REGULATORY ASSISTANCE PROJECT

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Health Benefits by the Kilowatt-Hour: Using EPA Data to Analyze the Cost-Effectiveness of Efficiency and Renewables

Nancy L. Seidman, John Shenot and Jim Lazar

Introduction[1]

We all have heard the expression, "There's no such thing as a free lunch," but what about free dessert? In the past, RAP has used a "layer cake" analogy to demonstrate how the multiple benefits of energy efficiency (EE) and renewable energy (RE) can stack up to create value for customers, utilities and society. Recent work by the U.S. Environmental Protection Agency (EPA) further demonstrates that we really can have our cake and eat it, too — because our metaphorical layer cake now includes newly quantified health benefits under its frosting. In this policy brief, we'll dive into the details of the EPA's benefits-per-kilowatt-hour (BPK) tool and discuss how it can be used to quantify the economic value of health care savings thanks to avoided emissions from EE and RE.

Energy planners and regulators have traditionally valued the health benefits of energy efficiency and renewable energy at zero — because these benefits do not flow to energy users in proportion to usage and because they had no simple and feasible way to estimate them. But just because the energy regulators have typically omitted health benefits from

[1] RAP gratefully acknowledges the technical review and support of the following in preparing this brief: the staff of the Office of Air Quality in the Arkansas Department of Energy and Environment, and David Tancabel, Colby Tucker and Emma Zinsmeister of the U.S. Environmental Protection Agency's State and Local Climate and Energy Program. The views set out in this publication are those of the authors. This brief also benefited from review by RAP's Ann McCabe and Donna Brutkoski. Ruth Hare and Kiera Manion-Fischer provided editorial assistance.

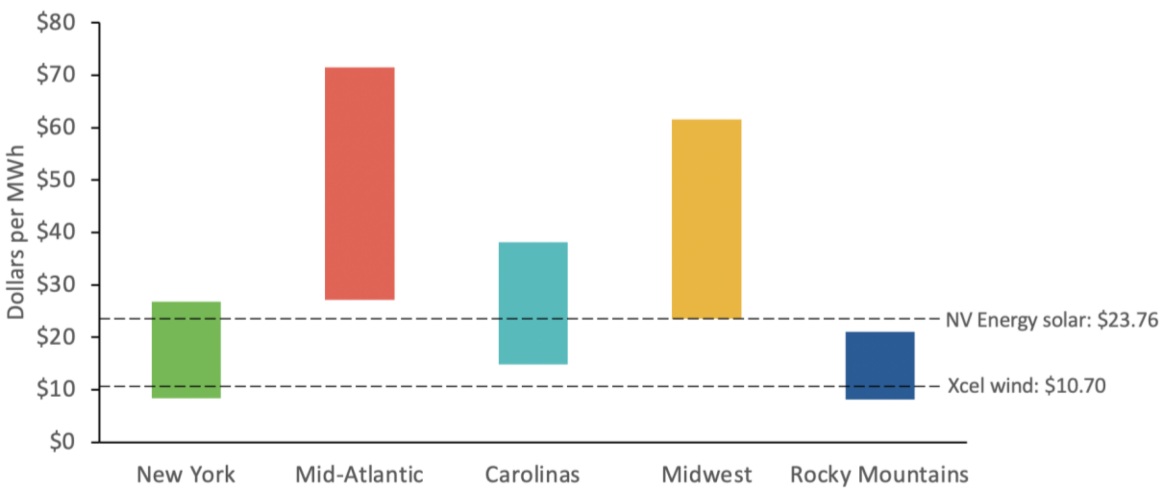
cost-benefit analysis doesn't mean they are not there. What it means is that information on the value of public health improvements is used by utility regulators and environmental regulators in distinctly different ways. And while the latter group of regulators have long made use of information about the costs and benefits of various energy sources to make air quality policies and plans, they too may find that a more specific value measurement will be useful for their work.

The EPA's BPK tool provides that measurement, with specific data for regions around the country. The EPA first published this groundbreaking analytic tool in 2019. BPK is now available in a second edition, with the data updated in spring 2021.[2]

The BPK tool contains regional estimates of the value in cents per kilowatt-hour (kWh) of the health benefits EE and RE provide.[3]

The results are quite dramatic. The health benefits alone for wind or solar may exceed the entire cost of these resources, while energy efficiency continues to show it should be the first fuel resource. For example, Figure 1 shows the extent of public health benefits the EPA identified for selected regions, compared with the amounts being paid by two utilities for new solar and wind resources in recent power purchase agreements.[4]

Figure 1. Select comparison of health benefits to cost of new solar and wind resources



Pricing sources: Bade, G. (2018, June 13). *NV Energy 2.3-Cent Solar Contract Could Set New Price Record*; Trabish, H. K. (2021, June 1). *Xcel's Record-Low-Price Procurement Highlights Benefits of All-Source Competitive Solicitations*

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2 U.S. Environmental Protection Agency. (2021a). *Estimating the health benefits per kilowatt-hour of energy efficiency and renewable energy*. https://www.epa.gov/statelocalenergy/estimating-health-benefits-kilowatt-hour-energy-efficiency-and-renewable-energy

3 These values come from the benefits of reducing criteria pollutants, particularly fine particles, and the associated costs for health impacts from those pollutants. Any values associated with ozone and carbon dioxide reductions are additional to the health effects quantified in the EPA tool.

4 Bade, G. (2018, June 13). *NV Energy 2.3-cent solar contract could set new price record*. Utility Dive. https://www.utilitydive.com/news/nv-energy-23-cent-solar-contract-could-set-new-price-record/525610/; Trabish, H. K. (2021, June 1). *Xcel's record-low-price procurement highlights benefits of all-source competitive solicitations*. Utility Dive. https://www.utilitydive.com/news/xcels-record-low-price-procurement-highlights-benefits-of-all-source-compe/600240/

In another example, a 2020 Maine procurement for utility-scale solar averaged $35 per MWh (or 3.5 cents per kWh).[5] This price was low for New England, though it looks high compared with the examples we cite for large western U.S. procurements. In addition, the New England BPK values are low due to the predominance of natural gas in the generation mix, ranging from 0.32 to 0.94 cents per kWh overall and 0.36 to 0.90 cents per kWh for utility-scale solar. We mention this example because New England, with relatively high electricity costs, still has health benefits that could account for more than a quarter of the cost per MWh of a new utility-scale solar deployment.

As we navigate the ongoing public health and economic challenges that began in 2020 and look to recovery this year and beyond, energy and environmental policymakers have a timely and urgent opportunity to use this data, wherever possible. States and utilities should include these values in evaluating the cost-effectiveness of their EE programs and measures and comparing the costs of new fossil fuel-fired generation to new renewable generation. And states and power plant owners can use them to review emissions control options for their required plans for meeting public health standards and reducing regional haze and the critical health impacts of fine airborne particles.

Energy and environmental policymakers and utilities have a timely and urgent opportunity to use this data to evaluate the cost-effectiveness of energy efficiency programs and to review emissions control options for air quality plans.

Over 30 years ago, the public health impacts of fine particles (frequently referred to as $PM_{2.5}$) were documented as causing premature mortality.[6] Reducing criteria pollutants, particularly fine particles, can reduce the incidence of premature mortality, heart attacks and asthma and other respiratory diseases. U.S. deaths from premature mortality caused by fine particle pollution are estimated at 100,000 people per year.[7] That makes the information the EPA has made available on health benefits of reducing fine particles critical for air and energy communities as they evaluate strategies for saving consumers money and improving their health, particularly in areas overburdened with fine particle levels.

This policy brief explains how the EPA developed the BPK values and how we suggest analysts and policymakers can use them — from air quality planning to energy efficiency programs and rate design. A first step is to make sure energy and environmental regulators are working together. We'll look at one state where that first step has already happened: Arkansas. The state provides a great model for collaboration across environmental and energy departments. For example, it has used EE to support its

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5 Foehringer Merchant, E. (2020, September 22). *Solar dominates Maine's largest renewables procurement on record*. Greentech Media. https://www.greentechmedia.com/articles/read/solar-dominates-maines-largest-renewables-procurement-on-record

6 Fine particles are emitted from power plants as nitrogen and sulfur oxides or directly as uncombusted or partially combusted fuel. $PM_{2.5}$ refers specifically to particles smaller than 2.5 microns; for comparison, the diameter of a human hair is around 50 microns.

7 Goodkind, A. L., Tessum, C. W., Coggins, J. S., Hill, J. D., & Marshall, J. D. (2019, April 30). Fine-scale damage estimates of particulate matter air pollution reveal opportunities for location-specific mitigation of emissions. *Proceedings of the National Academy of Sciences, 116*(18), 8775-8780. https://www.pnas.org/content/116/18/8775

compliance with a federal Clean Air Act mandate for improving visibility. We will demonstrate how Arkansas could use the BPK tool to account for the health benefits of its current and future EE efforts.

Description of the EPA Methodology

To determine the BPK values, the EPA assessed the impact that reducing fossil-fueled generation would have on criteria pollutants. The EPA then linked the criteria pollutant emissions reductions to health benefits and the resulting avoided costs associated with lost productivity, hospital admissions and other impacts. The methodology for determining the *annual* cents-per-kWh health benefits is based on the following steps:

1. Estimate changes in fossil fuel-based electricity generation due to representative EE/RE projects, programs and policies.

2. Estimate changes in air pollution emissions (NO_x, SO_2 and $PM_{2.5}$) due to changes in fossil fuel-based generation.

3. Estimate changes in ambient concentrations of air pollution due to changes in emissions.

4. Estimate changes in public health impacts due to changes in ambient concentrations of air pollution.

5. Estimate the monetary value of changes in public health impacts.

6. Divide the monetized public health benefits by the change in generation to determine the health benefits in cents per kWh.[8]

The annual health improvements measured are the result of reducing fine particles and their precursors emitted by fossil fuel combustion for electricity production. The EPA measures the health effects separately for four types of resources:

- Energy efficiency that is uniform across the year; for example, upgrades to commercial lighting.
- Energy efficiency concentrated during peak load periods; for example, measures to reduce water heater use during peak periods.
- Solar: utility scale and distributed.
- Wind: onshore and offshore.

The results provide low and high estimates[9] measured using 3% and 7% discount rates for future benefits. For example, Table 1 on the next page shows the complete results for the

[8] U.S. Environmental Protection Agency. (2021b). *Public health benefits per kWh of energy efficiency and renewable energy in the United States: A technical report* (2nd ed.). https://www.epa.gov/statelocalenergy/public-health-benefits-kwh-energy-efficiency-and-renewable-energy-united-states

[9] The EPA's low and high estimates are based on two separate sets of health impact functions that estimate the relationships between $PM_{2.5}$ exposure and different health outcomes, specifically adult mortality and nonfatal heart attacks.

California and mid-Atlantic regions in cents per kWh for the 3% discount rate.[10] In both locations, the high estimate for each strategy is more than twice the low estimate. With California's cleaner electricity mix, none of its values exceeds 1.7 cents per kWh, whereas the estimates for the mid-Atlantic region start at a level almost twice that of California, with the highest being over 7 cents per kWh. Both regions have densely populated areas affected by electricity generation.

Table 1. Sample values demonstrating breadth of benefits per kWh

		3% discount rate (2019 cents per kWh)	
Region	Project type	Low estimate	High estimate
California	Uniform energy efficiency	0.67	1.51
	Energy efficiency at peak	0.74	1.67
	Utility solar	0.65	1.47
	Distributed solar	0.64	1.44
	Onshore wind	0.63	1.41
	Offshore wind	0.67	1.50
Mid-Atlantic	Uniform energy efficiency	3.10	7.00
	Energy efficiency at peak	3.17	7.15
	Utility solar	3.10	7.00
	Distributed solar	3.09	6.98
	Onshore wind	3.04	6.85
	Offshore wind	3.05	6.88

Source: U.S. Environmental Protection Agency. (2021). *Estimating the Health Benefits per Kilowatt-Hour of Energy Efficiency and Renewable Energy*

The EPA's first order analysis combines the outputs of other tools it has developed — AVERT[11] and COBRA[12] — for power plant analysis in 14 regions across the United States. As Table 1 suggests, the health benefits vary dramatically by region, depending on two key factors: the types of power plants that will be displaced by energy efficiency and renewable energy, and the proximity of those power plants to population centers. The lowest impacts are in California and the Northwest, where coal is seldom the marginal generating resource and where high-emitting power plants are primarily located in remote areas away

[10] U.S. Environmental Protection Agency, 2021a.

[11] U.S. Environmental Protection Agency. (2021c). *AVoided Emissions and geneRation Tool (AVERT)*. https://www.epa.gov/avert

[12] U.S. Environmental Protection Agency. (2021d). *CO-Benefits Risk Assessment health impacts screening and mapping tool (COBRA).* https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool

from population centers. The highest impacts are in the mid-Atlantic, Midwest and Carolinas, where the opposite is true. The Appendix to this brief provides the full published EPA results.

Examples of BPK being cited or considered

- New Jersey utility regulators considered using BPK in a new cost test[13] when updating their energy efficiency program. Staff designed an initial New Jersey Cost Test using the state's "requirements to consider economic and environmental factors, ensure universal access to EE, and serve the needs of low-income communities." They sought input on the "estimation methods and values for avoided emissions" that were not included in past cost tests. However, in their final methodology they opted for adding an avoided carbon value instead of BPK values — though the two would not be mutually exclusive. One rationale was that the BPK values available from the EPA were regional rather than reflecting specific benefits in New Jersey.[14] The state's utility regulators may use this methodology in the future, and their consideration of the factors is still a significant advance for a state regulatory body.
- The Green Neighbor Challenge is a nongovernmental organization based in the Midwest dedicated to increasing the use of residential green energy by encouraging friends and neighbors and providing information on the cost and benefits of green energy. According to its website, "The Green Neighbor Challenge is a web tool and social media campaign to help anyone with a utility bill (including renters) find and sign up for green energy in the US. Together, we can create a cleaner future for all!" (https://www.greenneighborchallenge.com/). Using BPK values, the group calculated public health improvements of at least $953 million per year that can result if just 2% of U.S. homes switch to clean energy.[15] This example is an excellent way to demonstrate the power of BPK data to make citizens aware of how they can help improve air quality in their state.

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Health Effects as a Consideration in Utility Regulation

Utilities and utility regulators seldom consider health effects in a quantitative manner. Where these effects have been quantified and included in decision-making processes, however, health benefits have consistently been significant in value, enough to affect

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[13] New Jersey Board of Public Utilities. (2020). *New Jersey Cost Test proposal* [Draft for public comment]. https://www.nj.gov/bpu/pdf/NJ%20Cost%20Test%20Proposal.pdf

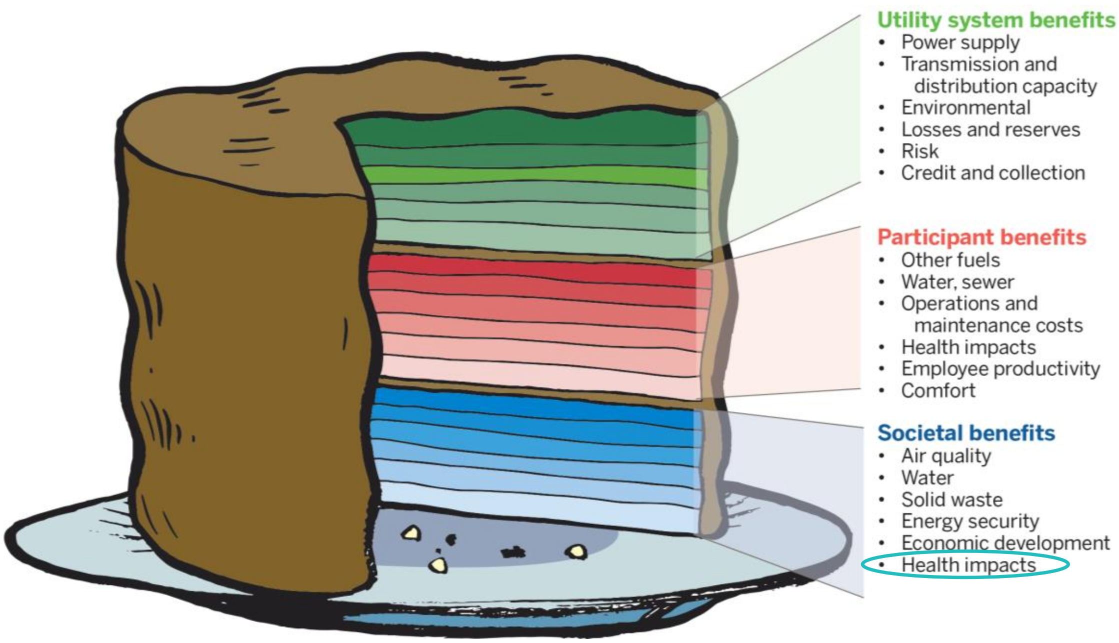
[14] New Jersey Board of Public Utilities, Docket Nos. QO19010040 and QO20060389, Order on Aug. 24, 2020, adopting the first New Jersey Cost Test. https://www.bpu.state.nj.us/bpu/pdf/boardorders/2020/20200824/8A%20-%20ORDER%20New%20Jersey%20Cost%20Test.pdf

[15] Green Neighbor Challenge. (n.d.) *Green Neighbor Challenge benefits.* https://www.greenneighborchallenge.com/wp-content/uploads/2020/08/GNC-Benefits-2.1.pdf

resource planning and power plant development decisions. Similar results can be expected if utilities and utility regulators fully internalize health effects in a broader range of decisions.

In 2013, RAP published a pathbreaking paper, *Recognizing the Full Value of Energy Efficiency*.[16] The paper is informally known as the "layer cake" because of a graphic showing the various benefits of EE as layers in a cake; two of these layers are health benefits for energy efficiency program participants and health benefits for society (see Figure 2). Analysts and EE program providers are making efforts to measure and use participant health benefits in energy planning.[17] And the EPA BPK tool provides important new data to use for societal health benefits. (The BPK values do not measure or quantify health benefits at the participant level and do not consider any benefits due to improvement in indoor air quality. For example, improved insulation can protect families from some of the health effects associated with extremely hot or cold weather, while also making their homes more energy efficient.)

Figure 2. A layer cake of benefits from electric energy efficiency



To utility regulators, public health benefits are non-energy benefits, often considered outside the scope or authority of utility regulators, but some circumstances might warrant the use of the EPA's BPK tool to include these benefits.

[16] Lazar, J., & Colburn, K. (2013). *Recognizing the full value of energy efficiency*. Regulatory Assistance Project. https://www.raponline.org/knowledge-center/recognizing-the-full-value-of-energy-efficiency/

[17] An example is the national Warm Up New Zealand: Heat Smart program to weatherize low-income households as an economic stimulus. The health benefits of weatherization were found to be three times as large as the direct economic benefits of energy savings. Residents of the treated homes had a 43% reduction in hospital admissions due to respiratory ailments. He Kainga Oranga, the Housing and Health Research Programme. (n.d.). *Evaluation of Warm Up New Zealand: Heat Smart*. University of Otago, Wellington. https://www.healthyhousing.org.nz/research/past-research/evaluation-of-warm-up-new-zealand-heat-smart/

For example, it could be used where a jurisdiction:

- Already uses a societal cost test as its primary test to evaluate EE programs.
- Is statutorily mandated to consider public health impacts and uses a jurisdiction specific cost test[18] as its primary test.
- Uses the utility cost test or total resource cost (TRC) as its primary test, but routinely considers or at least has authority to consider societal benefits (like public health benefits) as a secondary test in planning and evaluating DER programs.
- Has a broad interpretation of the public good or public interest.

If none of the above applies in a jurisdiction, then the regulators might ask for statutory authority to consider public health benefits or reconsider their current cost test policies and see if using BPK is within existing statutory authority.

Consider another option: Regulators could direct utilities to consider BPK values when determining EE program priorities among measures that were already determined to be cost-effective using a utility cost test or TRC. This application of the tool is especially important if the EE budget is limited and not every program that passes the cost test can be included in the portfolio of efficiency measures that are eligible for incentives. Using the BPK values might change priorities — for example, between things that reduce energy on peak versus off peak or reduce energy uniformly across the day or year.

For example, in Wisconsin, state law caps spending on the statewide EE portfolio. With a fixed budget, the goal of EE planning is to get maximum benefit from that budget. The primary cost-effectiveness test in Wisconsin is the TRC, which does not consider public health benefits. Lots of programs that would be cost-effective using the TRC do not get included in the EE portfolio because there is competition for scarce EE dollars. Only the *most* cost-effective programs get included in the portfolio (with some exceptions, such as low- and moderate-income programs).

If EE planners in Wisconsin used the BPK values, they might reorder their priorities and change the list of cost-effective programs included in the EE portfolio, without changing their use of the TRC as their primary test.

To further the example, Wisconsin is in the Midwest region in AVERT, and the BPK values in that region are higher for uniform EE than for EE at peak. One can imagine two EE programs in Wisconsin. Program A has a slightly better TRC score than program B. If there was room in the budget for only one of these programs, planners would choose program A based on the TRC score. But what if program B reduces consumption uniformly while program A is focused on peak reductions? Using BPK values could tip the scales and lead to a decision to include program B over program A. The state wouldn’t have to change its screening test to something other than the TRC, and it wouldn’t be including something

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[18] For many examples and further information on methodologies for assessing energy costs and benefits at the state level, see National Energy Screening Project. (2020). *National standard practice manual for benefit-cost analysis of distributed energy resources*. https://www.nationalenergyscreeningproject.org/national-standard-practice-manual/

in the portfolio that didn't pass the cost test, but use of BPK would change the portfolio to yield higher public health benefits and, more generally, higher societal benefits.

A variety of other utility regulatory decisions might be affected by using the BPK tool if the jurisdiction acknowledges and considers the monetary value of those decisions' public health impacts. We discuss further examples later in this brief.

How Air Quality Regulators Can Use the EPA's Values

Since air regulators are charged with reducing public health impacts, they routinely develop plans for doing so at least cost. The monetary health benefits of reduced emissions are the same no matter how the emissions are reduced, but the costs for different methods can vary widely. For example, the public health benefits of a 1 ton reduction in nitrogen oxides are the same no matter how that ton was reduced, but the economy will benefit from achieving that reduction at the lowest possible cost.

This may lead air regulators to recommend EE and RE as emissions reduction strategies.

As a first step, air regulators need to learn about the emissions reduction potential and the costs of EE and RE and how they compare to other emissions reduction strategies. EPA tools like AVERT, on which the BPK numbers are based, can help.

Although decisions about whether to proceed with EE or new RE projects are made at public utility commissions or state energy offices, air quality regulators can engage in those decision-making processes at other agencies and explain the public health benefits of EE and RE. This involvement can include explaining why BPK is a good tool and how to use the BPK values. Using BPK can make all three agencies' jobs easier by demonstrating lower costs to consumers for energy while achieving air quality benefits. This will also enable cooperation and coordination across agencies, which can bear fruit in other contexts.

EPA guidance[19] allows air quality regulators to use state EE and RE programs in state implementation plans — which are required to meet public health standards for ozone and $PM_{2.5}$ and regional haze visibility improvement goals — and other air quality plans, even if the EE and RE commitments are not enforced by the air agency but have enforceable provisions (such as the evaluation, measurement and verification provisions that utility regulators typically require for EE programs).

At least one state has already had the idea of using energy efficiency in air quality planning. In 2019, Arkansas produced a first-in-the-nation white paper[20] laying out its strategy for including EE as part of its compliance plan for regional haze, including SO_2,

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[19] U.S. Environmental Protection Agency. (2020). *Incorporating energy efficiency and renewable energy into state and tribal implementation plans.* https://www.epa.gov/energy-efficiency-and-renewable-energy-sips-and-tips

[20] Arkansas Department of Environmental Quality, Office of Air Quality. (2019). *Accounting for energy efficiency measures in regional haze planning* [Concept paper]. https://www.adeq.state.ar.us/air/planning/sip/pdfs/regional-haze/energy-efficiency-rh-pp2-emerge-concept-paper-final-with-cover-letter.pdf

NO_x and $PM_{2.5}$ emissions reductions demonstrated from its EE programs since 2010. This proposal presented an interesting opportunity to apply the BPK data, which we explore further in the text box beginning on Page 11.

As wind and solar energy generation scales up in many states, regional air quality planning can take into account the health benefits of renewables. The EPA's BPK tool allows planners to compare the health cost of retaining fossil fuel power plants (or building new ones) versus replacing them with renewable generation.

It can also offer air quality planners a window into whether they are achieving their attainment goals at least cost. Most states with attainment planning exercises have ambient concentration targets to achieve, and when they reach those targets with emissions reduction strategies, they don't look for additional control measures. And states don't quantify public health benefits for criteria pollutants. They don't need to because the EPA sets their target: the national ambient air quality standards for the six criteria pollutants. State and local agencies design their implementation plans to meet those standards. For example, the cost of selective catalytic reduction on power plants becomes part of the overall attainment plan if that measure is deemed the next most cost-effective on the ladder of control strategies that are needed to achieve additional NO_x reductions.

A question for air regulators: Could the benefits-per-kWh tool be used to assess whether energy efficiency should be considered before other more expensive emissions reduction strategies? One challenge is that tons of emissions reductions via EE accrue slowly; you don't get 10,000 tons of NO_x reductions with one measure like you can with selective catalytic reduction at one power plant. But over time with significant EE goals, the tons add up, and the program can deliver all the benefits RAP discusses in the layer cake concept.

State and local air quality agencies have a public stakeholder process where various control measures are compared for their cost and air quality impacts, and the EPA's BPK tool can be a part of that process. If using these values for ozone nonattainment plans, for example, the agency and the public would be able to compare the cost of retaining existing fossil-fueled generation, with the added health impacts, versus the cost of ramping up energy efficiency programs or adding new renewable energy (or both) to offset the existing fossil-fueled generation.

If a state or local agency is already attaining its target levels for criteria pollutants but the benefits-per-kWh tool suggests that there may be a missed opportunity to do so less expensively, air quality and utility regulators can tap the value of collaboration to uncover that opportunity. RAP coined "E-Merge" to describe a process for energy and air quality regulators to work together to coordinate air and energy planning efforts.[21] The BPK data offer another avenue for that collaboration. For example, timelines for utility integrated resource planning and nonattainment planning could be synced, allowing both processes to make use of the extensive and costly modeling required, as well as to more effectively

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[21] For an explanation of the E-Merge concept, see Colburn, K., & James, C. (2017, April 27). *E-Merge: Retooling regulation for clean air and clean energy* [Webinar]. Regulatory Assistance Project. https://www.raponline.org/event/retooling-regulation-for-clean-air-and-clean-energy-webinar/

analyze which resources can most cost-effectively meet power system needs and air quality goals at the same time.

Clean air and environmental justice advocates could make use of the EPA's data as they participate in air quality planning proceedings or utility regulatory processes to quantify the benefits of additional investments in EE in their communities or show how the benefits of additional renewable energy and shutting down fossil-fueled generation would benefit their communities by improving health.[22] A 2020 report by RAP, Synapse and Community Action Partnership[23] discusses how a clean energy future can be more equitable through a variety of planning mechanisms, including better stakeholder involvement in integrated resource planning processes and the integration of air quality and resource planning. BPK is a tool that can be used in local, state and regional planning processes.

Energy efficiency and BPK: An example from Arkansas

The EPA tool provides values for energy efficiency impacts that are uniform across the year and for energy efficiency impacts that occur during peak load periods. Most efficiency includes on-peak and off-peak savings and must be examined with respect to the time when the savings will occur. In some regions where on-peak savings displace natural gas, while off-peak savings displace coal, the utility direct dispatch cost benefit of off-peak savings will be lower, but the health benefits may be higher. The EPA values allow both situations to be evaluated.

For an example of how BPK could be used to discuss whether to expand an EE program, let's look at the Arkansas EE program. That program has the following characteristics:

- The Arkansas Public Service Commission evaluates its energy savings targets every three years.
- The state's EE program is ranked 33rd by ACEEE and won recognition as one of the most improved states in 2014.[24]
- Arkansas utilities have historically met or exceeded 100% of energy savings targets.

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[22] Given the dynamics of the electricity grid and pollution formation in the atmosphere, the health improvements from energy efficiency or renewable energy installations may not occur entirely within the area where the programs are implemented, or the power plant emissions are reduced.

[23] Synapse Energy Economics, Inc., Community Action Partnership, & Regulatory Assistance Project. (2020, April 29). *Energy infrastructure: Sources of inequities and policy solutions for improving community health and wellbeing.* https://www.synapse-energy.com/project/energy-infrastructure-sources-inequities-and-policy-solutions-improving-community-health-and

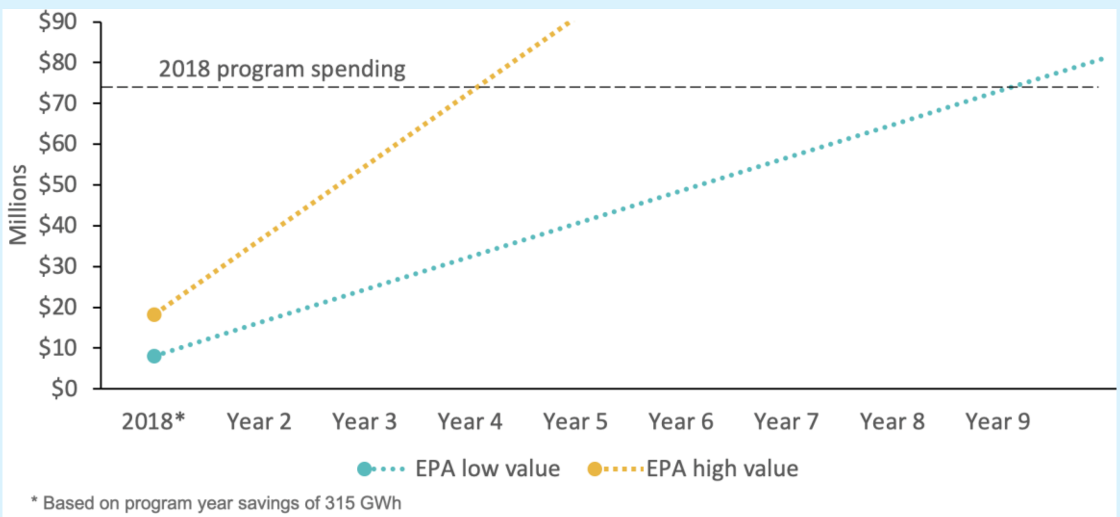
[24] Gilleo, A., Chittum, A., Farley, K., Neubauer, M., Nowak, S., Ribeiro, D., & Vaidyanathan, S. (2014, October). *The 2014 State Energy Efficiency Scorecard* (Report No. U1408). American Council for an Energy-Efficient Economy. https://www.aceee.org/research-report/u1408

- Based on this success, the commission has raised the energy savings target five times since the inception of the program in 2007.
- The savings target for the current program cycle (2020-2022) is 1.2% of 2018 retail sales.

As noted earlier, Arkansas plans to include emissions reductions from its EE program in its compliance plan for regional haze. The tonnage estimates for the EE savings might seem small (around 3,000 tons of SO_2, NO_x and $PM_{2.5}$ combined), but the health benefits are large and have been unaccounted for to date.

To extend this work to the BPK tool, we used the 2018 program's energy savings of 315 GWh,[25] the most recent year of full data available, to estimate the health benefits to Arkansas. The calculation required using the EPA's values for two AVERT regions, since Arkansas is split between the Central and Midwest regions.[26] We used the values for a 3% discount rate and the high and low EE annual values to estimate annual 2018 BPK benefits at $8.1 million to $18.2 million.[27] The Arkansas commission reported that the 2018 EE program cost $74 million.[28] So applying the EPA's data yields substantial unaccounted-for health benefits to offset some of the cost of the EE program in 2018. And, if we consider that many EE measures have a potential life span of up to 20 years, the calculated benefits for 2018 investments could be much higher over time and effectively cover the program costs if cumulative benefits were assessed (as illustrated in Figure 3).[29, 30]

Figure 3. Benefits from 2018 energy efficiency program in Arkansas and illustrative cumulative effect



Data source: Arkansas Public Service Commission General Staff. (2019, July 12). *Summary of Utility Program Year 2018 Annual Reports*

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[25] Arkansas Public Service Commission General Staff. (July 12, 2019.) *Summary of utility program year 2018 annual reports* (Attachment A to testimony of Robert Booth, Docket No. 07-077-TF). http://www.apscservices.info/pdf/07/07-077-TF_441_1.pdf

[26] The 14 AVERT regions are shown in U.S. Environmental Protection Agency, 2021a.

[27] Based on 315 GWh saved and using 90% of the BPK values for the Midwest region and 10% for the Central region, as per discussion with Arkansas's Energy and Environment Agency, since Arkansas is involved in two regions of AVERT. The EPA's low values for health benefits per kWh are 2.70 cents for the Midwest and 1.37 cents for the Central region; the high values are 6.10 and 3.09 cents, respectively.

[28] Arkansas Public Service Commission General Staff, 2019.

As the Arkansas data demonstrates, a BPK calculation could enable a state (energy or air quality regulators) to consider the cost-effectiveness of their EE programs differently. States that use a societal cost test or a jurisdiction specific test may be interested in using these values. They could consider expanding the program given these benefits, by changing their cost-effectiveness test to account for these benefits.

Keep in mind that health benefits are accrued across a region. EE program benefits are diffuse, as are the health benefits, but no less real. Substantial health benefits cannot be attributed to any one EE measure, company or program. Still, in the case of Arkansas, for example, the citizens are seeing health benefits from EE, and that's all to the good.

Health benefits, as the EPA factors demonstrate, can be substantial in areas where energy costs are low and fossil fuel use is high, especially if the power generation occurs in a high population area. They represent an opportunity to substantiate the value of EE programs, perhaps greater than the projected energy benefits given an area's fuel mix. While that may seem difficult to imagine, a state does not have to use the full value that the EPA estimates the health benefits are worth and can choose to be more conservative but use a value greater than zero.

Incorporating the EPA's Values Into Renewable Energy Valuation

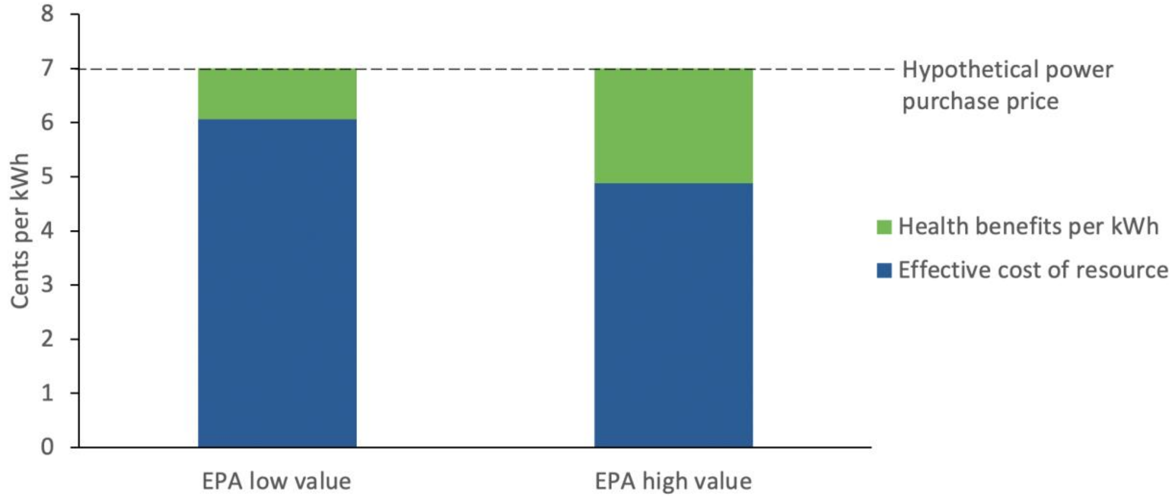
Incorporating the EPA's BPK values into renewable energy procurement processes is simpler than for energy efficiency. The EPA values can be subtracted from the cost estimate or power purchase agreement proposal for new renewable resources. For example, if an offshore wind resource were offered to a Northeast utility at a procurement cost of 7 cents per kWh, the regulator could evaluate that by looking at the low and high EPA estimates. Figure 4 on the next page shows such a comparison, using the BPK values for New York offshore wind.[31]

[29] As the EPA notes in the spring 2021 update to its BPK tool, the electricity grid in the United States is getting cleaner, leading to lower BPK values. A cleaner grid is excellent for public health but means the health benefits of EE and renewable energy will decrease over time, and therefore payback periods for investments may be longer.

[30] The Arkansas Division of Environmental Quality has calculated benefits per kWh based on its projected cumulative EE savings from ongoing annual investments in EE and the resulting emissions reductions in each future year estimated by AVERT. See Regulatory Assistance Project & Arkansas Department of Energy and Environment. (2021, August 11). *Energy efficiency for better air quality: Reducing air pollution and restoring scenic beauty* [Presentation], slides 14 and 17. https://www.raponline.org/knowledge-center/energy-efficiency-better-air-quality-reducing-air-pollution-restoring-scenic-beauty

[31] The hypothetical price chosen for this comparison is representative of actual recent transactions. For example, the New York State Energy Research & Development Authority in 2019 contracted for nearly 1.7 GW of offshore wind at an average development cost of $83 per MWh. Snieckus, D. (2019, October 24). *New York sets seal on biggest offshore wind procurement in US*. Recharge. https://www.rechargenews.com/wind/new-york-sets-seal-on-biggest-offshore-wind-procurement-in-us/2-1-694314

Figure 4. How benefits-per-kWh values can offset the assumed cost of renewable energy



Those working on the renewable energy permits and policies will want to consult with their health and environmental agencies on the appropriate level of valuation in their situation. The EPA values represent a range of what can be considered.

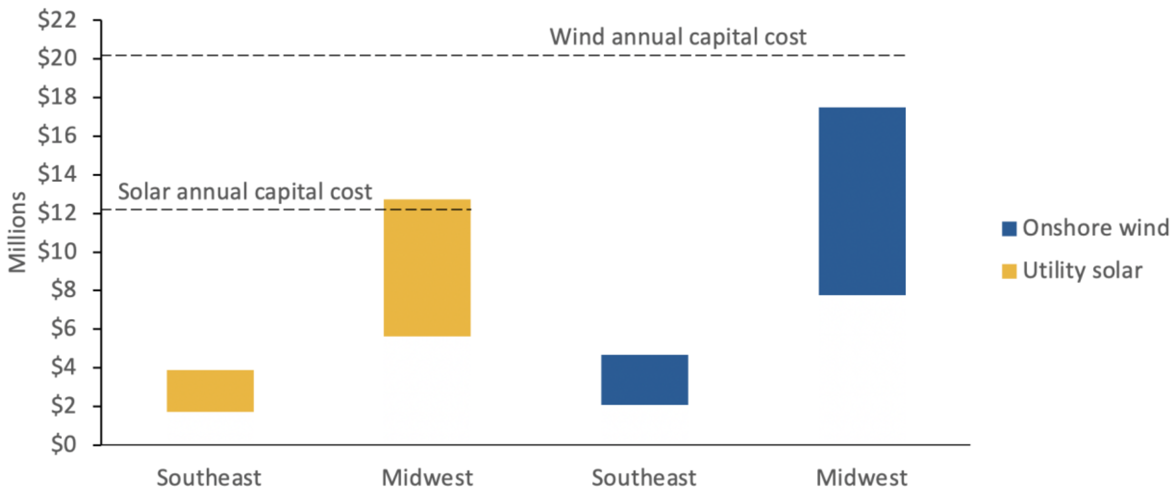
To illustrate the potential of this approach, we used the BPK tool to document the health benefits of a renewable energy example for two AVERT regions.

We started with a typical source of renewable energy: a 100 MW utility-scale facility. To enable the comparison, we calculated annualized capital costs for 100 MW of utility-scale wind and solar. Those costs are estimated to be $20.2 million for wind and $12.2 million for solar.[32] We compared those costs with the BPK health benefits if wind or solar replaces fossil fuel electricity.[33] These calculations lead to substantial annual health benefits that compare favorably to the capital costs (see Figure 5 on the next page).

[32] Assuming $1,500 per kW for wind and $1,000 per kW for solar, based on: Lazard. (2019). *Lazard's levelized cost of energy analysis — Version 13.0.* https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf. Also assuming an annual cost of capital of 10% and a 25-year life, with fixed operation and maintenance costs per kW of $36.50 for wind and $12 for solar.

[33] Assuming 100 MW wind yields 2,838,240 kWh per year and 100 MW solar yields 2,128,680 kWh per year (factoring in 10% line loss for each).

Figure 5. Values for public health benefits from 100 MW of new renewable energy in two regions



Our calculations for the Southeast and Midwest regions document health benefits of $2.1 million to $17.5 million per year from wind power and $1.7 million to $12.7 million from solar. This assessment demonstrates that the annual health benefits that accrue from using renewable energy instead of fossil fuel energy substantially defray (from a societal perspective) the costs of renewable energy. The capital costs have not been offset directly, but policies that encourage renewable energy can lead to fossil fuel units' no longer needing to run (or running less frequently) and lower the pollution and subsequent health impacts from electricity generation. This example shows the value of considering health benefits in the decisions on whether to build new renewable resources and the value of collaboration across the energy and environmental agencies to ensure policy goals of both are considered.

BPK can be used to make resource planning and procurement decisions, such as in an integrated resource plan or distribution system plan, that might prioritize renewables or energy efficiency. The data could also be used to consider non-wires alternatives (e.g., if these would mean less use of fossil fuel-fired generation resources). In effect, the numbers can be used as a shadow price added to the cost of fossil-fueled resources when comparing those resources for the near term (up to five years out).[34] If a jurisdiction is concerned about the accuracy of the EPA's BPK numbers, it can use the lowest values for an area as a conservative estimate that is in all likelihood more accurate than assuming the public health benefits have zero value.

Benefits per kWh have not been taken into account in any final commission proceeding to date that we know of, though the Sierra Club proposed using them in proceedings in Missouri.[35] With the EPA's tool, they can.

[34] The EPA recommends that the BPK values be used for no more than five years in the future due to the rapidly changing nature of the power sector and how fast resource mixes are changing in many areas.

[35] The EPA noted those comments and other uses of BPK. U.S. Environmental Protection Agency. (2020, December 11). *Publications that cite EPA's health benefits-per-kilowatt-hour (BPK) values* [Chart]. https://www.epa.gov/sites/production/files/2021-05/documents/bpk_publications_12.11.20.pdf

Other Issues in Regulation: Cleaner Energy Dispatch and Use

Our discussion on areas where BPK may prove valuable can be extended to other issues of interest to utility and air quality regulators.

The most important may be the dispatch of fossil-fueled generating units. Utilities that do not participate in wholesale electricity markets decide which power plants to operate in any given hour based primarily on an economic dispatch methodology, which considers the incremental costs of operating different plants. The EPA provides details that would enable assigning shadow costs to power plants with different emissions profiles based on BPK values.[36] Regulators could order these utilities to use BPK data as an addition to the operating expenses for each type of power plant when making dispatch decisions. Self-regulated utilities (such as some public power utilities and rural electric cooperatives) could choose to use the data in a similar fashion. In theory, this should lead to greater dispatch of cleaner units with somewhat higher operating costs but lower societal costs.

Another use of this data may be in valuing imports and exports of electricity from neighboring utilities. If the supplier has a cleaner unit available for dispatch, it may be economical for the receiving utility to reduce its own power production and purchase cleaner energy even if the direct operating costs are slightly higher.

BPK values may be relevant when designing rates for electric utilities.

- An off-peak rate may attract load, ranging from water heating and electric vehicle charging to industrial processes. But no rate should ever be set below the relevant short-run societal marginal cost, and that includes health effects. For example, in the mid-Atlantic region, while the variable running cost of the marginal off-peak coal resource may be 3 cents per kWh, when the EPA health effects are included this rises to roughly 6 to 10 cents per kWh (using BPK values of 3.04 to 7.15 cents per kWh) as a societal short-run marginal cost (and more than this if societal carbon emissions values are considered). The cost of using coal can double or triple if health impacts are included in some areas of the United States.

- Economic development rates have been set in the past to attract new industrial load and the associated employment. Consideration of health effects may result in a higher minimum rate that is acceptable from new customers in regions where fossil fuel resources are used to serve incremental load.

- The health benefits of EE and RE vary by time of day because emissions of SO_2, NO_x and $PM_{2.5}$ vary by time of day as different facilities generate electricity. Utilities and regulators should consider these values, in addition to direct economic costs and carbon costs, in designing time-varying rates by analyzing the impacts that increasing fossil-fueled generation off peak will have on emissions and therefore public health.

[36] U.S. Environmental Protection Agency, 2021b.

Conclusion

The EPA's benefits-per-kWh values provide important data estimates of the health benefits of energy efficiency and renewable energy from reduced particulate air pollution. These provide utilities and regulators guidance in selecting new generating and efficiency resources, dispatching existing resources and designing electricity rates. They can also provide guidance to regulators in examining alternative control options for air quality planning and compliance with federal public health standards.

The EPA values do not consider climate benefits associated with lower carbon dioxide emissions. In states where carbon emissions are regulated, or in states that have carbon emissions goals and policies, those values should be separately calculated and included in the resource planning and dispatch methods.

System fuel mixes are rapidly changing, which is why the EPA released updated BPK values in spring 2021.[37] As higher-emitting plants retire, the value of health effects can be expected to drop because overall power generation will be cleaner. But this process will not necessarily happen evenly across regions of the United States, and changes in population, among other factors, will affect BPK values. The updated BPK tool includes more granular regions, compared to the original version, corresponding more closely to the various regional power grids and their differing generation fuel mixes.

The tool provides a powerful and simple calculation to assess the cost impacts of fossil-fueled generation on public health. It allows energy and air quality regulators, utilities and advocates to collaborate and compare those costs more easily in evaluating power system resource options and the options for attaining the EPA's public health standards for the criteria pollutants NO_x, SO_2 and $PM_{2.5}$.

[37] The factors reflect 2019 power plant data, which is the most recent nationwide data in the EPA's systems.

Appendix: Complete EPA Values by Region

		3% discount rate (2019 cents per kWh)		7% discount rate (2019 cents per kWh)	
Region	Project type	Low estimate	High estimate	Low estimate	High estimate
California	Uniform energy efficiency	0.67	1.51	0.60	1.34
	Energy efficiency at peak	0.74	1.67	0.66	1.49
	Utility solar	0.65	1.47	0.58	1.31
	Distributed solar	0.64	1.44	0.57	1.29
	Onshore wind	0.63	1.41	0.56	1.26
	Offshore wind	0.67	1.50	0.60	1.34
Carolinas	Uniform energy efficiency	1.66	3.75	1.48	3.33
	Energy efficiency at peak	1.65	3.73	1.48	3.33
	Utility solar	1.69	3.80	1.50	3.39
	Distributed solar	1.69	3.81	1.51	3.40
	Onshore wind	1.66	3.75	1.48	3.34
	Offshore wind	1.66	3.74	1.48	3.34
Central	Uniform energy efficiency	1.37	3.09	1.22	2.75
	Energy efficiency at peak	1.33	2.99	1.18	2.67
	Utility solar	1.34	3.01	1.19	2.69
	Distributed solar	1.34	3.02	1.20	2.70
	Onshore wind	1.39	3.14	1.24	2.80

Florida	Uniform energy efficiency	0.79	1.79	0.70	1.58
	Energy efficiency at peak	0.91	2.05	0.81	1.83
	Utility solar	0.86	1.93	0.76	1.73
	Distributed solar	0.87	1.96	0.77	1.75
	Onshore wind	0.75	1.69	0.67	1.51
Mid-Atlantic	Uniform energy efficiency	3.10	7.00	2.78	6.26
	Energy efficiency at peak	3.17	7.15	2.83	6.37
	Utility solar	3.10	7.00	2.77	6.25
	Distributed solar	3.09	6.98	2.76	6.22
	Onshore wind	3.04	6.85	2.71	6.11
	Offshore wind	3.05	6.88	2.72	6.14
Midwest	Uniform energy efficiency	2.70	6.10	2.41	5.43
	Energy efficiency at peak	2.64	5.97	2.36	5.32
	Utility solar	2.65	5.98	2.36	5.33
	Distributed solar	2.65	5.99	2.37	5.34
	Onshore wind	2.73	6.16	2.44	5.50
New England	Uniform energy efficiency	0.34	0.77	0.32	0.73
	Energy efficiency at peak	0.42	0.94	0.37	0.84
	Utility solar	0.40	0.90	0.36	0.81
	Distributed solar	0.40	0.91	0.36	0.81
	Onshore wind	0.35	0.80	0.32	0.71
	Offshore wind	0.36	0.81	0.32	0.72
New York	Uniform energy efficiency	0.99	2.24	0.88	1.98
	Energy efficiency at peak	1.19	2.68	1.06	2.39

	Utility solar	1.10	2.49	0.99	2.22
	Distributed solar	1.10	2.49	0.98	2.22
	Onshore wind	0.95	2.13	0.85	1.90
	Offshore wind	0.94	2.12	0.84	1.89
Northwest	Uniform energy efficiency	1.06	2.39	0.95	2.14
	Energy efficiency at peak	1.11	2.49	0.99	2.22
	Utility solar	1.12	2.53	1.00	2.26
	Distributed solar	1.13	2.54	1.01	2.27
	Onshore wind	1.04	2.35	0.93	2.10
	Offshore wind	1.05	2.38	0.94	2.12
Rocky Mountains	Uniform energy efficiency	0.93	2.10	0.82	1.84
	Energy efficiency at peak	0.91	2.05	0.81	1.83
	Utility solar	0.91	2.05	0.81	1.83
	Distributed solar	0.92	2.07	0.82	1.85
	Onshore wind	0.92	2.08	0.82	1.85
Southeast	Uniform energy efficiency	0.69	1.55	0.67	1.51
	Energy efficiency at peak	0.84	1.90	0.75	1.70
	Utility solar	0.81	1.83	0.72	1.63
	Distributed solar	0.82	1.85	0.73	1.65
	Onshore wind	0.73	1.65	0.65	1.47
Southwest	Uniform energy efficiency	0.58	1.31	0.52	1.16
	Energy efficiency at peak	0.63	1.43	0.56	1.27
	Utility solar	0.61	1.38	0.55	1.23
	Distributed solar	0.62	1.39	0.55	1.24
	Onshore wind	0.57	1.28	0.51	1.14

Tennessee	Uniform energy efficiency	0.84	1.89	0.75	1.70
	Energy efficiency at peak	0.88	1.98	0.78	1.76
	Utility solar	0.84	1.89	0.75	1.68
	Distributed solar	0.82	1.85	0.73	1.65
	Onshore wind	0.82	1.85	0.73	1.65
Texas	Uniform energy efficiency	0.91	2.04	0.81	1.83
	Energy efficiency at peak	0.97	2.18	0.86	1.94
	Utility solar	0.95	2.13	0.85	1.90
	Distributed solar	0.94	2.13	0.84	1.90
	Onshore wind	0.88	1.99	0.79	1.78

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Belgium · China · Germany · India · United States

50 State Street, Suite 3
Montpelier, Vermont 05602
USA

+1 802-223-8199
info@raponline.org
raponline.org