Quantifying the monetized health benefits from energy efficiency and renewable energy in the United States

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Efficiency and Renewables Provide Air Quality and Health Benefits

- **Energy efficiency (EE)** and **renewable energy (RE)** deliver health and environmental benefits by avoiding fossil-fired power plant emissions, which improves air quality (AQ) and enhances public health

State and Local
Energy and Environment Program

- State and local governments are increasingly looking to quantify and document the **AQ and health benefits** of EE and RE, driven by:
  - ‣ **Policymaker and planner** interests in addressing local air quality and health concerns
  - ‣ **Energy regulators** seeking comprehensive assessments of costs and benefits of energy choices
  - ‣ **Green banking and EE/RE industries** looking to demonstrate public health benefits of investments

Environment

Energy   Health

We are here!

- **EPA's State and Local Energy and Environment program** provides free information, tools, and technical expertise to help states and locals understand, quantify, and communicate the multiple benefits of EE and RE
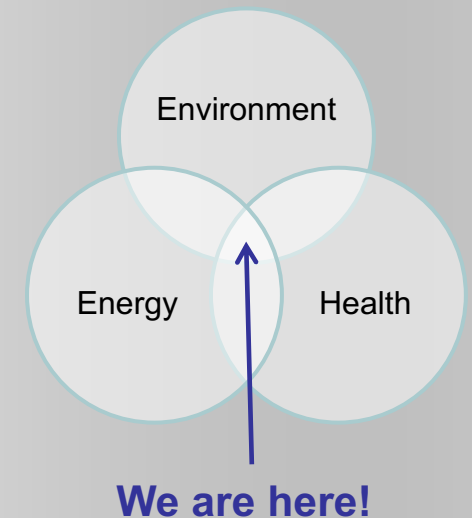
The Nature of the Grid Influences How EE/RE Impact Emissions

- The electricity we use is generated by multiple different sources – not just the power plant down the street

- Reducing fossil electricity consumption can affect emissions at electric generating units throughout the region

Image Source: Macrovector/Freepik
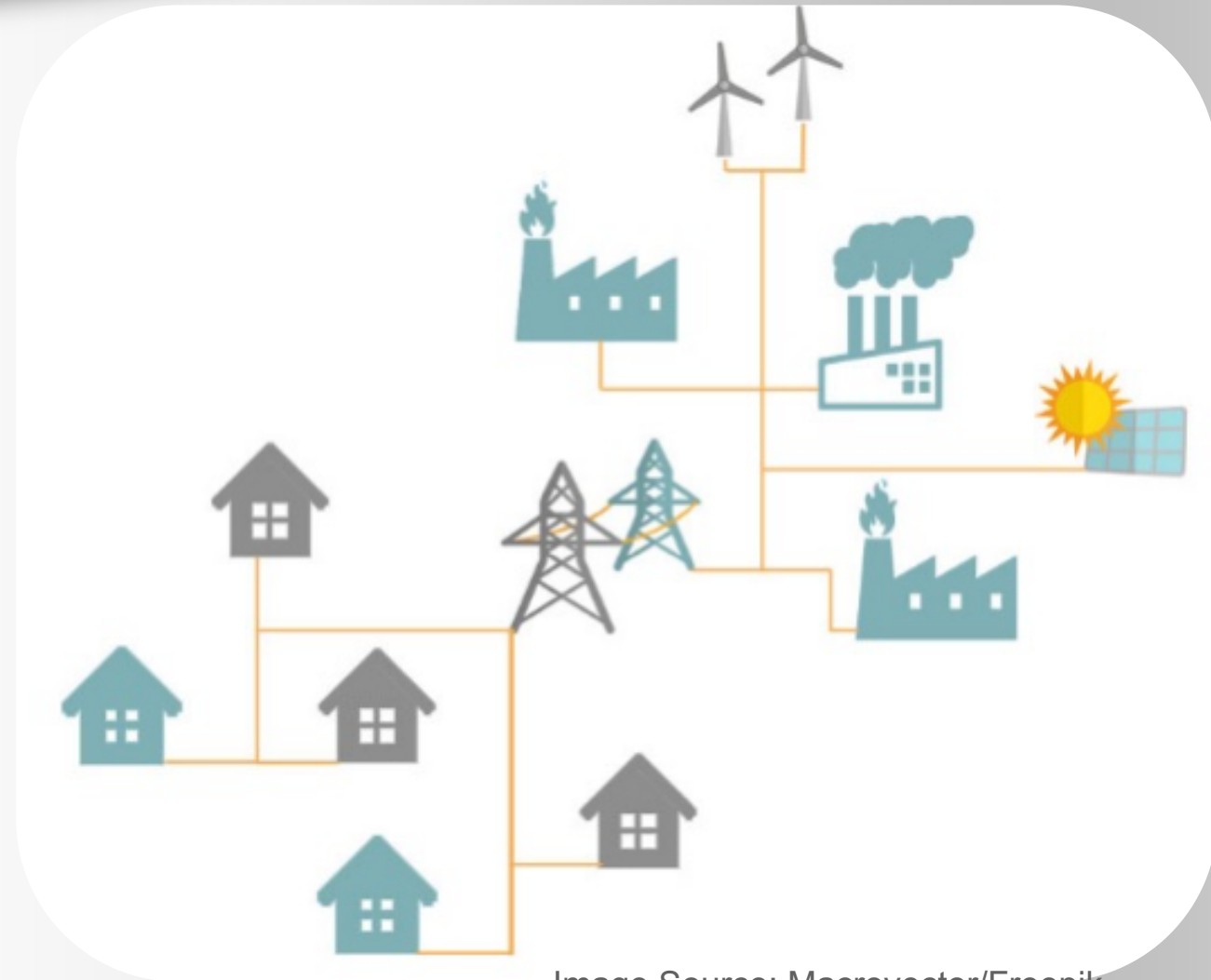
The Nature of the Grid Influences How EE/RE Impact Emissions

- Different power plants operate at different times of day

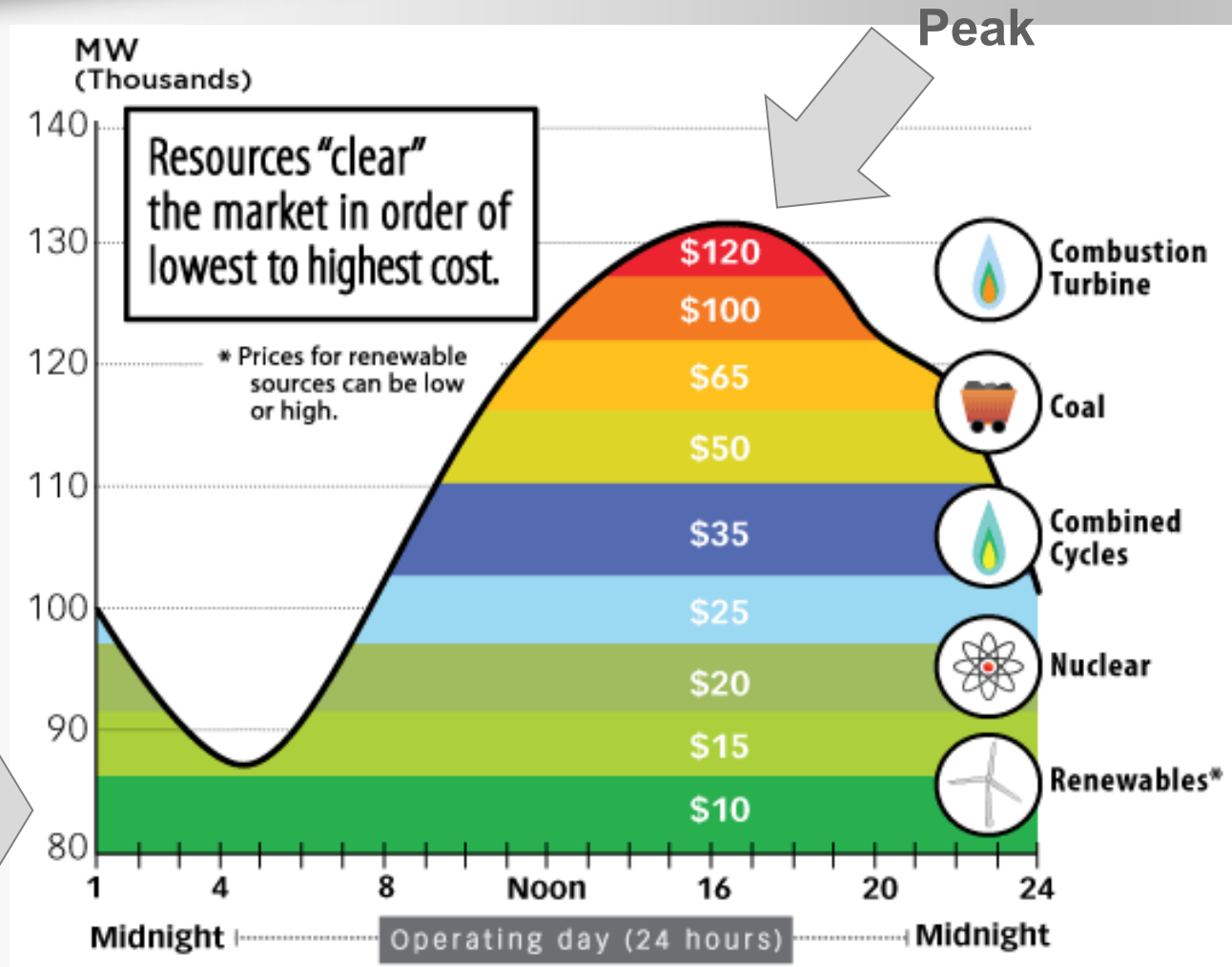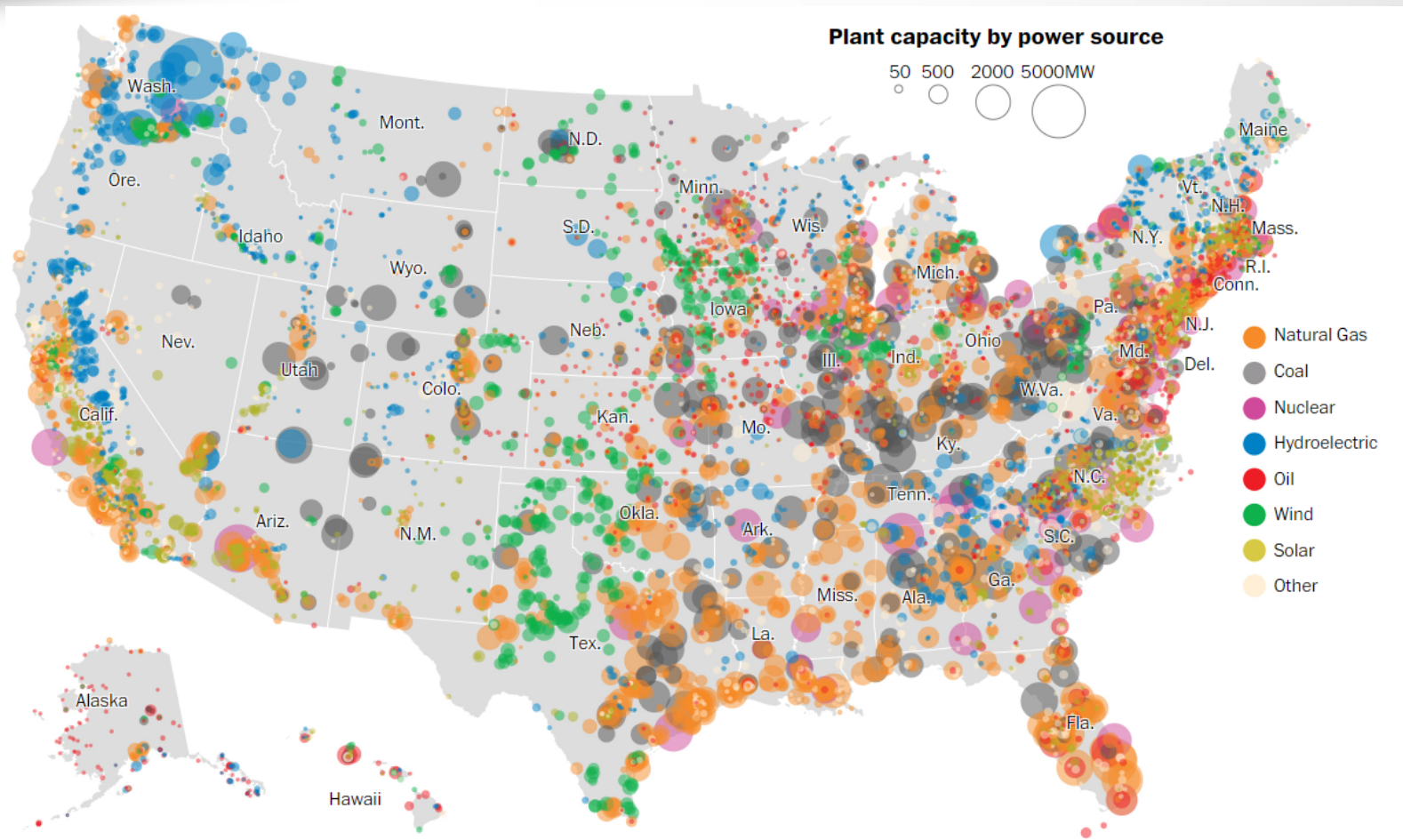- Reducing fossil electricity demand at different hours can affect different plants

Image Source: https://learn.pjm.com/three-priorities/keeping-the-lights-on/how-pjm-schedules-generation-to-meet-demand.aspx

The Nature of the Grid Influences How EE/RE Impact Emissions

Plant capacity by power source
50 500 2000 5000MW

Natural Gas
Coal
Nuclear
Hydroelectric
Oil
Wind
Solar
Other

- Emissions from electricity generation vary widely across regions, depending on the fuel used

Image Source:
https://www.washingtonpost.com/graphics/national/power-plants/?utm_term=.2bb81d8f8cb7

EPA's Framework for Assessing Multiple Benefits
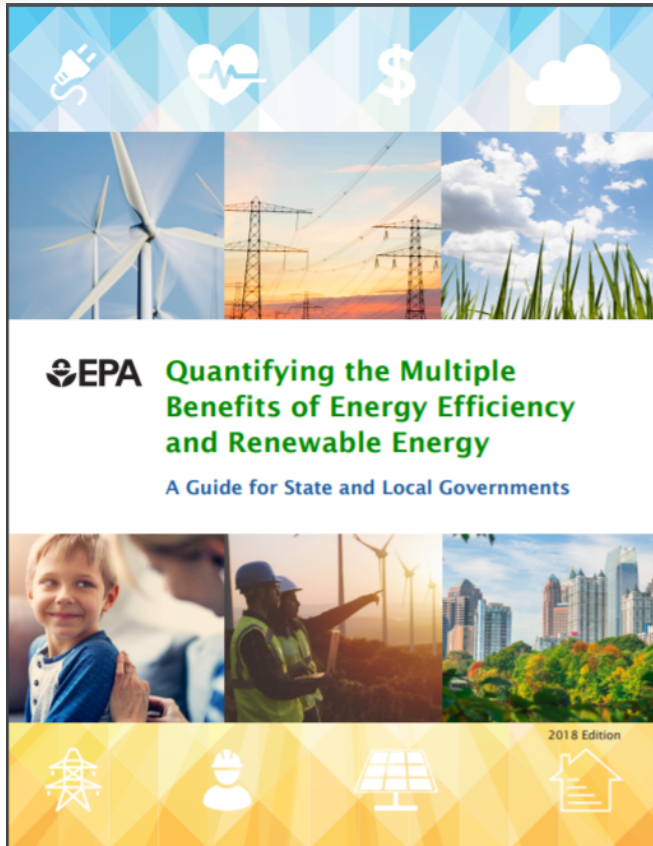
Available at: www.epa.gov/statelocalenergy

STEP 1: Determine Scope of and Strategy for the Analysis

Key Considerations
- Identifying the purpose, priorities, and constraints
- Understanding the characterization of analytic methods
- Mapping out the strategy for the analysis

STEP 2: Determine Direct Electricity Impacts

STEP 3: Quantify the Multiple Benefits From Direct Electricity Impacts

Electricity System Benefits
- Primary electricity system benefits
- Secondary electricity system benefits

Emissions and Health Benefits
- Air pollutant, GHG emissions benefits
- Air quality benefits
- Human health benefits

Economic Benefits
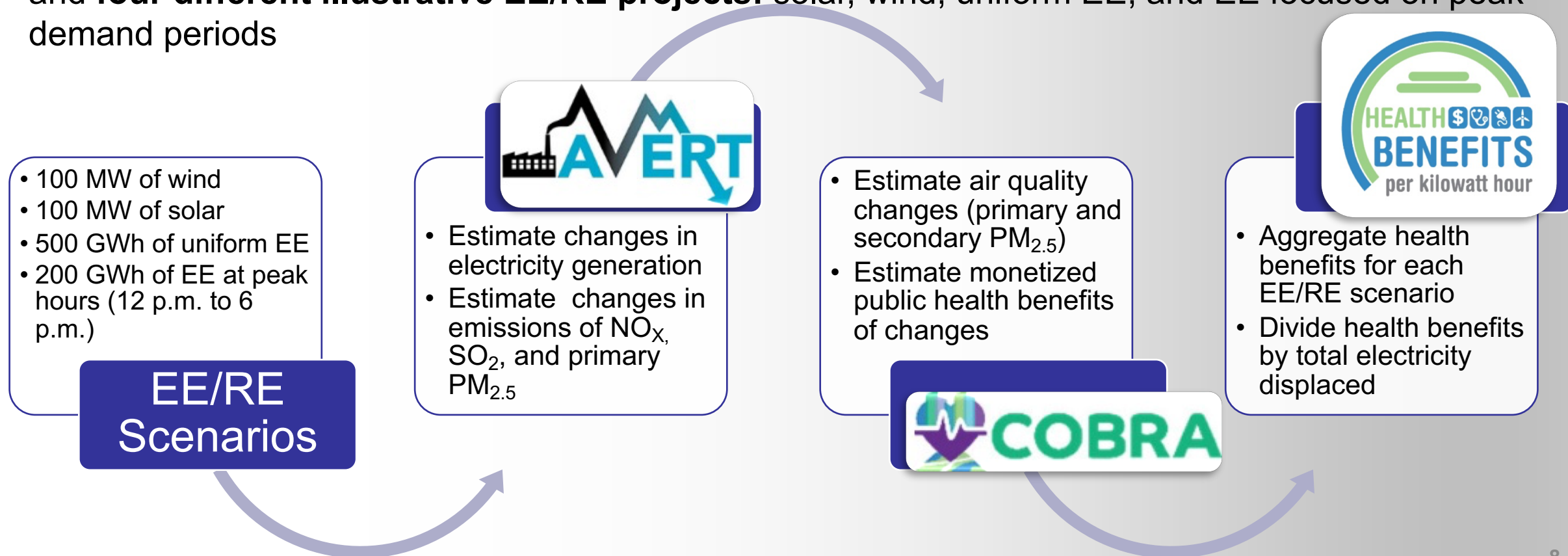- Direct economic benefits
- Indirect economic benefits

STEP 4: Use Benefits Information to Support Informed Decision-Making

Stakeholders Want Simplified **Health Benefits per Kilowatt-Hour (BPK)** Factors

EPA United States Environmental Protection Agency

- States and locals are looking for easy to use **EE/RE health BPK factors (¢/kWh)** to help with planning, assessing cost-effectiveness, and demonstrating value

- EPA conducted a **literature review** and talked to experts to identify existing health benefits factors, methods, and best practices
    - ‣ Estimates range widely (i.e., 0.1 ¢/kWh to 17.1 ¢/kWh)
    - ‣ Estimates are lacking for many regions of the United States
    - ‣ Methodologies are applied inconsistently across EE/RE technology types and geographic regions making them hard to compare

EPA Developed an Approach to Address Stakeholder Needs

- Using existing EPA tools, we are able to estimate health **BPK factors (¢/kWh)** for **10 U.S. regions** and **four different illustrative EE/RE projects:** solar, wind, uniform EE, and EE focused on peak demand periods

- 100 MW of wind
- 100 MW of solar
- 500 GWh of uniform EE
- 200 GWh of EE at peak hours (12 p.m. to 6 p.m.)

EE/RE Scenarios

- Estimate changes in electricity generation
- Estimate changes in emissions of NO_X, SO_2, and primary $PM_{2.5}$

- Estimate air quality changes (primary and secondary $PM_{2.5}$)
- Estimate monetized public health benefits of changes

- Aggregate health benefits for each EE/RE scenario
- Divide health benefits by total electricity displaced

EPA's AVoided Emissions and geneRation Tool (AVERT)

- Translates EE/RE programs to avoided NO_x, SO_2, $PM_{2.5}$, and CO_2 emissions impact
- User friendly, transparent, and credible
  - Locate your AVERT region
  - Obtain energy saved (MWh) for EE programs, or the capacity of wind and solar installation (MW)
  - Multiple options are built into the tool
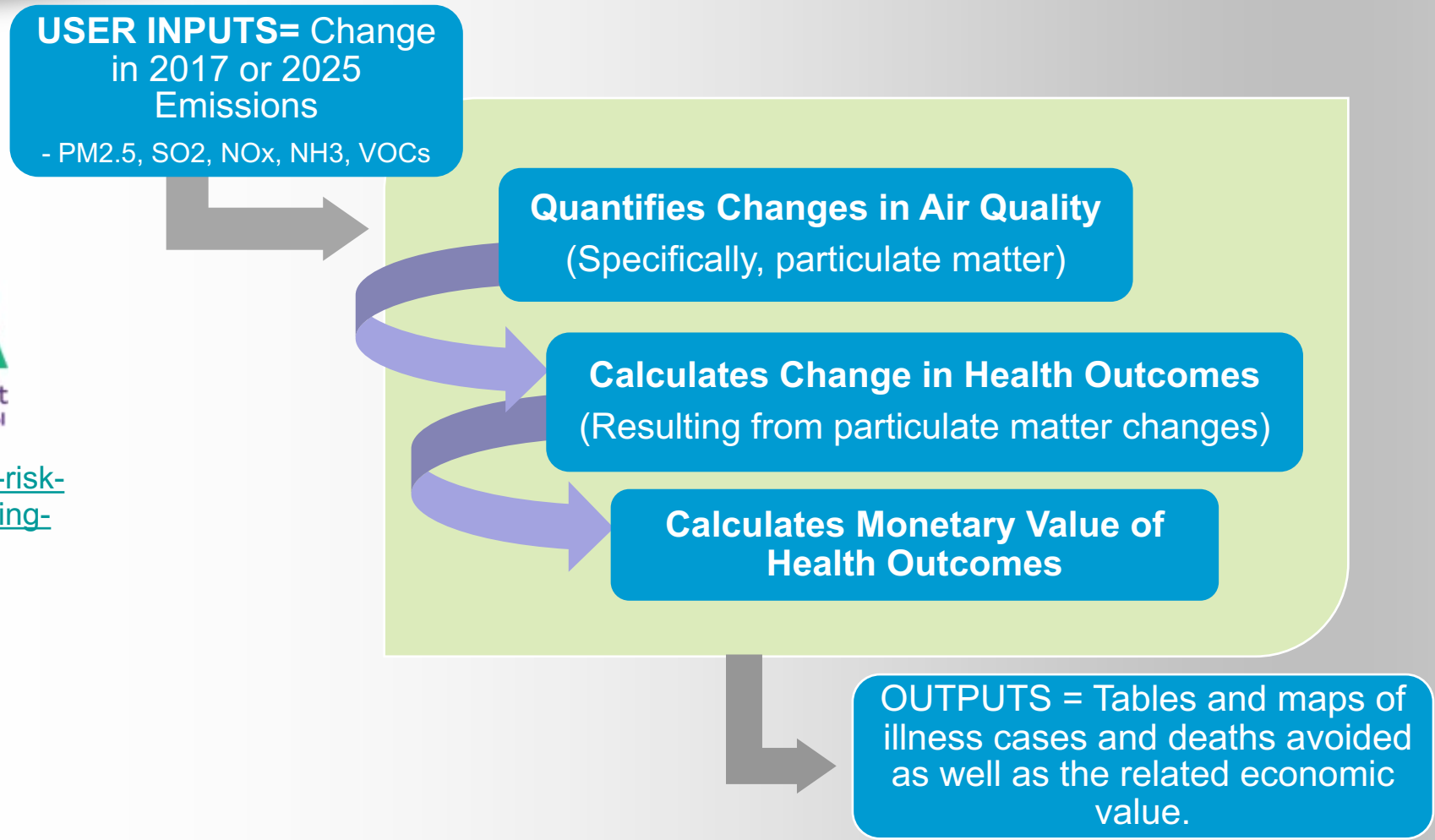 - Run the model
  - View results in graphical and savable formats

Breaks the grid into 10 regions

www.epa.gov/avert
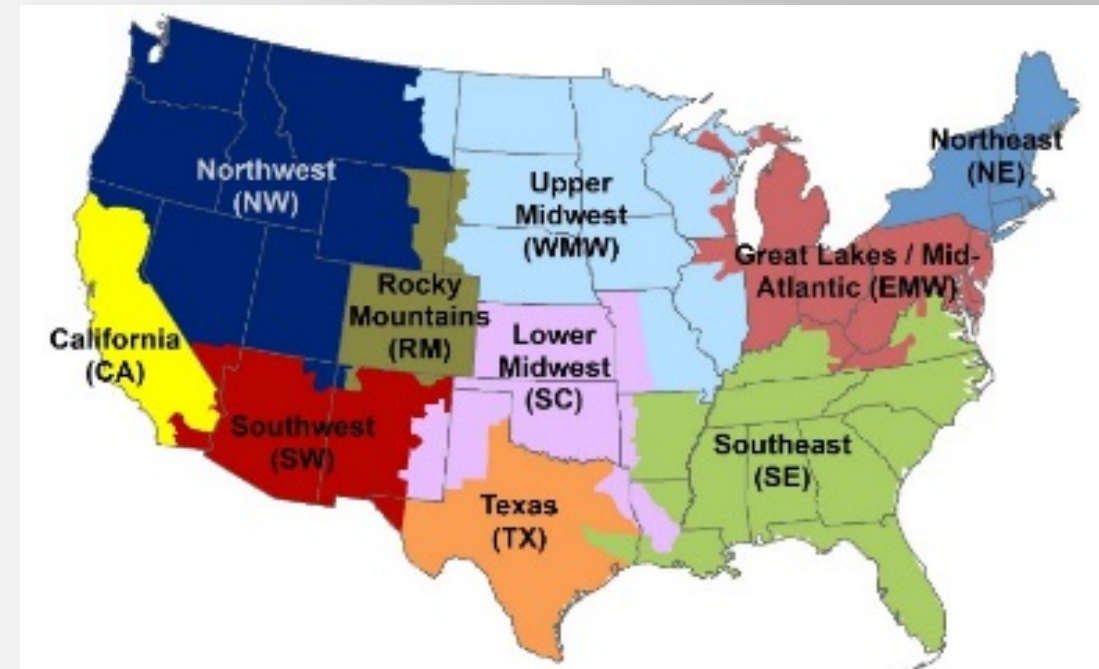
EPA's Co-Benefits Risk Assessment (COBRA) Screening Model

USER INPUTS= Change in 2017 or 2025 Emissions

- PM2.5, SO2, NOx, NH3, VOCs

COBRA
Co-Benefits Risk Assessment
Health Impacts Screening and Mapping Tool

www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool

Quantifies Changes in Air Quality
(Specifically, particulate matter)

Calculates Change in Health Outcomes
(Resulting from particulate matter changes)

Calculates Monetary Value of Health Outcomes

OUTPUTS = Tables and maps of illness cases and deaths avoided as well as the related economic value.

Calculating BPK Factors (¢/kWh)

$$BPK_{t,r} = \frac{HealthBenefits_{t,US}}{GenerationChange_{t,r}}$$

where:

$BPK_{t,r}$ = Monetized public health benefits per kilowatt-hour (¢/kWh) for each EE/RE technology type (t) and AVERT region (r)
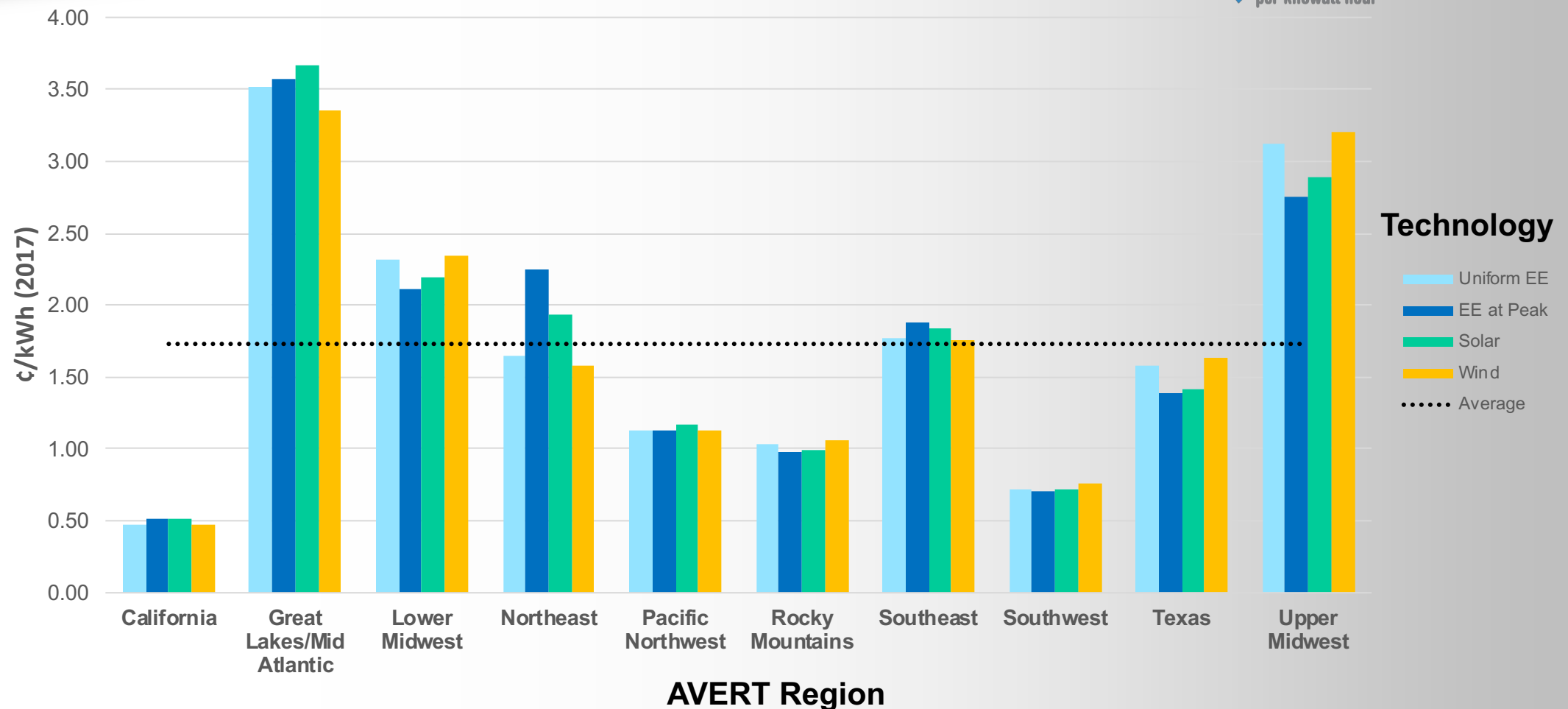
$HealthBenefits_{t,US}$ = Aggregated monetized public health benefits from emissions reductions for each of EE/RE technology type (t) for the entire United States (US)

$GenerationChange_{t,r}$ = Change in electricity generation for each EE/RE technology type (t) and AVERT region (r)
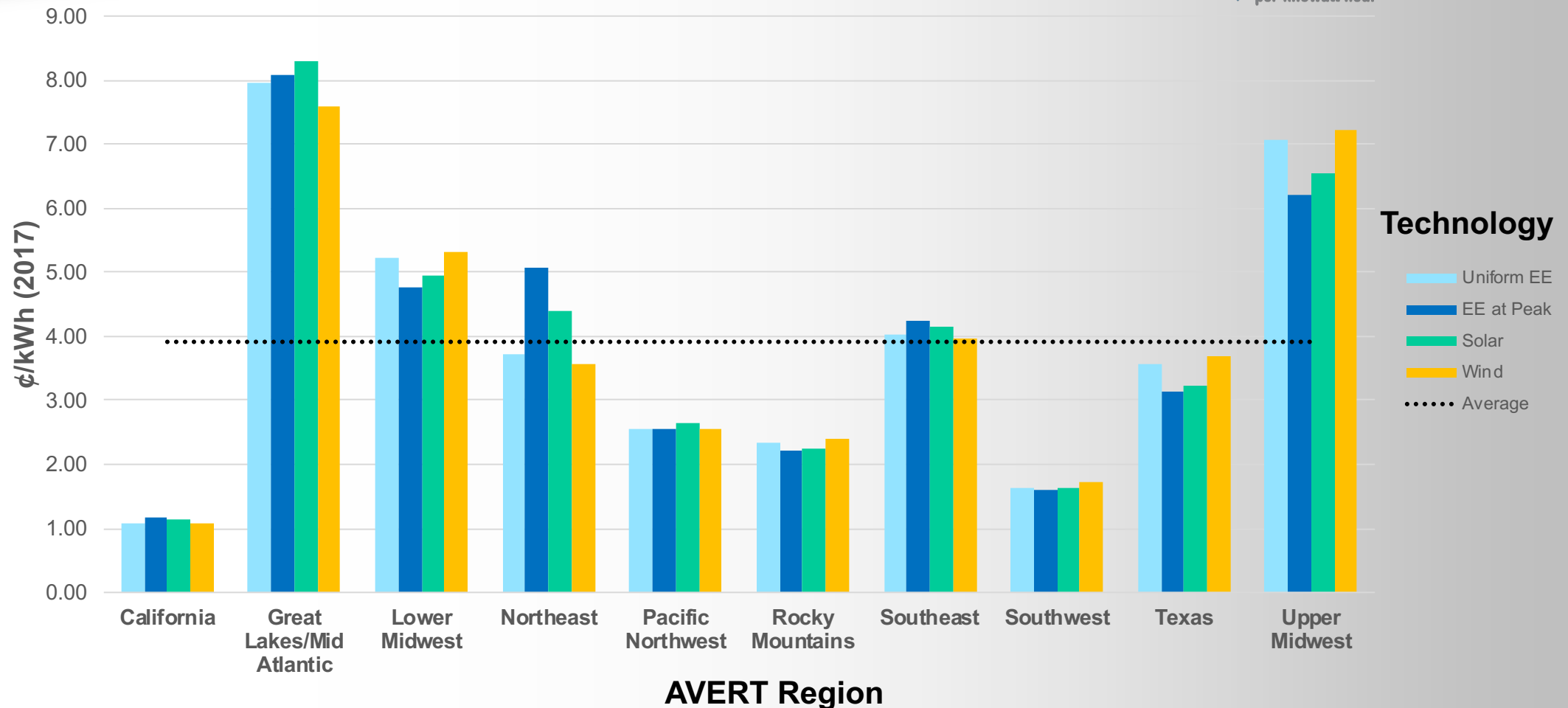

HEALTH BENEFITS per kilowatt hour

Preliminary Results: Low Sensitivity

2017 Benefits-per-kWh (3% Discount Rate, Low Estimate)

Technology
- Uniform EE
- EE at Peak
- Solar
- Wind
- Average

y-axis: ¢/kWh (2017), from 0.00 to 4.00

x-axis (AVERT Region): California, Great Lakes/Mid Atlantic, Lower Midwest, Northeast, Pacific Northwest, Rocky Mountains, Southeast, Southwest, Texas, Upper Midwest

Preliminary Results: High Sensitivity

2017 Benefits-per-kWh (3% Discount Rate, High Estimate)

Preliminary Results: Initial Insights

- Initial BPK factors range from:
  - ‣ 0.4 ¢/kWh to 3.7 ¢/kWh (low sensitivity)
  - ‣ 1.0 ¢/kWh to 8.3 ¢/kWh (high sensitivity)
- Vary more by region than technology
- Driven by both emissions changes and demographics, especially:
  - ‣ Existing fuel mix used for electricity generation
  - ‣ Population density
- Will change over time as the grid evolves

Note: EPA continually reviews its methods and assumptions for quantifying public health benefits. BPK factors will be updated, as appropriate, to reflect any future changes in methods or assumptions.

Limitations of BPK Factors

- Timeframe of the health benefits factors
  - ± 5 years
- Project, program, or policy evaluated
  - Limited to less than 15% of fossil generation in a region
  - EE programs that are significantly different from those modeled
- Limitations related to curtailment of renewables
- Pollutants beyond the scope of the tools
  - Does not include O_3 or CO_2
- Benefits beyond the scope of the analysis
  - Does not include ecosystem impacts or other welfare benefits beyond public health

How Can We Use These Factors?
(Illustrative Example)

EPA United States Environmental Protection Agency

91.8 MW added wind capacity in Northeast in 2018

Data from Energy Information Agency Form 860: https://www.eia.gov/electricity/data/eia860/

Estimated to displace **156,800,000 kWh** of fossil generation

AVERT

BPK x Generation = Estimated Benefits

HEALTH BENEFITS per kilowatt hour

Initial BPK Factors (¢/kWh)		Generation (kWh)	Benefits	
Low	High		Low	High
1.58	3.56	156,800,000	**$2,477,000**	**$5,582,000**

Summary

- State and local governments are interested in **quantifying health benefits from EE/RE**

- EPA is developing **regional-level health BPK factors (¢/kWh)** using AVERT and COBRA (final release TBD)

- EPA is interested in supporting the use of these values by a range of stakeholders working on environmental, energy, and public health issues

- Sign up for our newsletter to learn more!

Questions?

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