



Estimating the Public Health Benefits of Energy Efficiency and Renewable Energy with EPA's Benefits per kWh Values



EPA has developed a set of values that help state and local government policymakers and other stakeholders estimate the monetized public health benefits of investments in energy efficiency and renewable energy (EE/RE) using methods consistent with those EPA uses for health benefits analyses at the federal level.¹ It's important to note that EPA is continually reviewing methods and assumptions for quantifying public health benefits. The values presented here and the associated documentation will be updated as appropriate to reflect any future changes in methods or assumptions.

When to use benefits-per-kWh screening values?

Benefits per kilowatt-hour (BPK) values are reasonable approximations of the health benefits of state EE/RE investments that can be used for preliminary analysis when comparing across state and local policy scenarios to indicate direction and relative magnitude.

Examples of analyses where it would be appropriate to use them include:

- Estimating the public health benefits of regional, state, or local-level investments in EE/RE projects, programs, and policies
- Understanding the cost-effectiveness of regional, state, or local-level EE projects, programs, and measures
- Incorporating health benefits in short-term regional, state, or local policy analyses and decision-making

When not to use benefits-per-kWh values?

BPK values are not a substitute for sophisticated analysis and should not be used to justify or inform federal regulatory decisions. They are based on data inputs, assumptions, and methods that approximate the dynamics of energy, environment, and health interactions and include uncertainties and limitations, as documented in the technical report.

Audience for BPK screening values

Stakeholders interested in approximating the outdoor air quality-related public health benefits from EE/RE, including:

- State and local energy, air quality, or public health agencies
- Public utility commissions
- Energy efficiency and renewable energy project developers
- Industry organization
- Nongovernmental organizations
- Other researchers

¹ For more information about the methods and assumptions used, see EPA's technical report, Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States, 2018: <https://www.epa.gov/statelocalenergy/public-health-benefits-kwh-energy-efficiency-and-renewable-energy-united-states>.

Benefits-per-kWh screening values

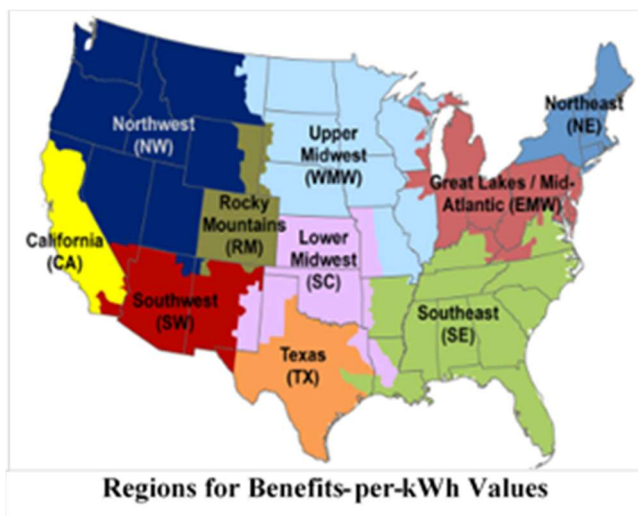
EPA used a peer reviewed methodology and tools to develop a set of screening-level regional estimates of the dollar benefits per kilowatt-hour from four different types of EE/RE initiatives.

- **Uniform Energy Efficiency** - Energy efficiency programs, projects, and measures that achieve a constant level of savings over time,
- **Peak Energy Efficiency** - Energy efficiency programs, projects, and measures that achieve savings during 12pm-6pm when energy demand is high (i.e. peak),
- **Solar Energy** – Programs, projects, and measures that increase the supply of solar energy available (e.g. utility-scale and rooftop solar generation), and
- **Wind Energy** – Programs, projects, and measures that increase the supply of wind available (e.g. wind turbines installed).

Understanding the Values

EPA created BPK values using existing tools, including EPA's AVOIDed Emissions and geneRation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool. BPK values are:

- Available for each of the four project types for each of the ten AVERT regions shown in the map below
- Based on 2017 electricity generation data and emissions, population, baseline mortality incidence rate, and income growth projections
- Presented in 2017 dollars and reflecting the use of either a 3% or a 7% discount rate as recommended by EPA's [Guidelines](#) for Preparing Economic Analyses (2010)
- Calculated using the same health impact functions EPA uses for regulatory impact analyses, including the calculation of low estimates of mortality using health impact functions that assume people are not very sensitive to changes in PM_{2.5} levels and high estimates of mortality using functions that assume people are more sensitive to changes in PM_{2.5}



How to use BPK values?

States and communities interested in screening-level estimates of outdoor air quality-related health impacts of energy efficiency or renewable energy can multiply the BPK values by the number of kWh saved from EE or generated from RE to estimate potential health benefits from projects in dollars saved. Users should note that EPA suggests that the values not be used to determine health benefits more than five years prior to or after 2017.

On the next page, we provide two examples of how to use the BPK values to estimate the benefits of a specific EE/RE project or policy.

For more information: See the technical documentation online or contact Emma Zinsmeister at zinsmeister.emma@epa.gov

Example: Benefits of Installing 10-MW of Solar Energy in North Carolina

To estimate the health benefits of 10-megawatt (MW) solar installation in North Carolina, you would use the BPK values for the Southeast and multiply them by the amount of electricity the project will generate. If you don't have project-level information about the amount electricity the project will generate, you can use a tool such as the National Renewable Energy Laboratory's (NREL) [PVWATTS Calculator](#), which estimates that a 10-MW solar project in North Carolina would generate approximately 13.9 million kWh per year. The estimated monetized health benefits of the project are calculated as shown below:

Type of BPK Value	BPK Value for the Southeast Region (¢/kWh)	Generation from Solar Project	Estimated Health Benefits
Low estimate, 3% discount rate	1.83	13.9 million kWh	\$254,370
High estimate, 3% discount rate	4.15		\$576,850
Low estimate, 7% discount rate	1.64		\$227,960
High estimate, 7% discount rate	3.70		\$514,300

According to Lazard's annual [Levelized Cost of Energy Analysis](#), the cost of utility solar in 2018 was 3.6–4.4 ¢/kWh. You can use these values to estimate the cost of the electricity generated by the installation—approximately \$500,400 to \$611,600. In comparing these costs with the estimated health benefits generated by the project, you can see that the health benefits could cover 45-94% of the cost of the electricity generation. Note that the BPK values do not include other pollution reduction benefits of EE/RE, such as reduced greenhouse gas emissions and reduced impacts to ecosystems.

Example: Benefits of Energy Efficiency in Illinois

According to the [U.S. Energy Information Administration](#), utility investments in EE programs in Illinois resulted in energy savings of approximately 3.2 billion kWh in 2017. However, Illinois is split across two AVERT regions—the Great Lakes/Mid-Atlantic and the Upper Midwest regions. If you don't know how much of the energy savings occurred in each region, you can estimate based on the portion of generation in each region. [AVERT's state apportionment by AVERT region table](#) shows that 39% of generation in Illinois is in the Great Lakes/Mid-Atlantic region and 61% is in the Upper Midwest region. To distribute the total state-level energy savings to the two regions, you can multiply it by the portion of generation in each region:

Region	Portion of Generation	Total Energy Savings in Illinois (kWh)	Energy Savings in Each Region (kWh)
Great Lakes / Mid-Atlantic	39%	3.2 billion	1.2 billion
Upper Midwest	61%		2.0 billion

You can then apply the BPK values for each region to estimate the health benefits in Illinois:

Type of BPK Value	Great Lakes/Mid-Atlantic			Upper Midwest			Total Health Benefits (Million \$)
	BPK Value (¢/kWh)	Energy Savings (kWh)	Health Benefits (Million \$)	BPK Value (¢/kWh)	Energy Savings (kWh)	Health Benefits (Million \$)	
Low estimate, 3%	3.57	1.2 billion kWh	42.8	2.75	2.0 billion kWh	55.0	97.8
High estimate, 3%	8.08		97.0	6.22		124.4	221.4
Low estimate, 7%	3.19		38.3	2.45		49.0	87.3
High estimate, 7%	7.21		86.5	5.55		111.0	197.5

According to the Energy Information Administration data, the incremental cost of the EE programs in Illinois in 2017 was approximately \$430 million. The estimated health benefits generated by the EE program would therefore cover 20-50% of the costs using both the low and high BPK values.

2017 Benefits-per-kWh Values (cents per kWh, 2017 USD)²

Region	Project Type	3% Discount Rate		7% Discount Rate	
		2017 ¢/kWh (low estimate)	2017 ¢/kWh (high estimate)	2017 ¢/kWh (low estimate)	2017 ¢/kWh (high estimate)
California	Uniform EE	0.48	1.08	0.42	0.96
	EE at Peak	0.52	1.17	0.46	1.04
	Solar	0.51	1.15	0.45	1.03
	Wind	0.48	1.09	0.43	0.97
Great Lakes/Mid-Atlantic	Uniform EE	3.51	7.95	3.14	7.09
	EE at Peak	3.57	8.08	3.19	7.21
	Solar	3.67	8.29	3.27	7.39
	Wind	3.35	7.59	2.99	6.77
Lower Midwest	Uniform EE	2.31	5.23	2.06	4.66
	EE at Peak	2.11	4.77	1.88	4.25
	Solar	2.19	4.96	1.96	4.42
	Wind	2.35	5.32	2.10	4.74
Northeast	Uniform EE	1.65	3.73	1.47	3.33
	EE at Peak	2.24	5.07	2.00	4.52
	Solar	1.94	4.38	1.73	3.91
	Wind	1.58	3.56	1.41	3.18
Pacific Northwest	Uniform EE	1.13	2.55	1.01	2.28
	EE at Peak	1.12	2.54	1.00	2.27
	Solar	1.17	2.64	1.04	2.35
	Wind	1.13	2.55	1.01	2.27
Rocky Mountains	Uniform EE	1.03	2.32	0.92	2.07
	EE at Peak	0.98	2.21	0.87	1.98
	Solar	0.99	2.25	0.89	2.01
	Wind	1.07	2.41	0.95	2.15
Southeast	Uniform EE	1.78	4.02	1.58	3.58
	EE at Peak	1.87	4.24	1.67	3.78
	Solar	1.83	4.15	1.64	3.70
	Wind	1.76	3.98	1.57	3.55
Southwest	Uniform EE	0.71	1.62	0.64	1.44
	EE at Peak	0.70	1.59	0.63	1.42
	Solar	0.73	1.64	0.65	1.46
	Wind	0.77	1.73	0.68	1.54
Texas	Uniform EE	1.58	3.58	1.41	3.19
	EE at Peak	1.39	3.13	1.24	2.80
	Solar	1.42	3.22	1.27	2.87
	Wind	1.63	3.69	1.45	3.29
Upper Midwest	Uniform EE	3.12	7.06	2.78	6.30
	EE at Peak	2.75	6.22	2.45	5.55
	Solar	2.89	6.53	2.58	5.83
	Wind	3.20	7.23	2.85	6.45

² In addition to using these regional values, users can also use EPA's [AVERT](#) and [COBRA](#) tools to develop more specific analyses, such as state- or county-level health benefits estimates. For more information on other more sophisticated options for modeling health benefits for or how to quantify the electricity impacts of energy efficiency and renewable energy, see the EPA report, *Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy: A Guide for State and Local Governments*.