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U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Efficiency Potential for States

Support for State Energy Planning

July 13, 2017

Agenda for Today's Webinar: EE Potential for States

I. **Overview** – Danielle Sass Byrnett, Office of Energy Efficiency

II. **State Level Electric Energy Efficiency Potential Estimates**
Kara Podkaminer, EERE Strategic Priorities & Impact Analysis Team

III. **Industrial Energy Efficiency Potential**
Sandy Glatt, EERE Advanced Manufacturing Office

IV. **Economic Energy Efficiency Potential in Single-Family Detached Homes**
Erin Boyd, Office of Energy Policy and Systems Analysis

V. **Energy Efficiency Potential in States: Building Energy Codes**
Jeremy Williams, EERE Building Technologies Office

VI. **Combined Heat and Power (CHP) Technical Potential in the United States**
Anne Hampson, ICF supporting EERE Advanced Manufacturing Office

VII. **Where to Find Resources & Next Steps**
Danielle Sass Byrnett, Office of Energy Efficiency

VIII. **Questions & Answers**

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Energy Efficiency Potential for States: Overview

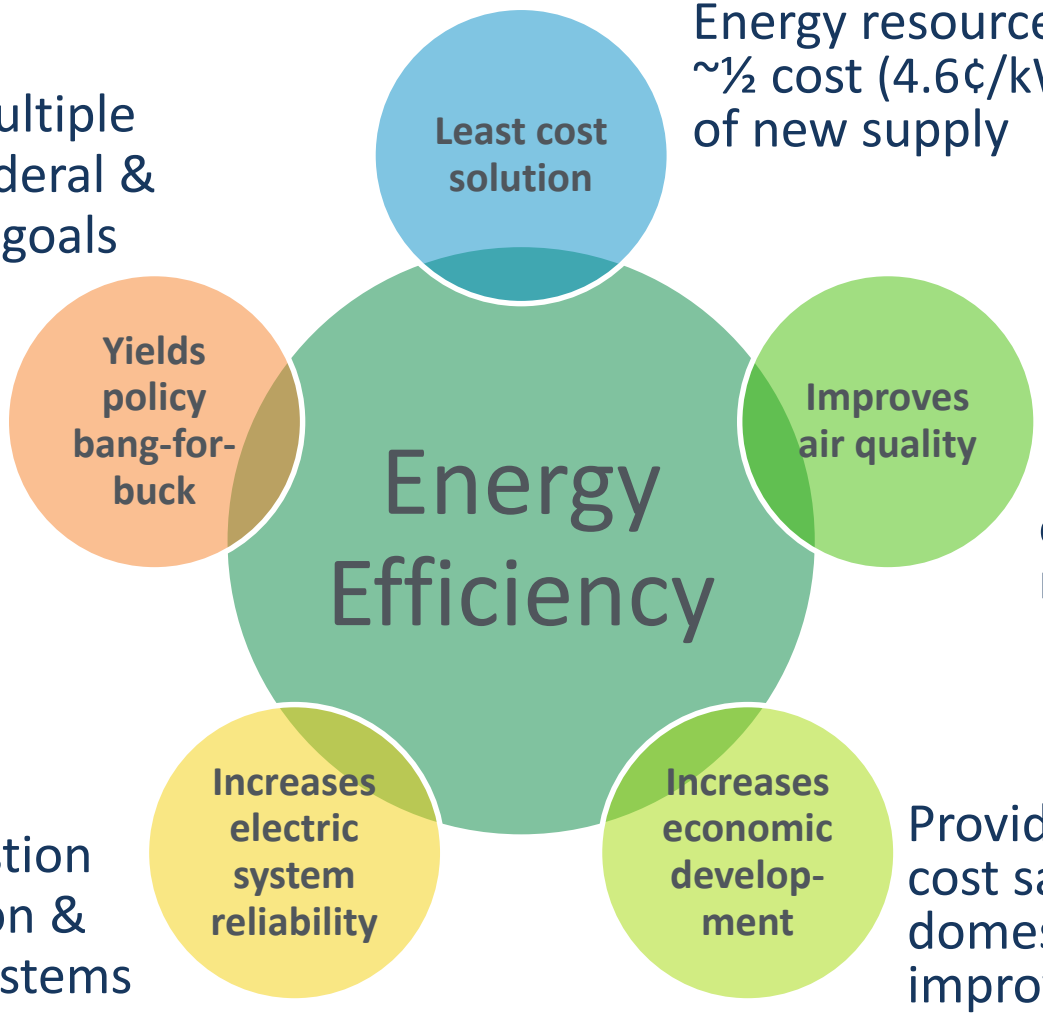
Danielle Sass Byrnett

Office of Energy Efficiency, U.S. Department of Energy

July 13, 2017

Energy Efficiency Offers Numerous Benefits

Helps meet multiple state, local, federal & private sector goals



Energy resource at ~½ cost (4.6¢/kWh) of new supply

Reduces all types of power-plant related emissions

Lowers overall energy congestion on transmission & distribution systems

Provides energy cost savings, domestic jobs, improved competitiveness

Capturing Energy Efficiency Savings is Feasible

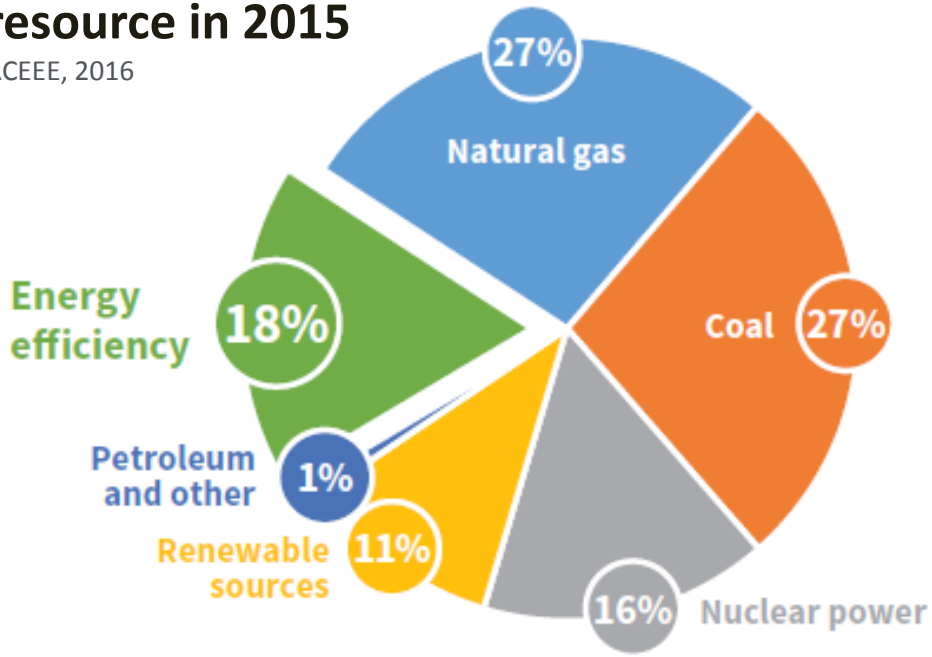
- 16 states (1/3) **achieving** ≥1% annual incremental electricity savings
- 34 states (2/3) achieving ≥0.5%*

Top 10 States

State	2015 net incremental savings, MWh	% of 2015 retail sales
RI	222,822	2.91%
MA	1,472,536	2.74%
VT	110,642	2.01%
CA	5,040,603	1.95%
ME	183,347	1.53%
HI	144,240	1.52%
CT	435,740	1.48%
WA	1,275,447	1.42%
AZ	918,582	1.19%
MI	1,177,277	1.16%

Share of U.S. electricity generation by resource in 2015

ACEEE, 2016

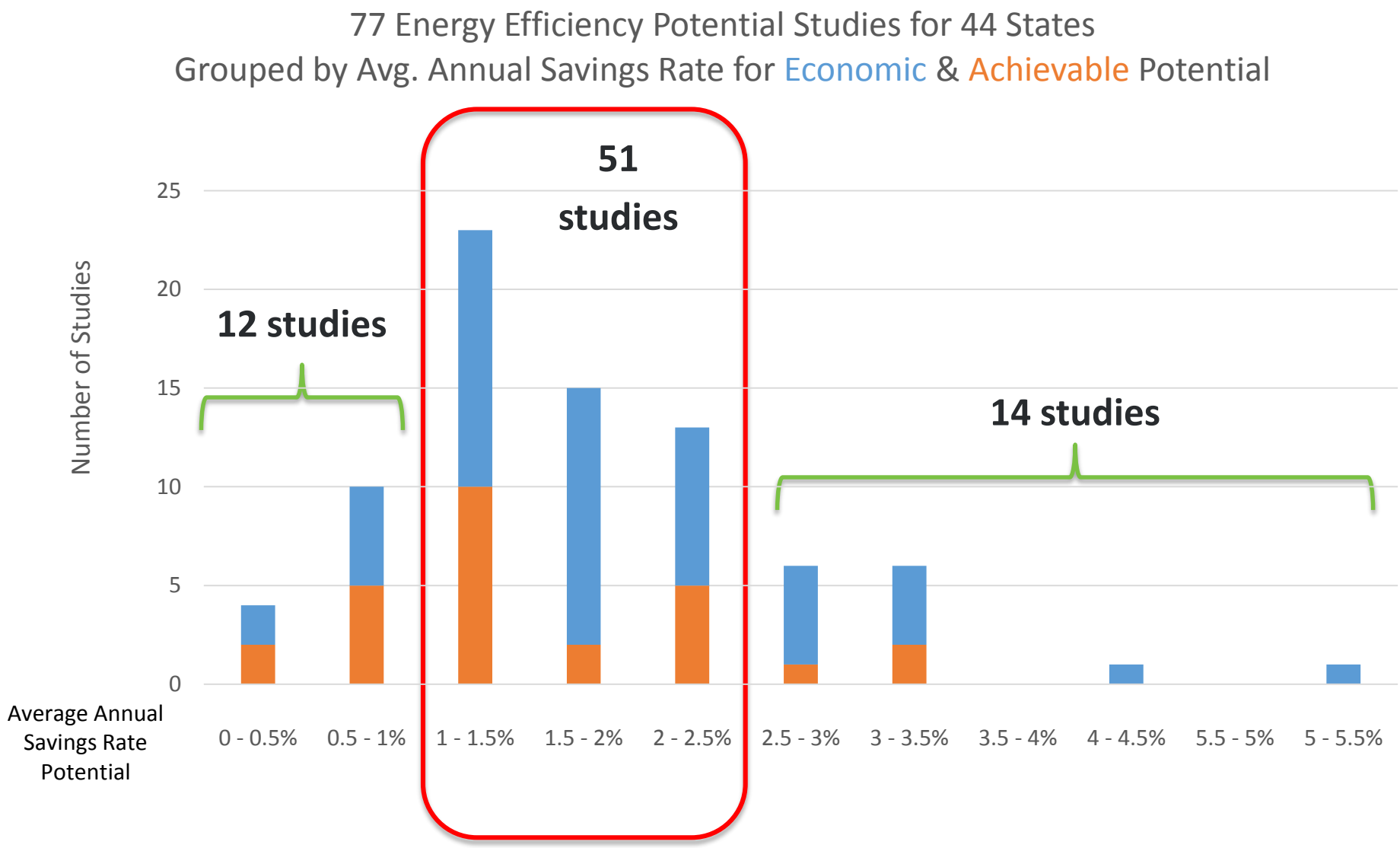


Sources: ACEEE, 2016, The 2016 State Energy Efficiency Scorecard. ACEEE, 2016, The Greatest Energy Story You Haven't Heard.

* Includes states achieving ≥1% annual incremental electricity savings

DRAFT

Diverse State/Utility Analyses Show 1.0-2.5% Avg. Annual EE Potential



U.S. DOE, 2017, *Energy efficiency potential studies catalog*.

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Electric Power Research Institute (EPRI) Report: State Level Electric Energy Efficiency Potential Estimates

Kara Podkaminer

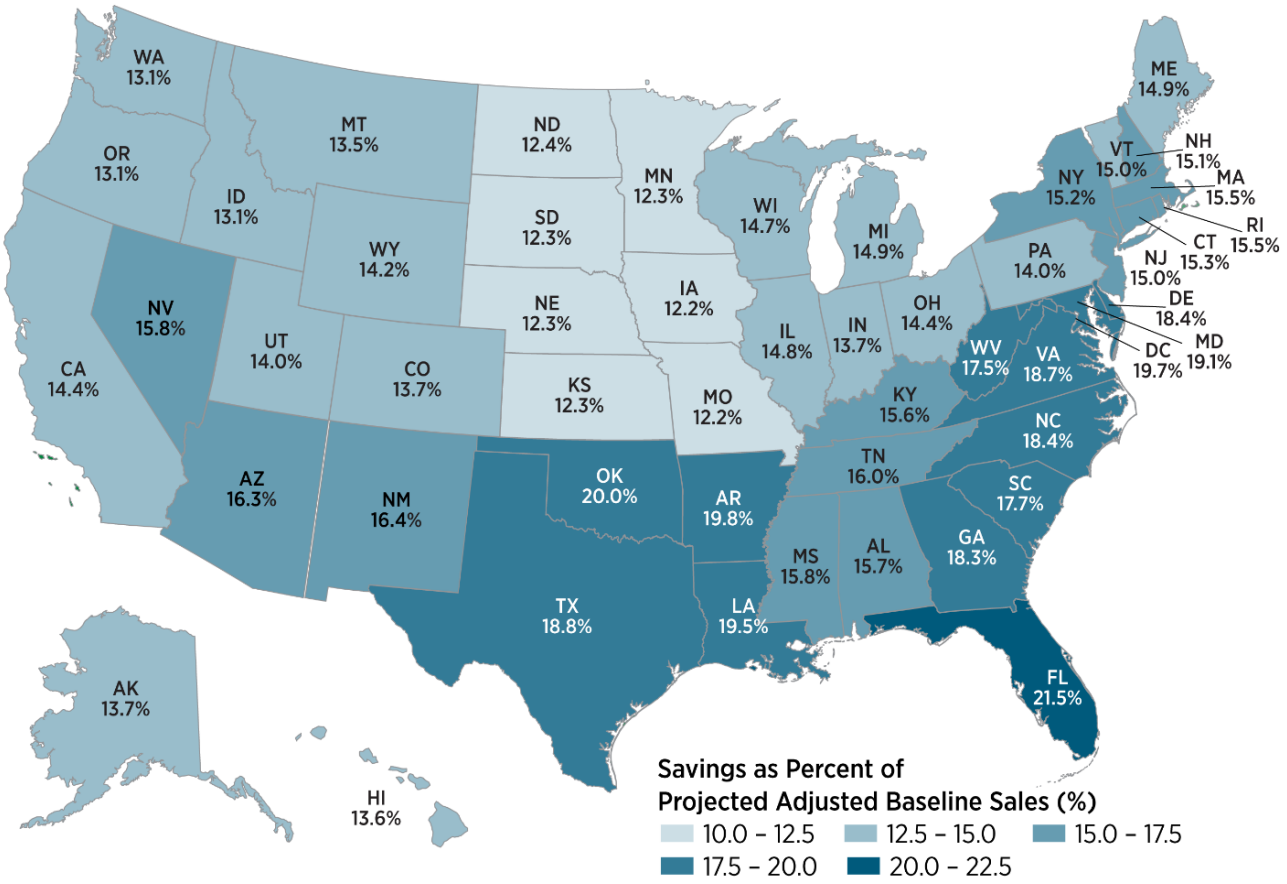
Strategic Priorities and Impact Analysis, EERE

July 13, 2017

State Level Electric Energy Efficiency Potential Estimates

EPRI model estimates economic potential for *electricity* across <u>residential</u>, <u>commercial</u> and <u>industrial</u> sectors, with most recent national study in 2014.

- With DOE support, EPRI developed a methodology to determine state level electricity economic savings potential.
  - Comparison for states with existing potential studies
  - Starting point for states without recent potential studies
- Cost-effective energy efficiency potential equal to 16% of baseline sales in 2035.



Methodology

Based upon the 2014 EPRI national potential study

Key analyses in the updated study:

- State level results disaggregated from national / regional potential
- Benchmark analysis – comparison to historical achievements
- Incentive analysis – potential assessed with $5–$20/MWh incentive

Commercial and Residential Sectors:

- Bottom up, stock turnover model for equipment, tested for cost-effectiveness at end of useful life; estimates controls and shell improvements

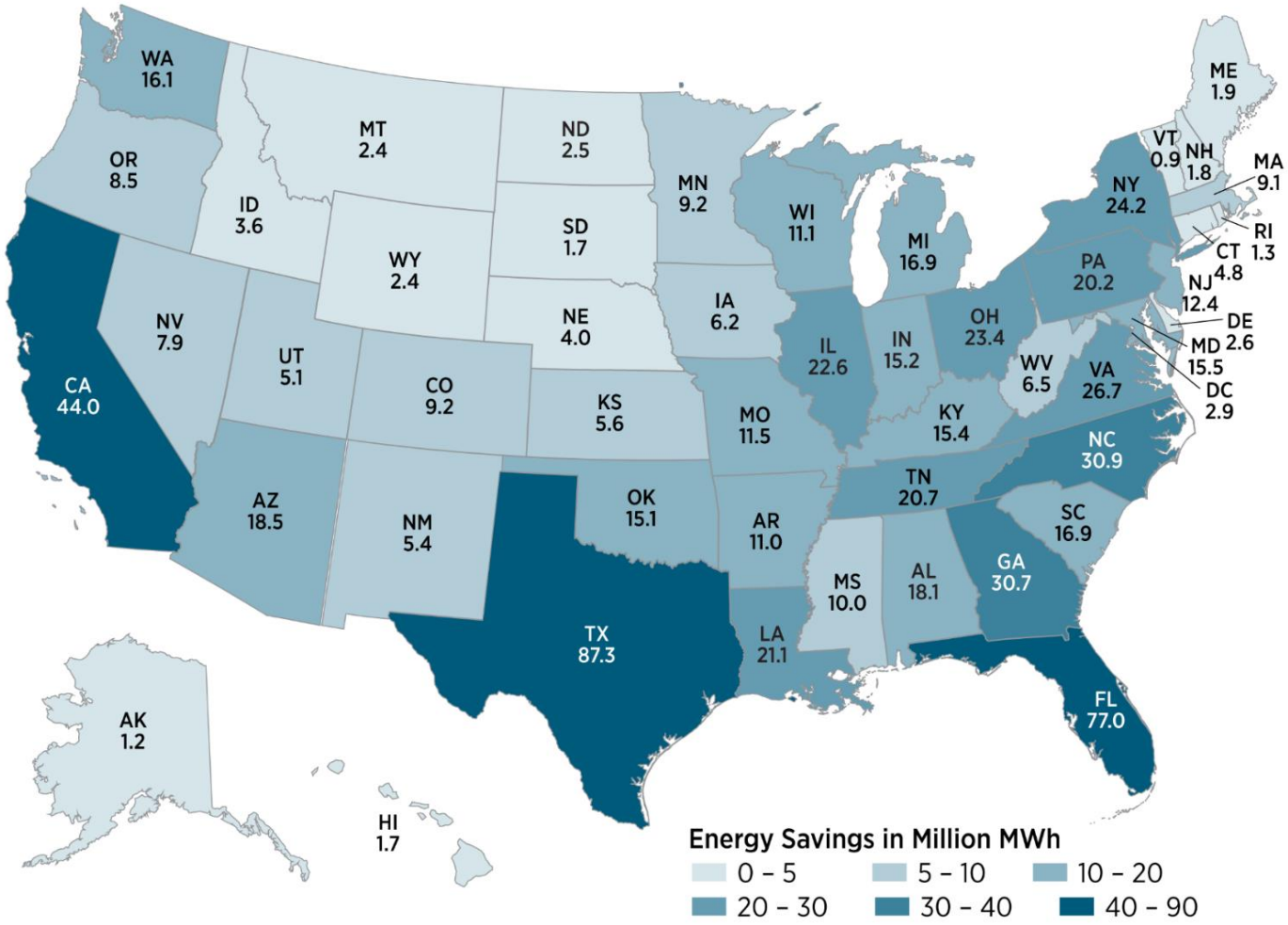
Industrial:

- Top down approach, estimating savings with the EIA Plant Energy Profiler tool

Note: excludes behavioral or program efficiency; limited technology improvement

State-Level Results

Large potential savings from electricity energy efficiency in every state



Largest savings correlate to:

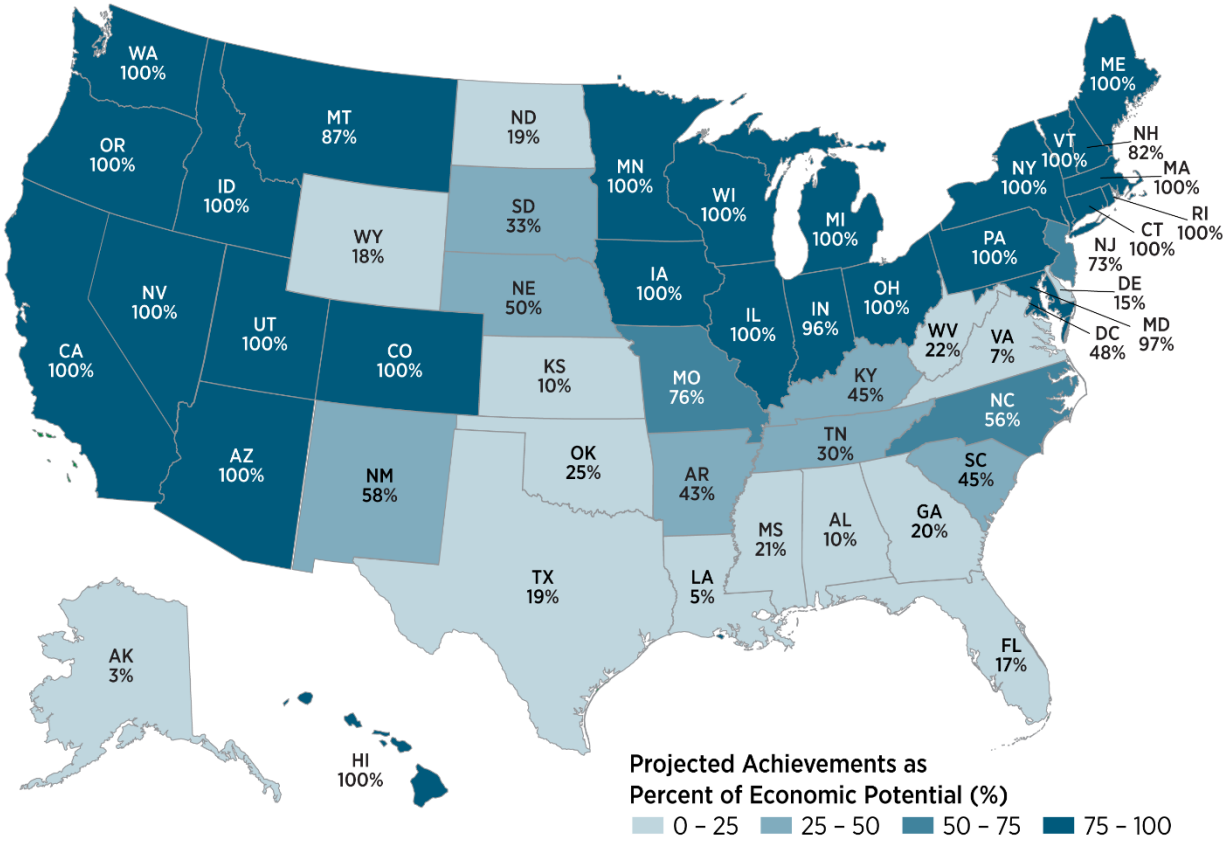
- Climate
- High electricity use
- Population
- Electricity-intensive manufacturing

Additional data in the report

Benchmark Analysis

State progress towards achieving even conservatively modeled EE potential varies widely

- 22 states can capture the modeled savings by continuing to save at their historical rates
  - ➢ Additional savings possible through program efficiency, behavioral efficiency, and innovation
- 29 states are leaving cost-effective savings on the table
  - ➢ 20 states are poised to achieve <50% of the modeled savings

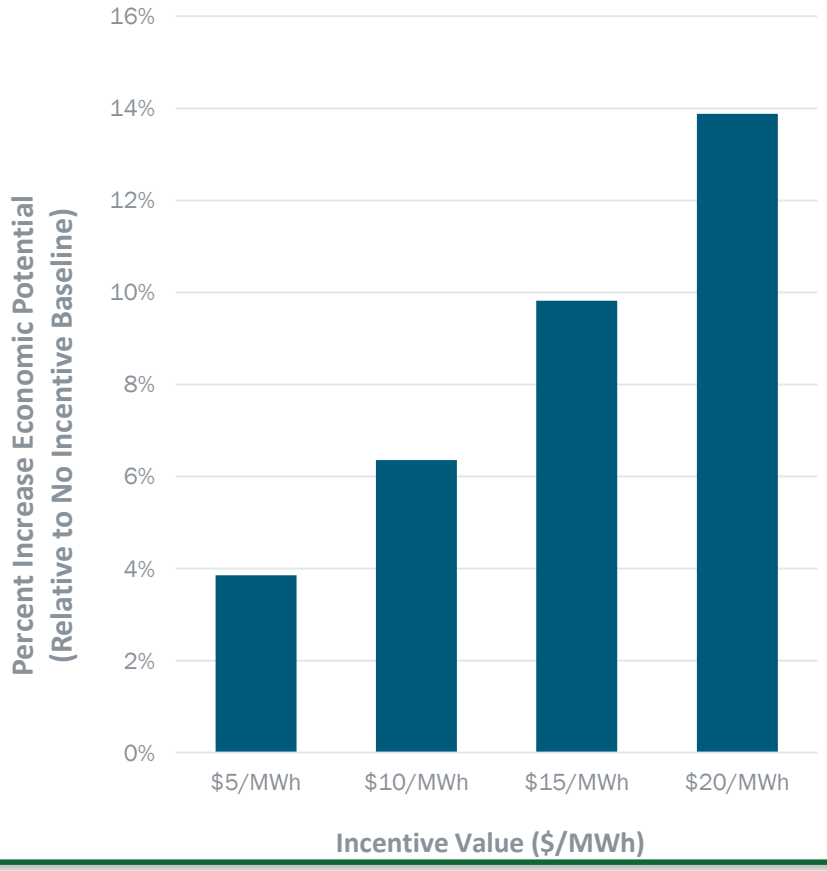


Data on savings rates from ACEEE State Scorecard. Assumes progress at historical rate. Higher savings are feasible.

Incentives Analysis

Re-ran the model with added incentive, a proxy for lower EE cost or higher avoided cost

- $20/MWh incentive increases EE economic potential by 102,848 GWh to 19% of baseline sales



A $20/MWh incentive increases economic potential by nearly 14%

- Identifies technologies near cost-effective where cost reduction has a large impact

  ex: Television, computers, heat pumps

Impact most prominent in the residential sector

- Economic potential increased by 25% with $20/MWh incentive for residential sector relative to no incentive
- Commercial and industrial sector economic potential increases by 7% with a $20/MWh incentive

Additional data in the report

Thanks!

- Download the full report on the EPRI website or at: https://energy.gov/eere/analysis/downloads/state-level-electric-energy-efficiency-potential-estimates-0

- Keep an eye out for new analysis: EPRI plans to update the national study in 2017 or 2018
  - Update technology cost and performance
  - EPRI is hosting a planning workshop in October

- For additional questions, contact:
  - Kara Podkaminer (Kara.Podkaminer@ee.doe.gov)
  - Chris Holmes (cholmes@epri.com)
  - Sara Mullen-Trento (smullen@epri.com)

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Industrial Energy Efficiency Potential

Sandy Glatt

U.S. Department of Energy

Advanced Manufacturing Office

July 13, 2017

Industrial Energy Efficiency Opportunity

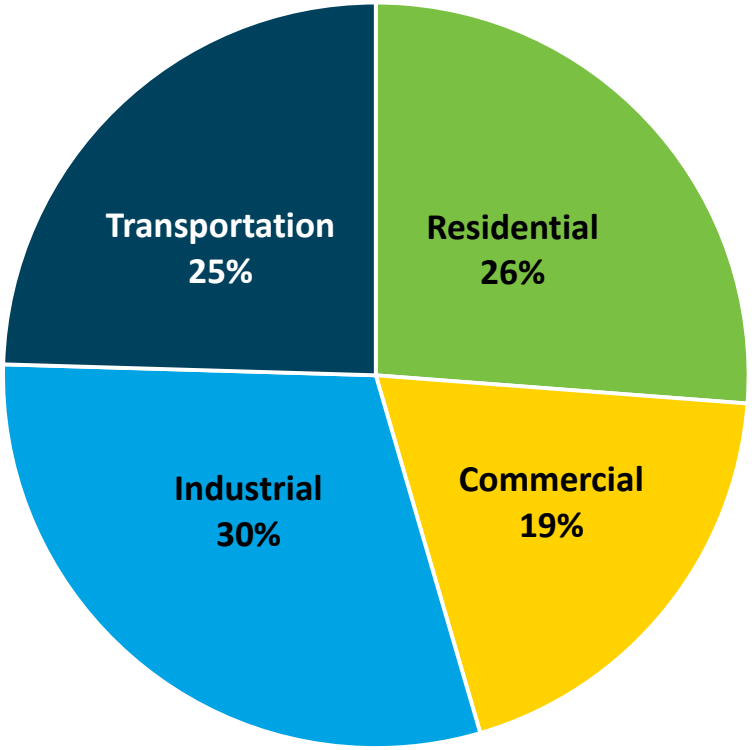
- Industrial sector accounts for largest share of energy consumption in the U.S. at 30%
- There is a large opportunity for capturing energy efficiency potential in the industrial sector

2030 Industrial Energy Efficiency Savings Opportunity:

7,500.3 trillion Btu national energy savings

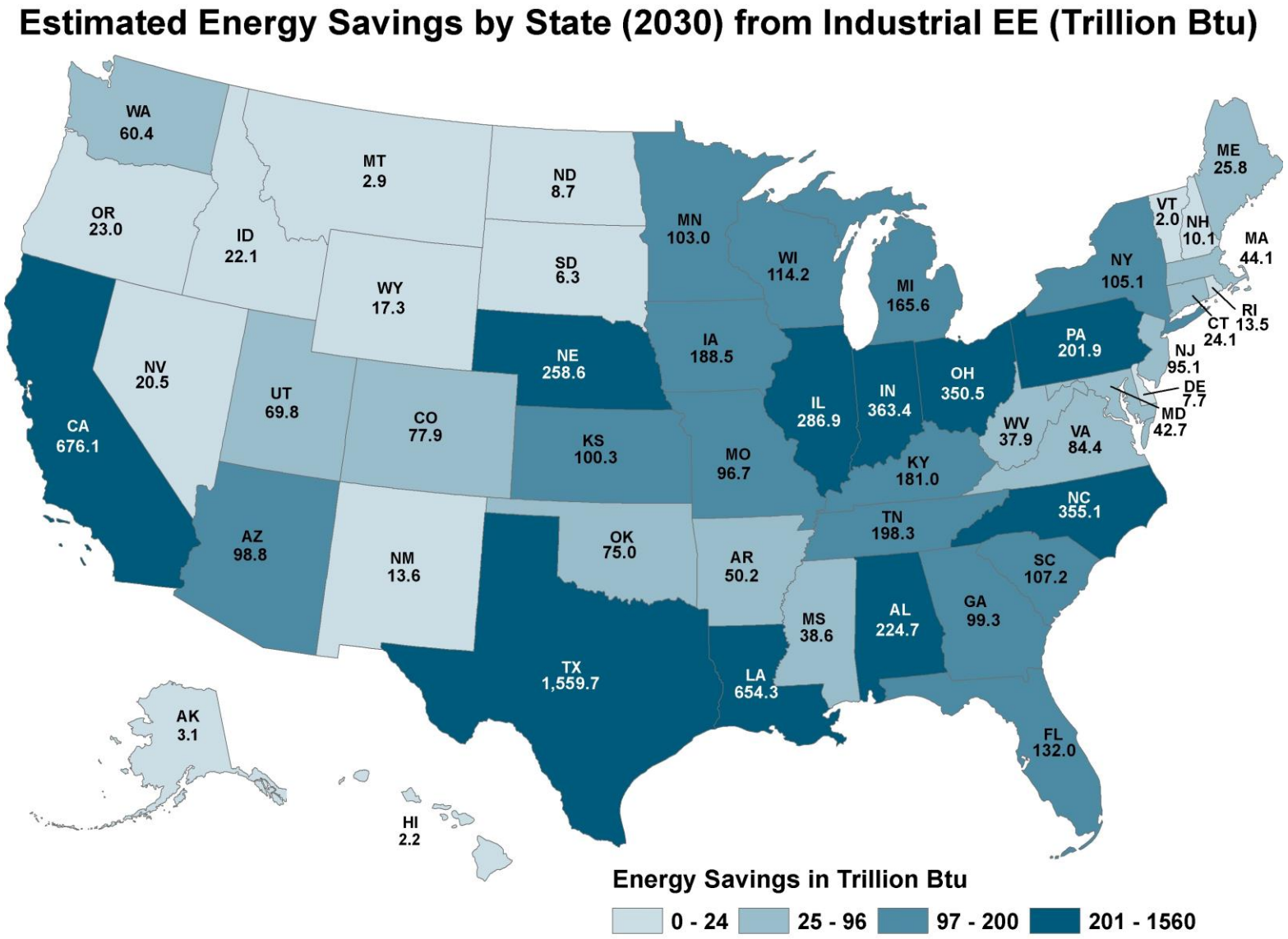
2.2 to 1,559.7 trillion Btu per state

U.S. Energy Consumption by Sector



Source: U.S. Energy Information Administration, January 2016 to January 2017, *Monthly Energy Review* – Table 2.1.

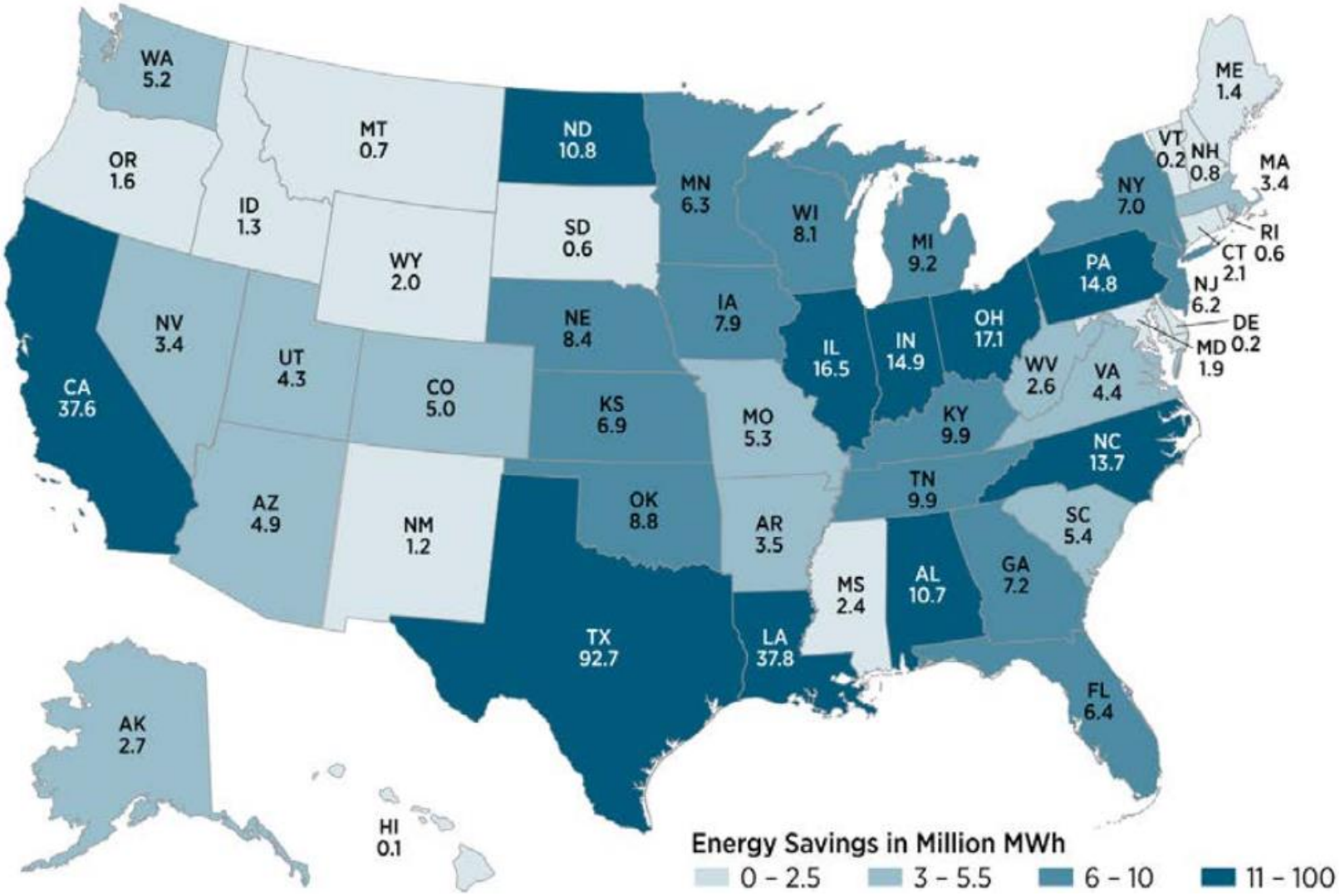
State-Level Industrial Savings Estimates (All Fuels)



Source: DOE, 2017, energy.gov/eere/slsc/Eeopportunities.

State-Level Industrial Electricity Savings Estimates

Estimated Electricity Savings by State (2030) from Industrial EE (million MWh)



State-Level Industrial Savings Methodology

- Analysis uses historical growth averages for value of shipments to project economic growth out to 2030 for sectors within each state
- This projection is combined with energy intensity projections to estimate future state energy consumption for two different scenarios:
    1. The BAU scenario utilizes EIA's projections in energy efficiency out to 2030; for example, EIA's industry-wide BAU rate is 1.2%
    2. The second scenario estimates savings by 2030 if each sector were to double their BAU rate of energy efficiency improvement, which would be 2.4% industry-wide
- Results indicated 435.8 million MWh in electricity savings and 7,500 trillion Btu in total fuel savings could be achieved by 2030

What Is Included in Industrial Energy Efficiency?

Industrial energy efficiency can be improved through equipment, process, or organizational changes. A wide range of approaches are available:

- Individual facilities make **project-by-project** capital investments to improve the energy efficiency of one process or piece of equipment at a time.
  - DOE's Advanced Manufacturing Office (AMO) has a robust R&D program which addresses new and emerging technologies, materials and processes
  - Partners in DOE's **Better Plants** Initiative pledge a 25% reduction in energy intensity across their facilities over 10 years; how they determine which investments to make and how to measure the improvements varies.
- **Strategic Energy Management (SEM) programs** supports a change in corporate culture that takes a systematic view across the organization, in addition to the facility's processes.
- **50001 Ready** Voluntary program that recognizes a facility's self-attestation to the requirements of the ISO 50001 (International Energy Management Standard) with companion tools for implementation
- **ISO 50001 Certification** provides an approach to implement international best practice standard and includes third party verification and certification to the ISO 50001 standard
- DOE's **Superior Energy Performance** (SEP) program requires implementation of ISO 50001 and adherence to DOE's SEP EM&V protocol to create and measure continual and persistent energy savings for all types of fuels, including electricity.

- Significant cost-effective opportunities (often less than one-year payback) are available for industrial, institutional and commercial facilities that adopt ISO 50001.

DOE Industrial Energy Efficiency Support and Tools

Technical Tools & Support

- **50001 Ready Navigator**: Online tool, with simple, step-by-step approach to 50001 Ready implementation
- **EnPI/EnPI lite tools**: Supports quantifying facility-wide energy performance improvement
- **Energy Footprint Tool**: Helps gather energy bills; identify all fuel consumption and costs; determine where energy is going
- **Energy System Tools**:
  - Steam System Modeler Tool
  - Process Heating Assessment Tool 4.0
  - Pump System Assessment Tool
  - Fan System Assessment Tool
  - Compressed Air Master Tool
- **Industrial Assessment Centers**: Provides energy assessments for facilities across the country
- **Case studies**: Facilities describe their SEP implementation and lessons

Industrial EE Appendix – Assumptions in Methodology

In order to perform the analysis, some assumptions had to be made, which included:

- Fuel consumption for specific 3-4 digit NAICS codes is not available at the state level; therefore, this analysis assumed that the sectors in each state have the same electricity intensity as the national average.
- This analysis a Assumed that economic growth out to 2030 would be consistent with the historical growth seen in that sector from 2004-2012.
  - We wanted our estimate to utilize a conservative approach in projecting economic growth. Therefore, 2004-2012 was used since economic cycles tend to last approximately 8 years, and this period incorporates a full economic cycle, including both a period of growth and recession.

Industrial EE Appendix – Data Sources

- U.S. Energy Information Administration 2014 Annual Energy Outlook
- Baseline data:
  - For NAICS 21, 23, & 31-33: Value of shipments data from the U.S. Census Bureau 2012 Economic Census
  - For NAICS 11 (Agriculture): Value of shipments data from the U.S. Census Bureau 2012 Survey of Business Owners
- Projecting growth multiplier to 2030:
  - For NAICS 31-33: Annual change in value of shipments data from the U.C. Census Bureau Annual Survey of Manufactures (ASM)
  - For NAICS 11, 21, & 23: Average annual change in Gross Domestic Product (GDP), using data from The U.S. Department of Commerce Bureau of Economic Analysis (BEA)

Questions & Contact Information

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Advanced Manufacturing Office
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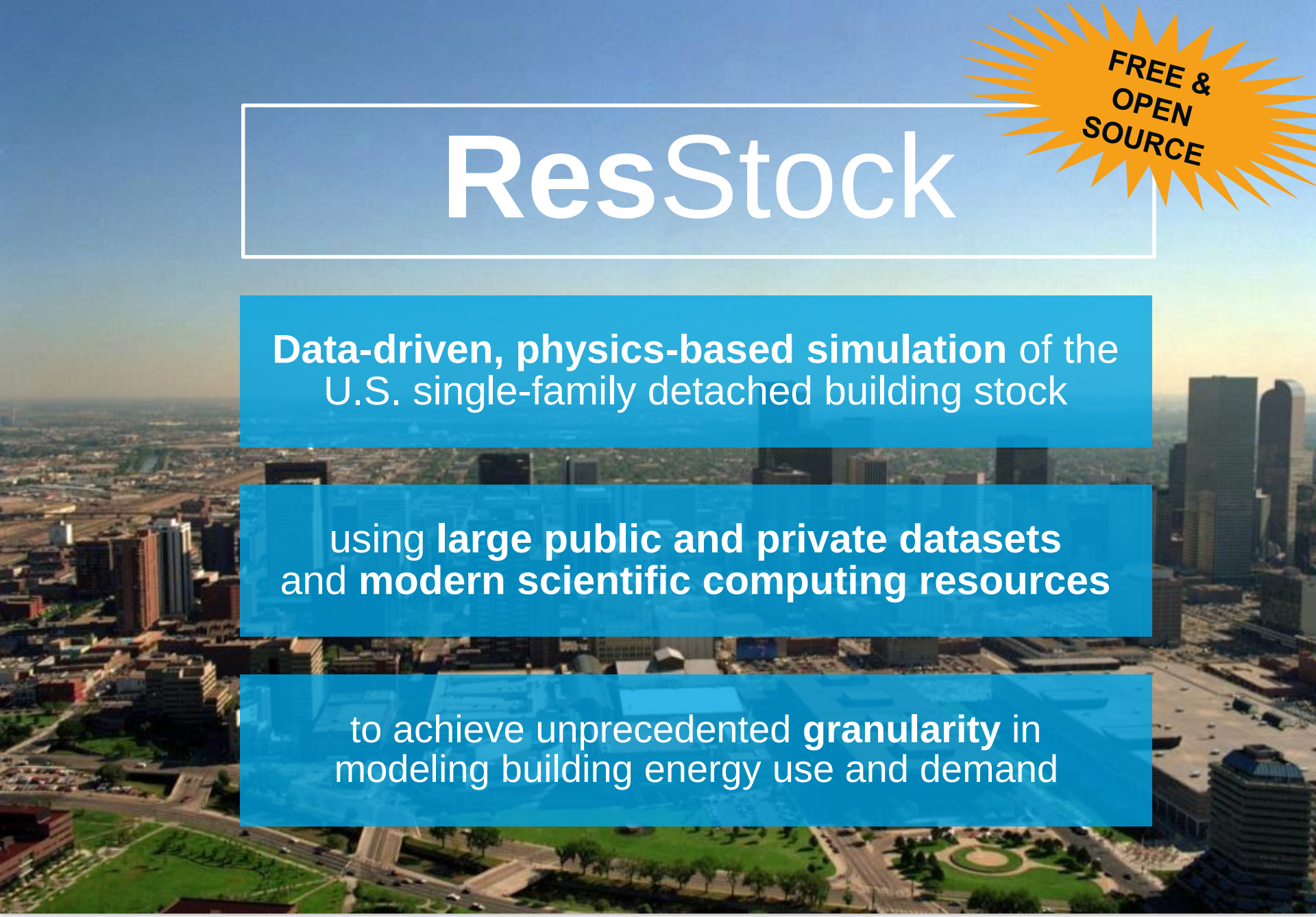
Economic Energy Efficiency Potential in Single-Family Detached Homes

Erin Boyd

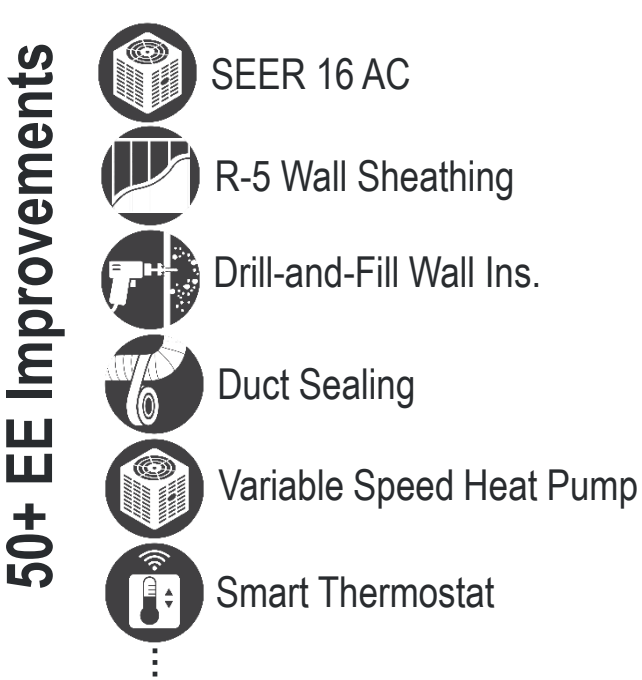
U.S. Department of Energy

Office of Energy Policy and Systems Analysis

July 13, 2017


FREE & OPEN SOURCE
ResStock
Data-driven, physics-based simulation of the U.S. single-family detached building stock
using large public and private datasets and modern scientific computing resources
to achieve unprecedented granularity in modeling building energy use and demand

ResStock Improvements and Packages



Potential to save 4,200 trillion Btu of primary energy per year (24% of SFD consumption) and avoid 273 million tons carbon equivalent per year (24% of SFD emissions)

- State level results with potential to add higher resolution to future analysis
- Analysis covers all of the residential fuel types—electricity, natural gas, propane, and fuel oil

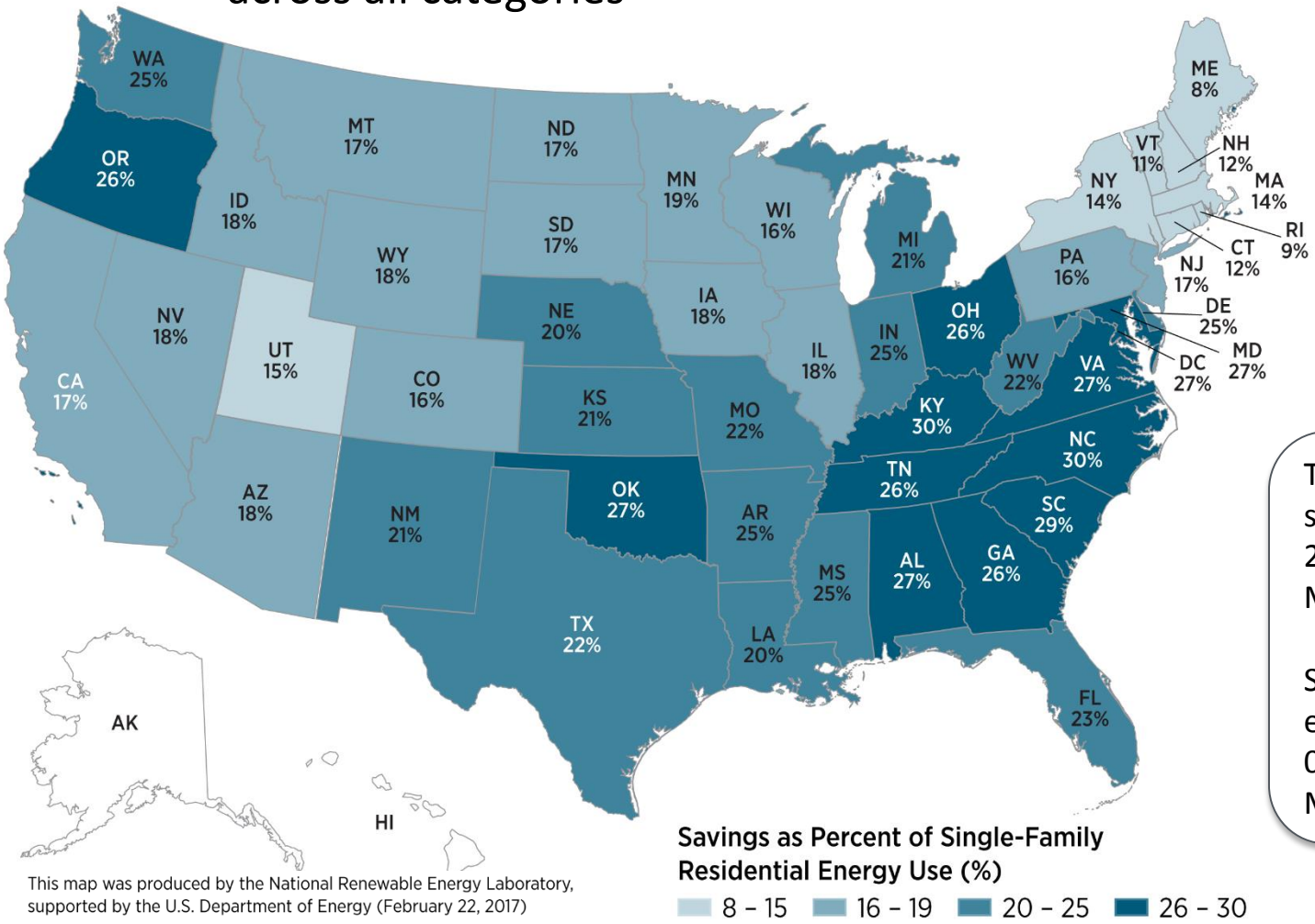
Full Report: Electric End-Use Energy Efficiency Potential in the U.S. Single-Family Housing Stock

Example Output Variables – Available by State

- Electricity, natural gas, oil, or propane savings
- Primary energy savings
- Carbon emission reductions
- Aggregate and per-house savings
- Economic variables
- Applicability statistics
- Output for different slices of the housing stock (e.g., vintage, income)

Single-Family Economic Potential Electricity Savings (2042)

Packages of the most cost-effective (NPV>0) upgrades in each home across all categories



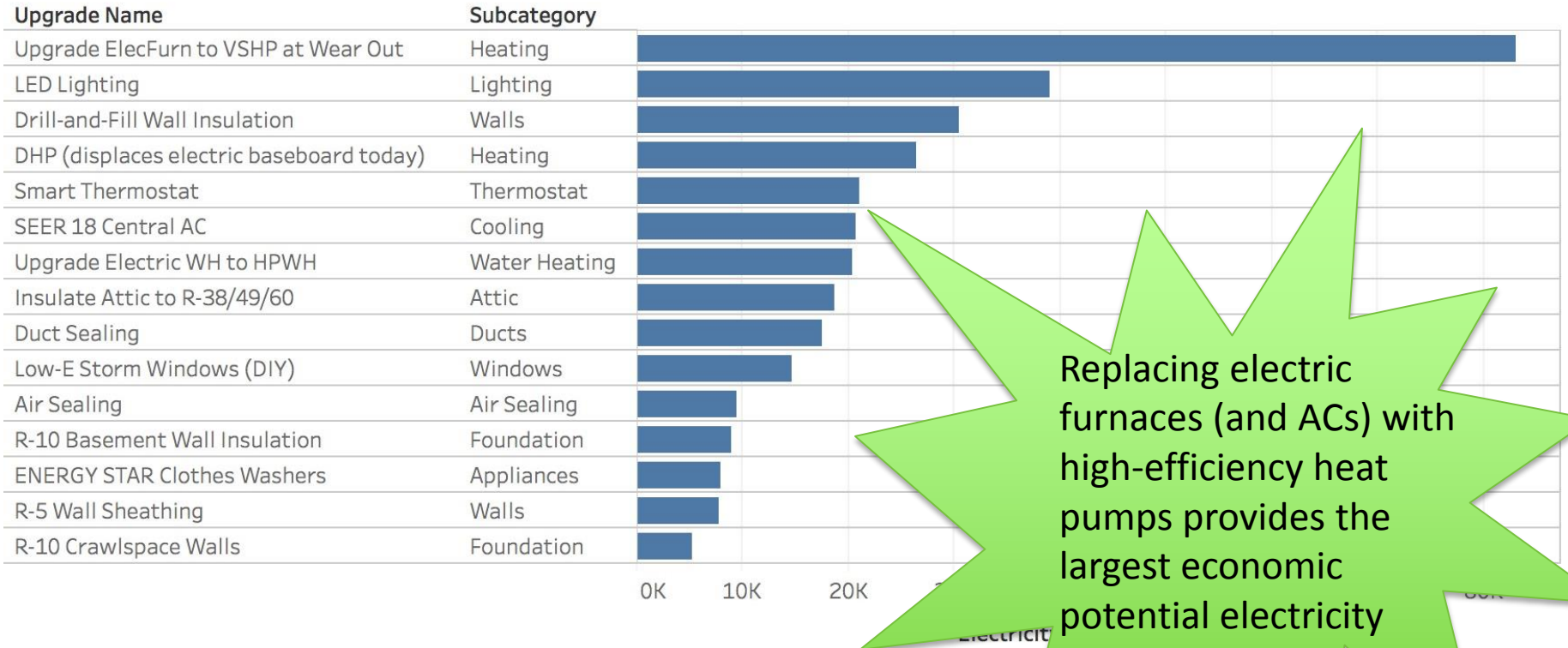
This map was produced by the National Renewable Energy Laboratory, supported by the U.S. Department of Energy (February 22, 2017)

Total electricity savings:
245 million MWh/yr

State-level electricity savings:
0.2 to 22.2 million MWh/yr per state

Individual Improvements- Economic Potential Electricity Savings

Efficiency Improvements with the Highest Cost-Effective Savings Potential Nationally (positive NPV)



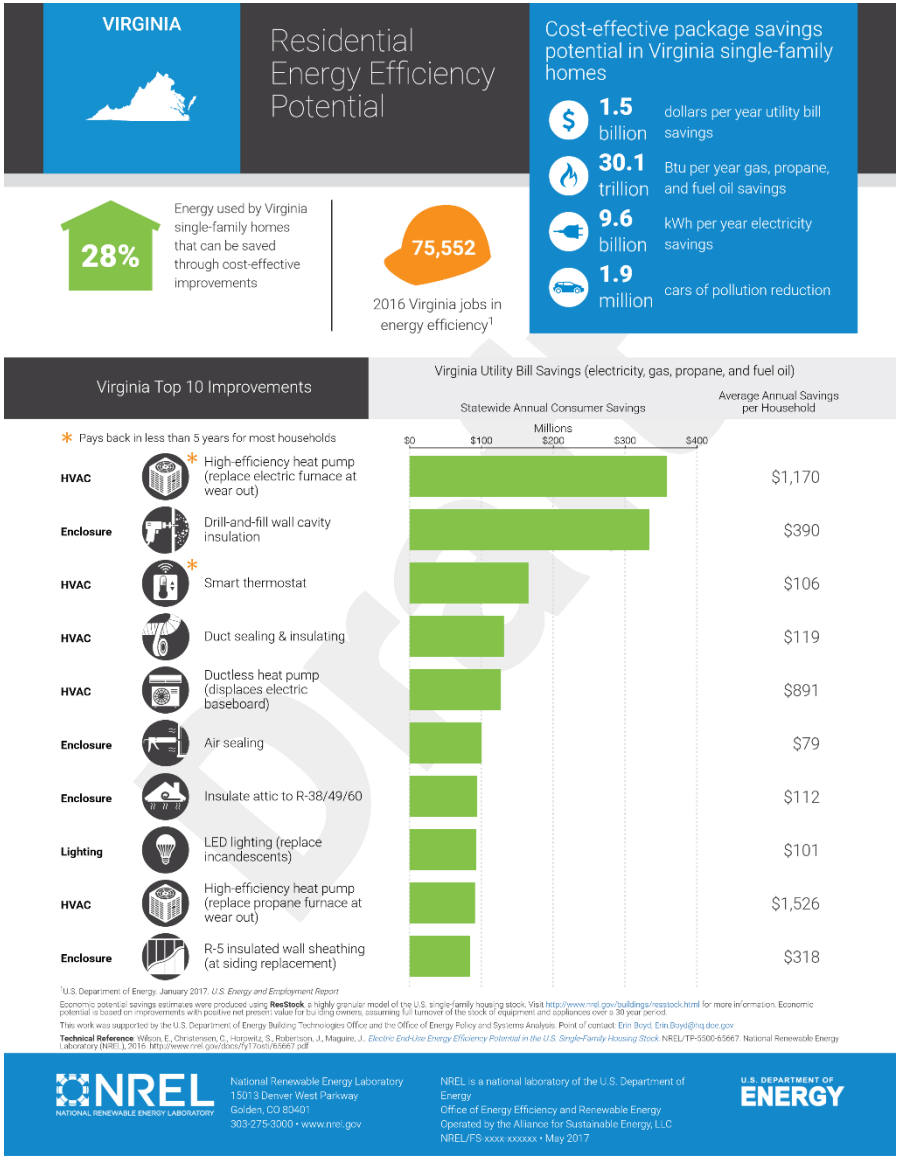
Replacing electric furnaces (and ACs) with high-efficiency heat pumps provides the largest economic potential electricity savings nationally.

State Resources on Energy Efficiency Potential in Single-Family Detached (SFD) Homes

- Actionable results for states
  - Top priority upgrades
  - Relative cost effectiveness of measures
- Custom fact sheets for the lower 48 states
- State EE supply curves
- For questions contact:
  Erin Boyd – erin.boyd@hq.doe.gov

Residential Energy Efficiency Improvements: Additional DOE Partnerships, Tools, and Resources

- Home Performance with ENERGY STAR
- Better Buildings Residential Network
- Home Energy Score
- SEE Action Residential Retrofit Working Group
- Residential Program Solution Center



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Building Energy Codes

Jeremy Williams

Building Energy Codes Program
U.S. Department of Energy

July 13, 2017

DOE Building Energy Codes Program

- **Mission**: Support the building energy code development, adoption, implementation and enforcement processes to achieve the maximum practicable, cost-effective improvements in energy efficiency while providing safe, healthy buildings for occupants.
- **Study Background**: DOE regularly evaluates impacts of building energy codes—most recent update published last year by Pacific Northwest National Laboratory (October 2016).

Building Energy Codes

Methodology Highlights:

- Residential & commercial buildings
- National and state-level perspectives
- Annual and cumulative projections (2010-2040)

All three phases of codes:

- **Development**: Code-to-code savings—represents *potential* savings based on updated model codes [DOE Determination]
- **Adoption**: Future adoption projected based on historical state adoption trends [DOE state adoption tracking]
- **Compliance**: Savings de-rated based on what is achieved in the field [DOE and external studies]

Building Energy Codes

Methodology (continued):

- Excludes states without statewide codes (AK, HI, KS, MO, MS), or that fundamentally differ from the model codes (CA, OR, WA)
- Some 'home rule' states rely on data from populous jurisdictions as a surrogate for state compliance (AZ, CO, WY)
- Residential compliance rates based on recent DOE field studies—commercial based on past DOE and external studies
- Incremental savings are scaled by new floor space to calculate statewide and national savings (AEO 2015)
- Several metrics reported (site, primary, FFC, cost, and CO_2)

Building Energy Codes

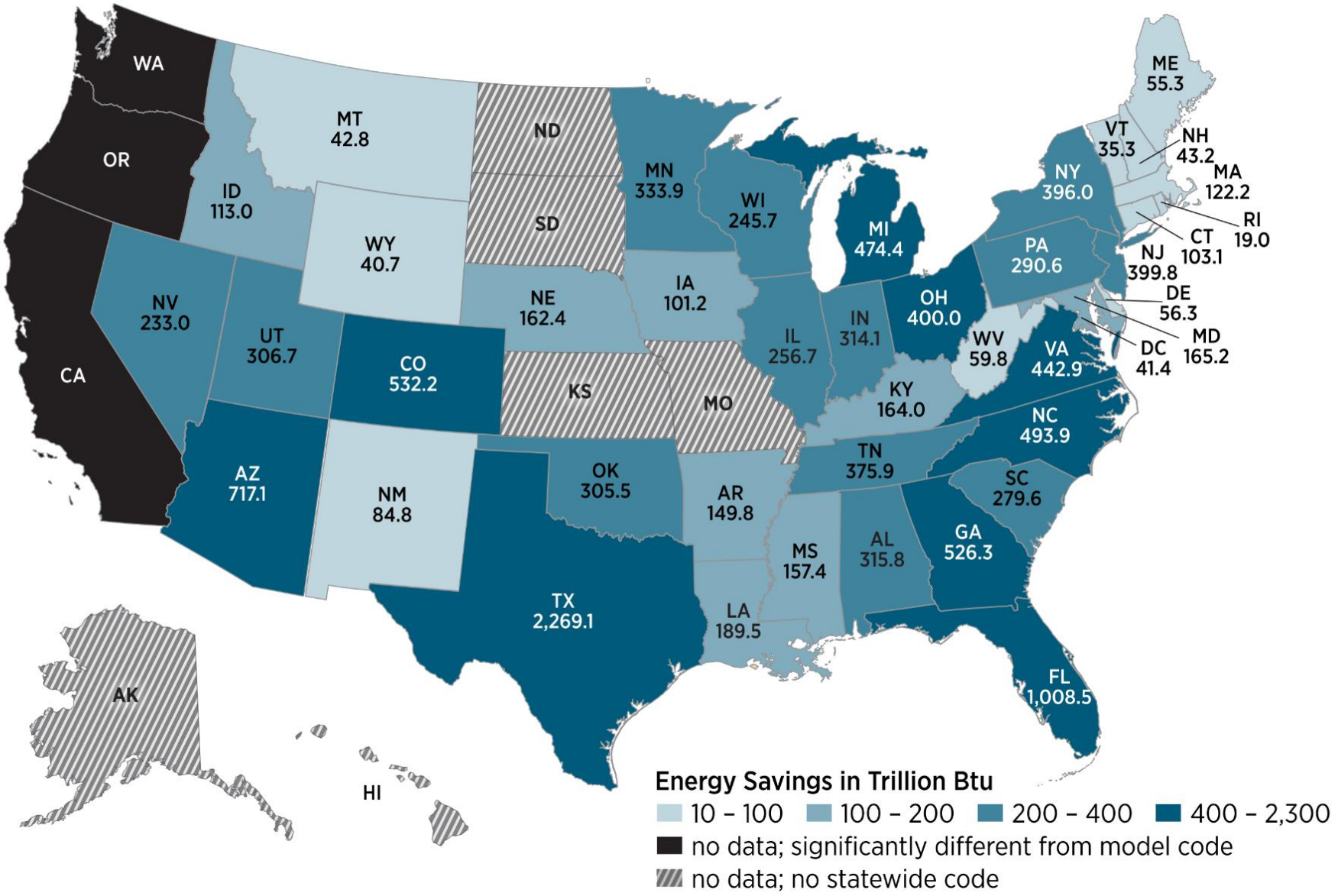
National Savings (2010-2040):

- **$126 billion** in energy cost savings
- **12.82 quads** of primary energy
- **841 MMT** of avoided CO_2 emissions

Additional details available, including a breakout of residential and commercial sector estimates, state estimates, and more:

www.energycodes.gov/about/results (full report)

Estimated Achievable Potential Energy Savings by State (2010–2040) from Building Energy Codes (Trillion Btu)



Learn More: https://energy.gov/eere/slsc/EEopportunities

Building Energy Codes

State Savings Map:

https://energy.gov/eere/slsc/EEopportunities

Additional Building Energy Codes Resources:

- Energy savings analysis and state certification guidance
- National and state cost-effectiveness analysis
- Education & training resources
- Impact analysis
- Code questions Help Desk
- State technical assistance requests

Contact: Jeremy Williams (jeremy.williams@ee.doe.gov)

www.energycodes.gov

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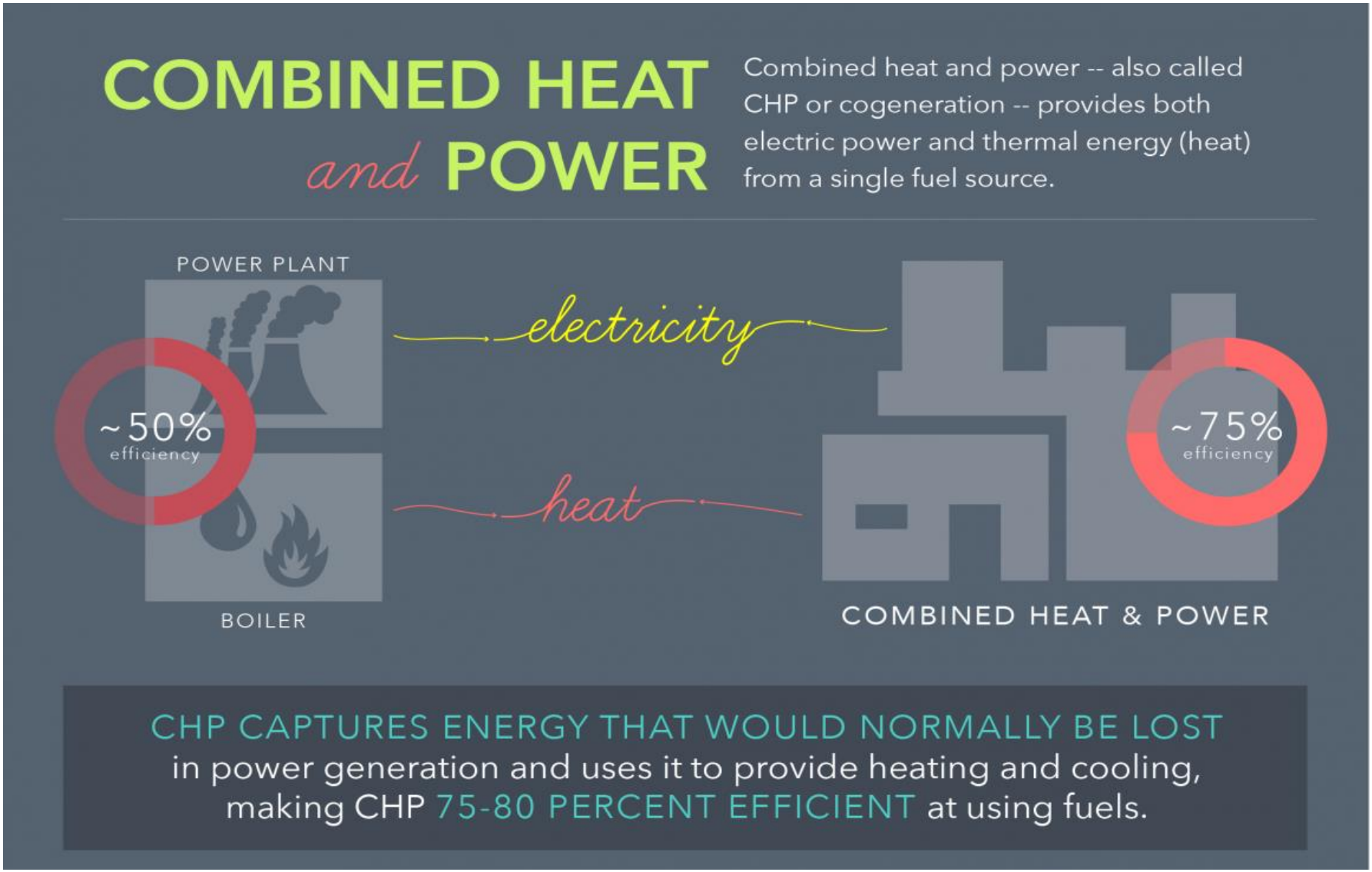
Anne Hampson
ICF supporting EERE's Advanced Manufacturing Office

July 13, 2017

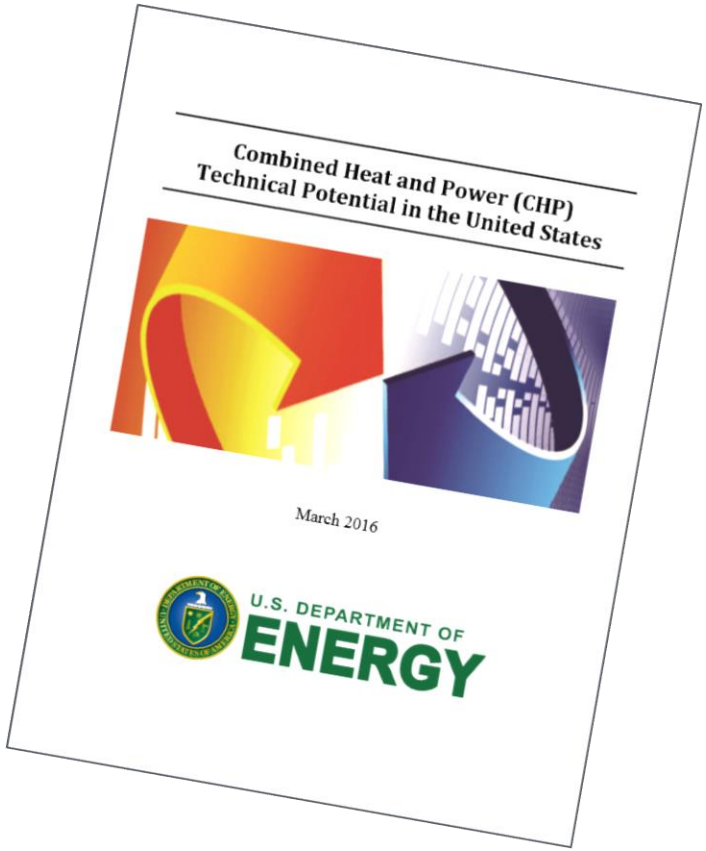
CHP Potential



CHP Technical Potential

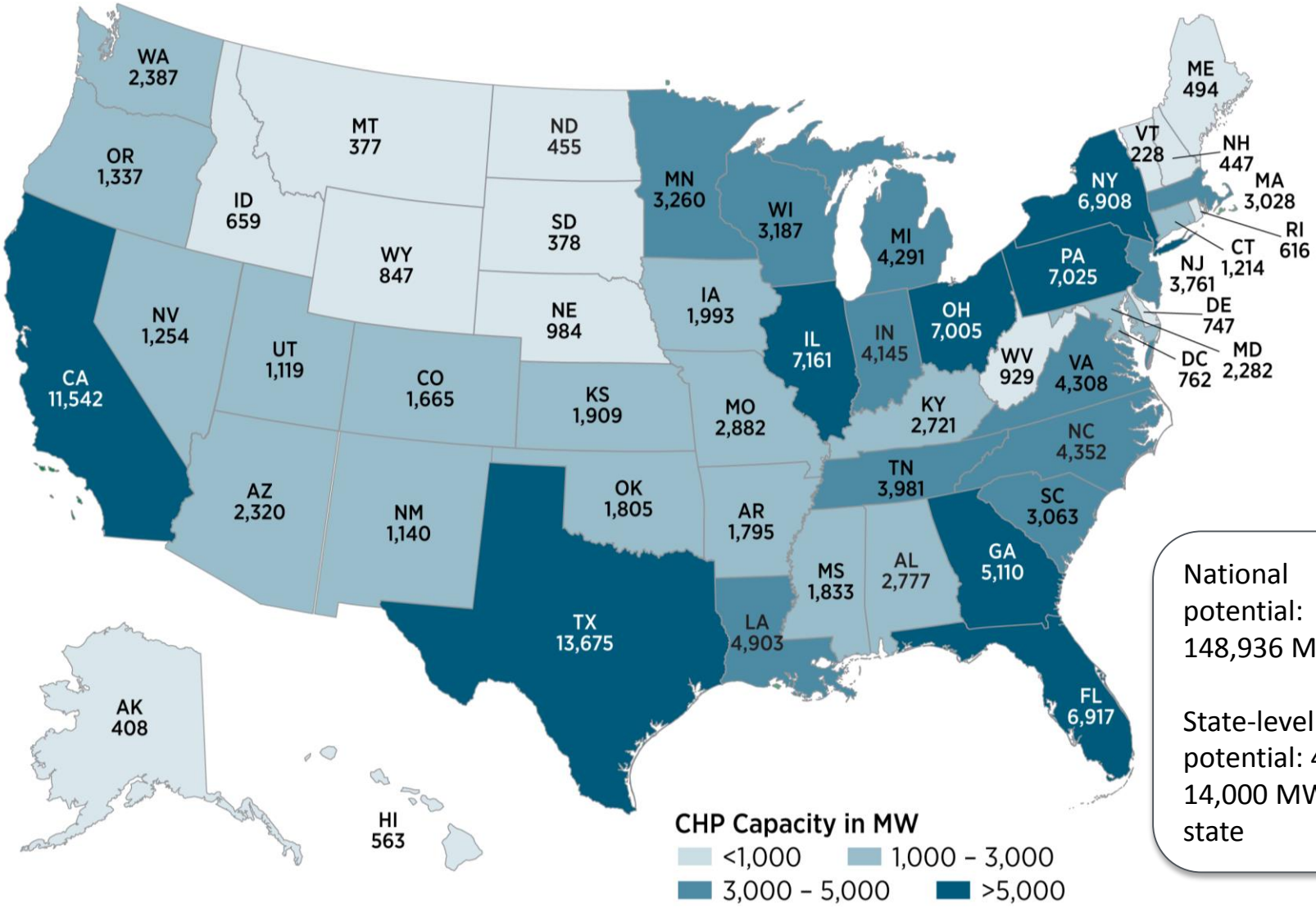
- Technical potential for CHP in U.S. industrial facilities and commercial buildings
- Total U.S. CHP Technical Potential = 240.6 GW at over 291,000 sites
  - Onsite Potential = 148.9 GW
  - Export Potential = 91.7 GW

Technical potential is an estimation of the market size for "topping cycle" CHP, waste heat to power CHP (WHP CHP), and district energy CHP when constrained only by technological limits —without regard to economic or market factors.



To obtain a copy, visit http://energy.gov/chp-potential

Estimated On-Site Technical Potential by State from *Combined Heat and Power (CHP)* (MW)

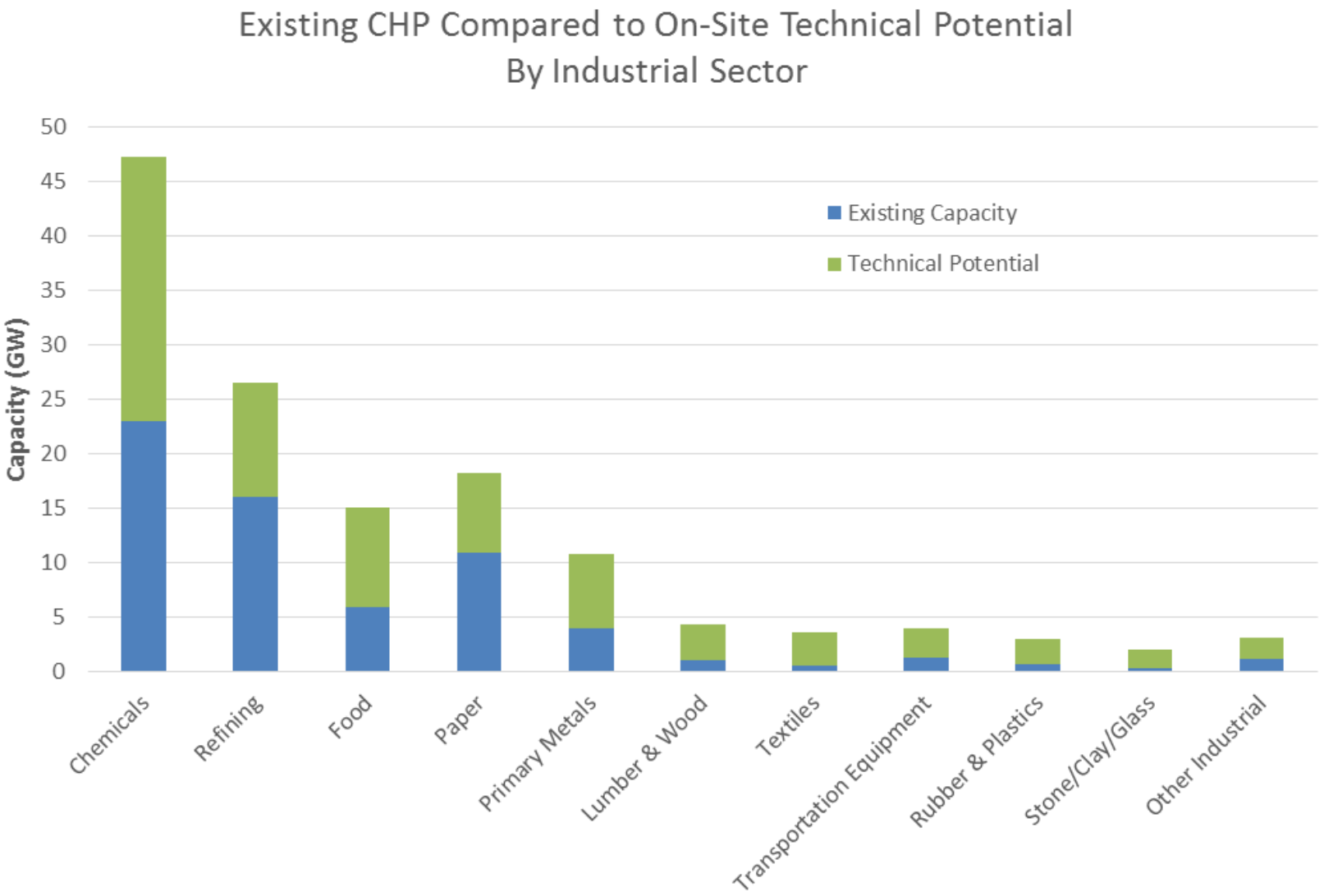


National potential: 148,936 MW

State-level potential: 400 to 14,000 MW per state

U.S. DOE, 2016, *Combined Heat and Power (CHP) Technical Potential in the United States*, http://energy.gov/chp-potential

Where is the Remaining Potential for CHP?



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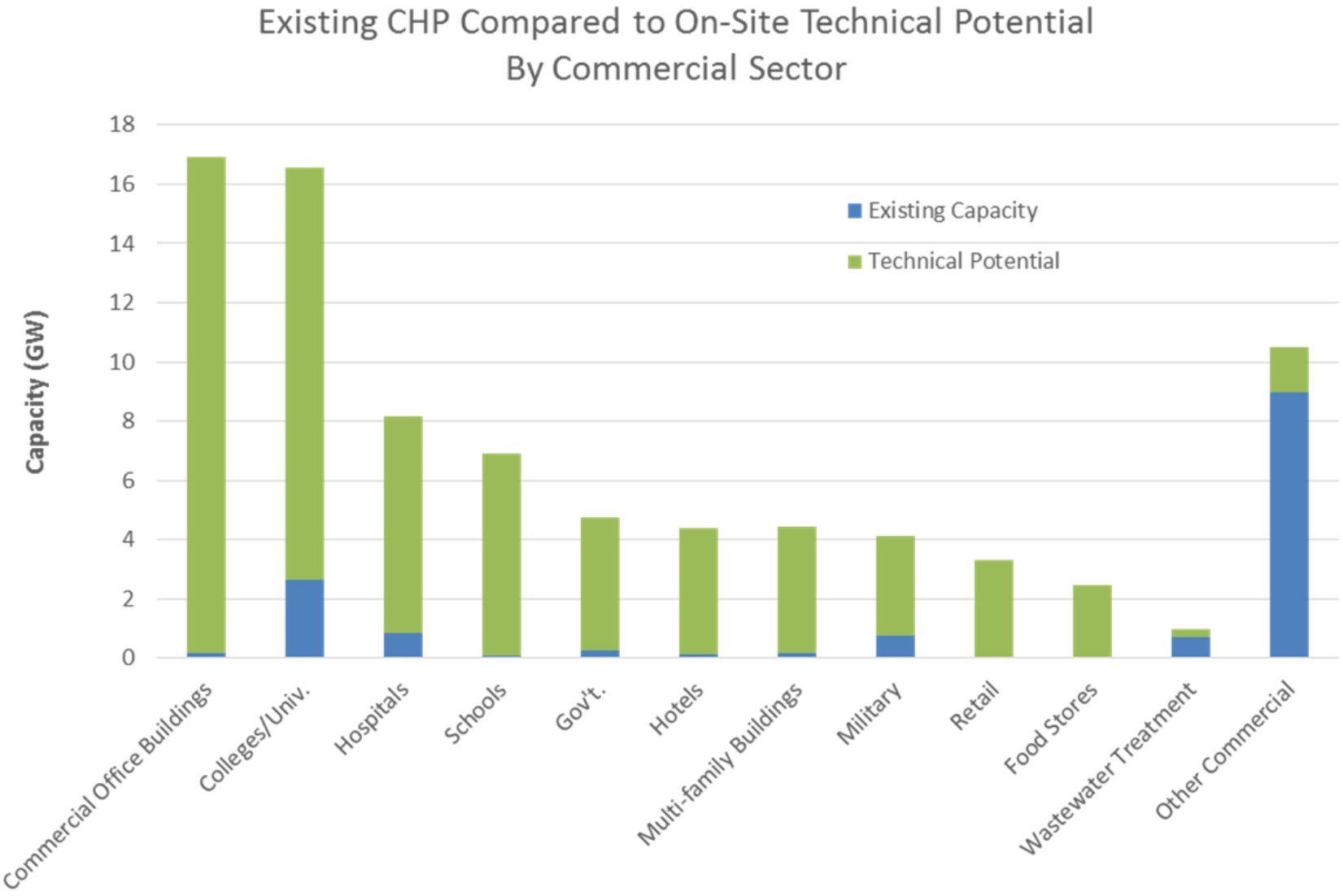
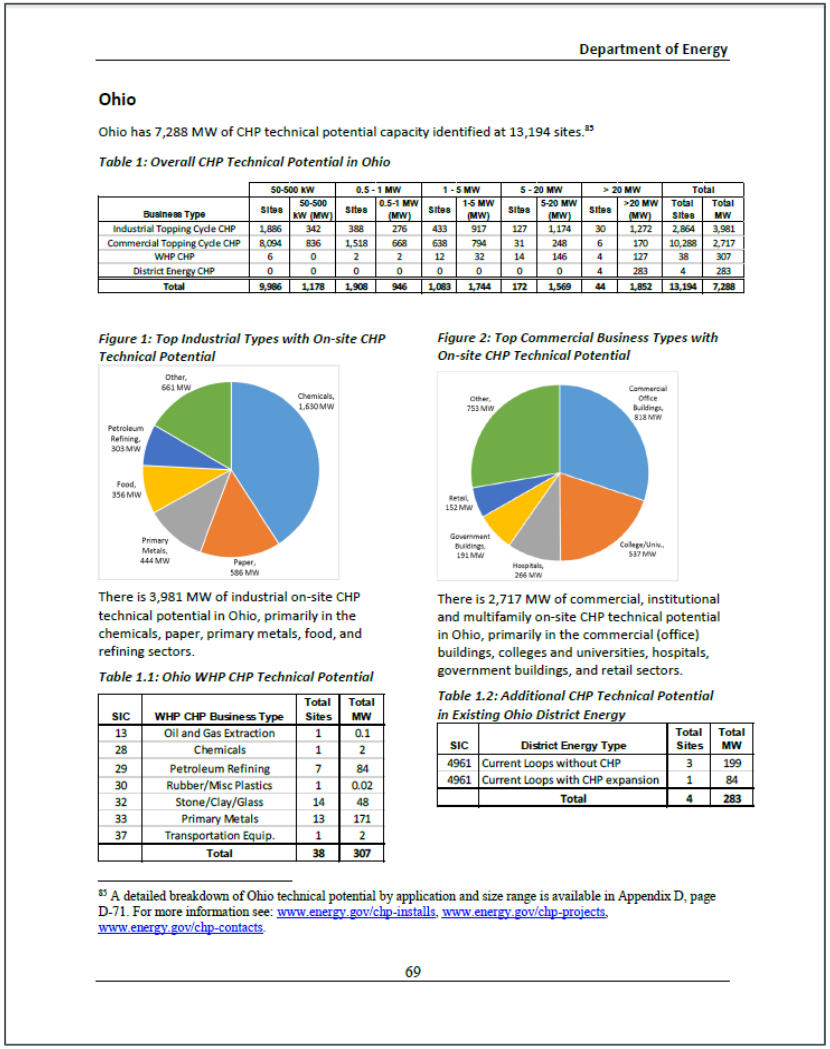
Where is the Remaining Potential for CHP?



U.S. DOE, 2016. *Combined Heat and Power (CHP) Technical Potential in the United States,* http://energy.gov/chp-potential

Where is the Remaining Potential for CHP?

- Report includes national summaries and detailed state profiles and tables that include CHP opportunities by
  - Sector
  - Facility type
  - Size range
- Sufficient detail for stakeholders to consider CHP in strategic energy planning and energy efficiency program design



Department of Energy

Ohio

Ohio has 7,288 MW of CHP technical potential capacity identified at 13,194 sites.[85]

Table 1: Overall CHP Technical Potential in Ohio

Business Type	50-500 kW Sites	50-500 kW (MW)	0.5 - 1 MW Sites	0.5-1 MW (MW)	1 - 5 MW Sites	1-5 MW (MW)	5 - 20 MW Sites	5-20 MW (MW)	> 20 MW Sites	>20 MW (MW)	Total Sites	Total MW
Industrial Topping Cycle CHP	1,886	342	388	276	433	917	127	1,174	30	1,272	2,864	3,981
Commercial Topping Cycle CHP	8,094	836	1,518	668	638	794	31	248	6	170	10,288	2,717
WHP CHP	6	0	2	2	12	32	14	146	4	127	38	307
District Energy CHP	0	0	0	0	0	0	0	0	4	283	4	283
Total	9,986	1,178	1,908	946	1,083	1,744	172	1,569	44	1,852	13,194	7,288

Figure 1: Top Industrial Types with On-site CHP Technical Potential

There is 3,981 MW of industrial on-site CHP technical potential in Ohio, primarily in the chemicals, paper, primary metals, food, and refining sectors.

Figure 2: Top Commercial Business Types with On-site CHP Technical Potential

There is 2,717 MW of commercial, institutional and multifamily on-site CHP technical potential in Ohio, primarily in the commercial (office) buildings, colleges and universities, hospitals, government buildings, and retail sectors.

Table 1.1: Ohio WHP CHP Technical Potential

SIC	WHP CHP Business Type	Total Sites	Total MW
13	Oil and Gas Extraction	1	0.1
28	Chemicals	1	2
29	Petroleum Refining	7	84
30	Rubber/Misc Plastics	1	0.02
32	Stone/Clay/Glass	14	48
33	Primary Metals	13	171
37	Transportation Equip.	1	2
	Total	38	307

Table 1.2: Additional CHP Technical Potential in Existing Ohio District Energy

SIC	District Energy Type	Total Sites	Total MW
4961	Current Loops without CHP	3	199
4961	Current Loops with CHP expansion	1	84
	Total	4	283

[85] A detailed breakdown of Ohio technical potential by application and size range is available in Appendix D, page D-71. For more information see: www.energy.gov/chp-installs, www.energy.gov/chp-projects, www.energy.gov/chp-contacts.

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U.S. DOE, 2016, *Combined Heat and Power (CHP) Technical Potential in the United States*, http://energy.gov/chp-potential

Agenda for Today's Webinar: EE Potential for States

I. **Overview** – Danielle Sass Byrnett, Office of Energy Efficiency ✓

II. **State Level Electric Energy Efficiency Potential Estimates** ✓
Kara Podkaminer, EERE Strategic Priorities & Impact Analysis Team

III. **Industrial Energy Efficiency Potential** ✓
Sandy Glatt, EERE Advanced Manufacturing Office

IV. **Economic Energy Efficiency Potential in Single-Family Detached Homes** ✓
Erin Boyd, Office of Energy Policy and Systems Analysis

V. **Energy Efficiency Potential in States: Building Energy Codes** ✓
Jeremy Williams, EERE Building Technologies Office

VI. **Combined Heat and Power (CHP) Technical Potential in the United States** ✓
Anne Hampson, ICF supporting EERE Advanced Manufacturing Office

VII. **Where to Find Resources & Next Steps**
Danielle Sass Byrnett, Office of Energy Efficiency

VIII. **Questions & Answers**

Energy-Saving
HOMES, BUILDINGS, & MANUFACTURING

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Where to Find Resources & Next Steps

Get More Information on How Others Have Used EE and Find Resources to Support State Energy Planning

energy.gov/eere/slsc/EEopportunities

State-Level EE Potential Studies Catalog

- Compilation of energy efficiency potential studies published by states, utilities, and non-governmental organizations between 2007 and 2016.

SEE Action Guide for States

- Energy Efficiency as a Least-Cost Strategy to Reduce Greenhouse Gases and Air Pollution, and Meet Energy Needs in the Power Sector Includes case studies, expected savings, common protocols, sources of info.

SEE Action EM&V Portal

- Evaluation, monitoring & verification (EM&V) tools and approaches that can be applied nationally, address EM&V consistency, and are widely recognized.

Energy Modeling 101 Presentation

- PPT on the basics of power sector capacity expansion modeling that briefly touches on other types of modeling and analytical tools available to provide data on the electric power system, including EE.

U.S. Energy & Employment State Report

- The 2017 USEER State Report provides a demographic and sector analysis of direct energy employment across four categories for each state: power generation, transmission, EE, vehicles.

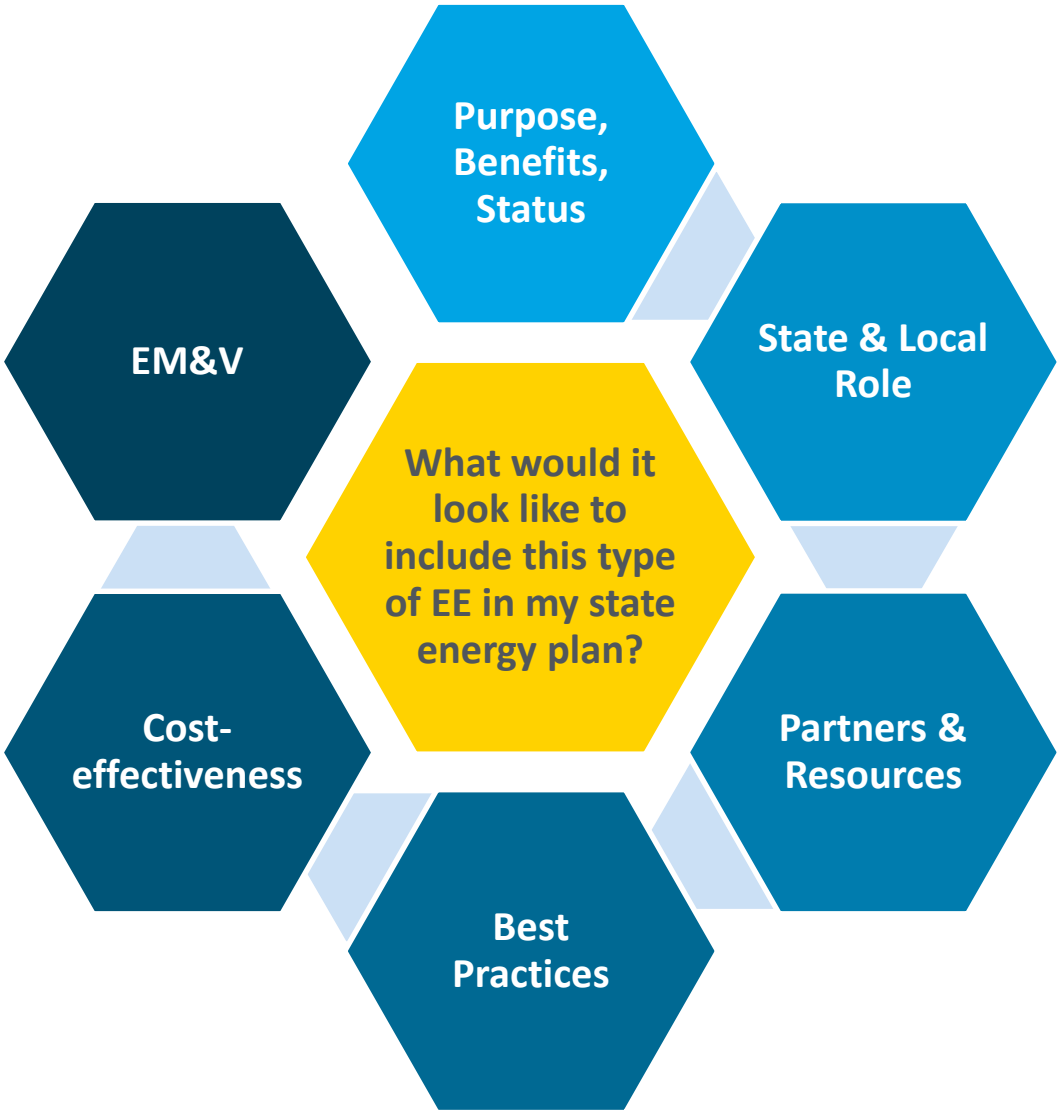
DOE Programs and Resources

- Brief synopsis presentation of current DOE programs and resources (documents, tools) by sector that can support program administrators and planners interested in pursuing energy efficiency.

DOE Technical Assistance Gateway

- Provides an access point to DOE's technical assistance and cooperative activities with state, local, and tribal officials.

What Next? Review Concise Pathway Presentations (15-20 slides each)



Learn how to access your state's EE potential or use as a starting point for familiarizing stakeholders

- How energy efficiency programs can support state energy planning (2017)
- **Building energy codes** (2017)
- **City-led energy efficiency** (2016)
- **Combined heat and power** (2017)
- **Energy savings performance contracting** (2016)
- **Industrial energy efficiency** (2017)
- **Ratepayer-funded energy efficiency** (2017)

energy.gov/eere/slsc/EEopportunities

Additional DOE Analyses & Updates Underway

- EE Potential:
  - Low income residential
  - Public buildings (energy savings performance contracting)
  - City- / locally-led efficiency
  - Industrial (to county level)
  - Low rise multifamily

- Pathways Presentations:
  - Residential
  - Low income
  - Energy savings performance contracting (update)
  - City- / locally led efficiency (update)

Question and Answer

All resources in this presentation are available at
energy.gov/eere/slsc/EEopportunities

To Follow Up Further, Contact:

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