rutgers.edu/publications/>.

### I. Electricity Prices

**Table 1: Retail and Wholesale Electricity Prices**

	Retail (\$/kWh)		Wholesale (\$/MWh)				
	Residential	Commercial & Industrial	Average Price	Summer Peak	Summer Off-Peak	Non-Summer Peak	Non-Summer Off-Peak
2013	\$0.17	\$0.14	\$40.81	\$52.17	\$33.50	\$47.49	\$36.82
2014	\$0.17	\$0.14	\$41.74	\$53.36	\$34.27	\$48.57	\$37.66
2015	\$0.17	\$0.14	\$42.69	\$54.57	\$35.05	\$49.67	\$38.51
2016	\$0.18	\$0.14	\$41.52	\$53.08	\$34.09	\$48.31	\$37.46
2017	\$0.18	\$0.15	\$42.97	\$54.93	\$35.27	\$50.00	\$38.77
2018	\$0.18	\$0.15	\$43.18	\$55.20	\$35.45	\$50.24	\$38.96
2019	\$0.19	\$0.15	\$45.24	\$57.83	\$37.14	\$52.64	\$40.82
2020	\$0.19	\$0.16	\$46.03	\$58.85	\$37.79	\$53.56	\$41.53
2021	\$0.19	\$0.16	\$49.55	\$63.34	\$40.68	\$57.66	\$44.71
2022	\$0.19	\$0.16	\$51.30	\$65.58	\$42.11	\$59.69	\$46.28
2023	\$0.20	\$0.16	\$53.34	\$68.19	\$43.79	\$62.07	\$48.13
2024	\$0.20	\$0.17	\$56.46	\$72.17	\$46.35	\$65.69	\$50.94
2025	\$0.21	\$0.17	\$58.50	\$74.78	\$48.03	\$68.07	\$52.78
2026	\$0.22	\$0.17	\$60.58	\$77.44	\$49.74	\$70.49	\$54.66
2027	\$0.22	\$0.17	\$63.07	\$80.63	\$51.78	\$73.39	\$56.91
2028	\$0.23	\$0.18	\$65.38	\$83.59	\$53.68	\$76.08	\$58.99
2029	\$0.23	\$0.18	\$67.08	\$85.75	\$55.07	\$78.05	\$60.52
2030	\$0.24	\$0.19	\$69.30	\$88.59	\$56.89	\$80.64	\$62.53
2031	\$0.25	\$0.19	\$71.42	\$91.30	\$58.63	\$83.10	\$64.44
2032	\$0.25	\$0.19	\$74.16	\$94.81	\$60.89	\$86.29	\$66.91
2033	\$0.26	\$0.20	\$76.21	\$97.43	\$62.57	\$88.68	\$68.76
2034	\$0.26	\$0.21	\$78.32	\$100.12	\$64.30	\$91.13	\$70.66
2035	\$0.27	\$0.22	\$80.70	\$103.17	\$66.25	\$93.90	\$72.81
2036	\$0.28	\$0.22	\$84.04	\$107.43	\$68.99	\$97.78	\$75.82
2037	\$0.29	\$0.23	\$88.83	\$113.56	\$72.93	\$103.37	\$80.15

**Retail Electricity Prices:** Historic 2013 U.S. Energy Information Administration (EIA) New Jersey retail electricity prices were escalated using an annual price growth rate derived from the EIA Annual Energy Outlook 2014 for the Mid-Atlantic region. On average, the annual growth rate was about 2.2%. The NJ Clean Energy Programs do not distinguish between commercial and industrial sectors, therefore the commercial and industrial prices were averaged based on historic 2013 New Jersey retail electricity sales. Retail electricity prices reported to EIA include the Societal Benefits Charge (SBC)<sup>1</sup>, but not the 7% Sales and Use Tax, which CEEEP added.

**Wholesale Electricity Prices:** Historic 2013 New Jersey wholesale electric prices from PJM were escalated based on the annual percent change in the EIA 2014 Annual Energy Outlook Reliability First Corporation/East Electricity Generation Prices. The annual percent change was, on average, about 2.8%. The seasonal peak and off-peak factors were derived using historic 2013 PJM LMP data. Summer is defined as May through September, winter is defined as October through April, on-peak is defined as Monday through Friday 8am-8pm (HB), and off-peak is defined as Monday-Friday 8pm-8am (HB) and weekends and holidays.

## II. Natural Gas Prices

**Retail Natural Gas Prices:** Historic 2013 EIA New Jersey retail natural gas prices were escalated using an annual growth rate derived from the Mid-Atlantic Region EIA Annual Energy Outlook 2014 natural gas price forecasts. On average, the annual growth rate was about 3.2%. The residential natural gas price for April 2013 was missing from the EIA data, so the average of March and May 2013 was used. For industrial natural gas price, January 2013 data was missing, so the average of December 2012 and February 2013 was used. Retail natural gas prices reported to EIA include the Societal Benefits Charge (SBC)<sup>2</sup>, but not the 7% Sales and Use Tax, which CEEEP added.

**Wholesale (Henry Hub) Natural Gas Prices:** Wholesale natural gas prices are taken from the EIA Annual Energy Outlook 2014. The winter and summer prices were derived from the 1994 to 2013 historic average ratio of summer and winter prices to Henry Hub. The summer average ratio was 96.8% and the winter average ratio was 103.2%.

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<sup>1</sup> The Societal Benefits Charge for electric customers of 3.6% for residential and 4.8% for C&I is included in the retail prices reported to EIA by the utilities.

<sup>2</sup> The Societal Benefits Charge for natural gas customers of 4.1% for residential and 5.0% for C&I is included in the retail prices.

**Table 2: Retail and Wholesale Natural Gas Prices (\$/MMBTu)**

	Retail Prices			Henry Hub Wholesale Prices		
	Residential	Commercial	Industrial	Average Price	Summer	Winter
2013	\$12.23	\$9.91	\$8.78	\$3.66	\$3.54	\$3.77
2014	\$12.23	\$9.77	\$8.68	\$3.86	\$3.74	\$3.99
2015	\$12.23	\$9.75	\$8.84	\$3.93	\$3.80	\$4.06
2016	\$12.88	\$10.34	\$9.51	\$4.41	\$4.27	\$4.55
2017	\$13.32	\$10.69	\$9.84	\$4.76	\$4.61	\$4.91
2018	\$13.91	\$11.19	\$10.39	\$5.27	\$5.10	\$5.44
2019	\$14.32	\$11.51	\$10.70	\$5.19	\$5.03	\$5.36
2020	\$14.73	\$11.82	\$11.01	\$4.96	\$4.80	\$5.12
2021	\$15.12	\$12.10	\$11.27	\$5.37	\$5.20	\$5.55
2022	\$15.66	\$12.54	\$11.75	\$5.64	\$5.46	\$5.83
2023	\$16.17	\$12.95	\$12.18	\$5.90	\$5.71	\$6.09
2024	\$16.65	\$13.33	\$12.58	\$6.20	\$6.00	\$6.40
2025	\$17.09	\$13.65	\$12.90	\$6.45	\$6.24	\$6.66
2026	\$17.76	\$14.22	\$13.55	\$6.72	\$6.50	\$6.93
2027	\$18.18	\$14.50	\$13.82	\$7.00	\$6.77	\$7.22
2028	\$18.71	\$14.91	\$14.23	\$7.26	\$7.02	\$7.49
2029	\$19.25	\$15.31	\$14.65	\$7.63	\$7.39	\$7.88
2030	\$19.79	\$15.71	\$15.06	\$8.12	\$7.86	\$8.39
2031	\$20.42	\$16.21	\$15.60	\$8.47	\$8.19	\$8.74
2032	\$21.00	\$16.64	\$16.03	\$8.91	\$8.62	\$9.19
2033	\$21.65	\$17.14	\$16.56	\$9.41	\$9.11	\$9.72
2034	\$22.43	\$17.78	\$17.26	\$9.83	\$9.51	\$10.15
2035	\$23.25	\$18.45	\$17.99	\$10.31	\$9.98	\$10.65
2036	\$24.25	\$19.32	\$18.98	\$10.93	\$10.58	\$11.28
2037	\$25.09	\$20.01	\$19.72	\$11.23	\$10.87	\$11.60

### III. Environmental Externalities

**Environmental Externality Benefits:** Avoided emission savings are calculated by multiplying the emission permit prices by the energy savings. CEEEP is currently researching reputable sources for determining a value for avoided mercury emissions.

**Forecasted Carbon Dioxide (CO<sub>2</sub>) Social Cost:** Values for the Social Cost of Carbon were taken from the U.S. Government Interagency Working Group on Social Cost of Carbon<sup>3</sup>. Values were reported in 2007\$/metric ton, and were converted to nominal dollars using the EIA projected U.S. GDP Price Index<sup>4</sup>. The study presented three values for the social cost of carbon, using a discount rate of 2.5%, 3%, and 5%. The scenario using a discount rate of 3% is presented here.

<sup>3</sup> Interagency Working Group on Social Cost of Carbon, “Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866”, United States Government, May 2013.

<sup>4</sup> EIA Annual Energy Outlook 2014. 2005=1.0

**Table 3: Social Cost of Carbon (Nominal \$/metric ton) and U.S. GDP Chain-type Price Index**

	<b>Social Cost of CO<sub>2</sub></b>	<b>GDP Chain-type Price Index</b>
<b>2013</b>	\$39.69	1.17
<b>2014</b>	\$41.53	1.19
<b>2015</b>	\$43.32	1.21
<b>2016</b>	\$45.14	1.23
<b>2017</b>	\$46.98	1.25
<b>2018</b>	\$48.89	1.27
<b>2019</b>	\$50.86	1.29
<b>2020</b>	\$52.90	1.31
<b>2021</b>	\$55.02	1.33
<b>2022</b>	\$57.21	1.35
<b>2023</b>	\$59.48	1.37
<b>2024</b>	\$61.82	1.40
<b>2025</b>	\$64.22	1.42
<b>2026</b>	\$66.70	1.45
<b>2027</b>	\$67.86	1.47
<b>2028</b>	\$70.48	1.50
<b>2029</b>	\$73.20	1.52
<b>2030</b>	\$76.04	1.55
<b>2031</b>	\$79.04	1.58
<b>2032</b>	\$82.14	1.62
<b>2033</b>	\$85.38	1.65
<b>2034</b>	\$88.74	1.68
<b>2035</b>	\$92.22	1.72
<b>2036</b>	\$95.85	1.76
<b>2037</b>	\$99.60	1.79

**Historical Emissions Permit Price:** Historical emission permit prices for sulfur dioxide (SO<sub>2</sub>) and nitrogen oxide (NO<sub>x</sub>) in Table 4 were taken from the National Research Council’s 2010 study - Hidden Costs of Energy.<sup>5</sup> All emission permits are in \$/short ton.

**Table 4: Mean Damages per Short Ton of Criteria-Pollutant-Forming Emissions (2007 \$/short ton)**

<b>From Coal-fired Power Plants</b>	<b>Unit</b>	<b>2007 \$</b>
SO <sub>2</sub>	\$/Short Ton	5,800
NO <sub>x</sub>	\$/Short Ton	1,600
<b>From Gas-fired Power Plants</b>	<b>Unit</b>	<b>2007 \$</b>
SO <sub>2</sub>	\$/Short Ton	13,000
NO <sub>x</sub>	\$/Short Ton	2,200

<sup>5</sup> National Research Council. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*. Washington DC: The National Academies Press, 2010.

<http://www.aaec.arkansas.gov/Solutions/Documents/Hidden%20Costs%20of%20Energy%20Unpriced%20Consequences%20of%20Energy%20Production%20and%20Use.pdf>

#### IV. Other Assumptions

**Capacity Prices:** New Jersey Utility PJM Reliability Pricing Model (RPM) prices for the four electric utilities (AE, JCP&L, PSE&G and RECO) for 2010 to 2017 were weighted by each utility’s historic 2013 peak load<sup>6</sup> to estimate an average New Jersey capacity price. From 2018 to 2030, the capacity prices were escalated based on the EIA projected annual change in U.S. GDP Chain-type Price Index, which was reported in Table 3.

**Table 5: Capacity Price (\$/KW-year)**

	\$/kW- year
2013	\$75.38
2014	\$70.92
2015	\$59.41
2016	\$61.67
2017	\$62.12
2018	\$63.26
2019	\$64.44
2020	\$65.66
2021	\$66.92
2022	\$68.22
2023	\$69.57
2024	\$70.97
2025	\$72.36
2026	\$73.79
2027	\$75.27
2028	\$76.77
2029	\$78.36
2030	\$80.02
2031	\$81.79
2032	\$83.63
2033	\$85.55
2034	\$87.57
2035	\$89.64
2036	\$91.83
2037	\$94.05

**Discount Rate:** Discount rates are used to convert future economic values into present day dollars. A nominal discount rate of 8% is used<sup>7</sup>.

**Avoided Electric and Natural Gas Losses:** Avoided average electric transmission and distribution losses are assumed to be 7.6%<sup>8</sup> based on data calculations from EnerNOC Utility Solutions<sup>9</sup>. Avoided natural gas losses are assumed to be 1%<sup>10</sup> based on the 2014 New Jersey Protocols.

<sup>6</sup> PJM Reliability Pricing Model User Information. Base Residual Auction Results [www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx#Item01](http://www.pjm.com/markets-and-operations/rpm/rpm-auction-user-info.aspx#Item01); PJM. Historic Load Data.

<sup>7</sup> Levitan & Associates, Inc. Long-term Capacity Agreement Pilot Program (March 2011).

**Avoided Electric and Natural Gas Transmission and Distribution (T&D):** EnerNOC has recommended that CEEEP use an Avoided Electric T&D cost of \$30/kW-yr. Further research should be undertaken to develop an estimate of avoided T&D for New Jersey.

CEEEP is currently researching reputable sources for Avoided Natural Gas T&D costs.

**PJM Marginal Units:** Table 6 shows the type of fuel used by marginal resources in the PJM Real-Time Energy Market<sup>11</sup> in 2014.

**Table 6: 2014 (Jan-June) PJM Marginal Units**

Fuel Type	% on the Margin
Coal	47.59%
Gas	40.97%
Oil	5.73%
Wind	5.11%
Other	0.43%
Municipal Waste	0.01%

**Power Plant Emission Rates:** Power plant emission rates for CO<sub>2</sub>, NO<sub>x</sub>, and SO<sub>x</sub> are shown in Table 7. Emission rates are in pounds per MWh. CEEEP is currently researching externality values and emission rates for mercury.

**Table 7: Power Plant Emission Rates (lbs/MWh)**

	CO <sub>2</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Coal <sup>12</sup>	2,249	6	13
Natural Gas <sup>13</sup>	1,135	1.7	0.1
Oil <sup>14</sup>	1,672	4	12
Wind	0	0	0
Other	0	0	0
Municipal Waste <sup>15</sup>	2,988	5.4	0.8

CEEEP recognizes that there is a range of uncertainty associated with each of the avoided cost estimates given. These avoided cost estimates will be updated in summer 2015 when EIA and PJM data becomes available.

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<sup>8</sup> 10 year (2001-2010) Average: "New Jersey Supply and Disposition of Electricity"

<http://www.eia.gov/electricity/state/newjersey>

<sup>9</sup> EnerNOC Utility Solutions performed the calculations as part of the 2012 Energy Efficiency Market Potential Study for the New Jersey Clean Energy Program. The line losses are derived from EIA data referenced above.

<sup>10</sup> "New Jersey Clean Energy Program Protocols to Measure Resource Savings", updated March 17, 2014.

[http://njcleanenergy.com/files/file/Appeals/NJ%20Protocols%20Revisions%202013%20Update\\_04-16-2014\\_clean.pdf](http://njcleanenergy.com/files/file/Appeals/NJ%20Protocols%20Revisions%202013%20Update_04-16-2014_clean.pdf)

<sup>11</sup> PJM State of the Market – 2014, Section 3 – Energy Market, pg. 63.

<sup>12</sup> U.S. EPA, eGRID 2000.

<sup>13</sup> Ibid.

<sup>14</sup> Ibid.

<sup>15</sup> U.S. EPA, Compilation of Air Pollutant Emission Factors (AP-42).