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Beneficial Electrification: The Dawn of Emissions Efficiency

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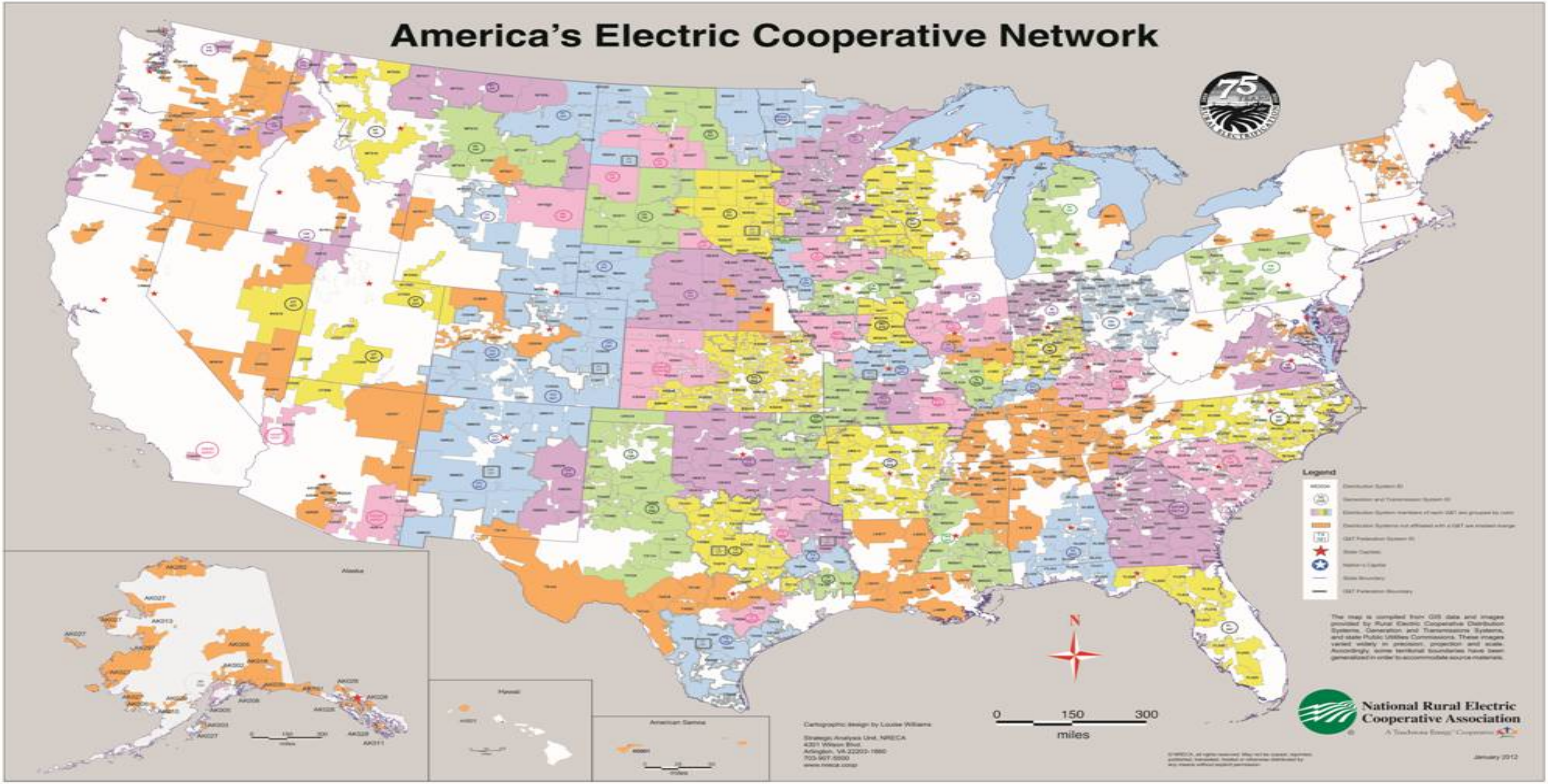
Key Take-Aways

1. Beneficial Electrification (BE) is key to meeting US and global GHG reduction goals
2. BE may lead to scenarios where more electricity is used, but fewer overall GHG emissions are produced
3. The metrics we use are critical; “Emissions efficiency” will be as important as energy efficiency moving forward
4. Let’s get started ASAP!

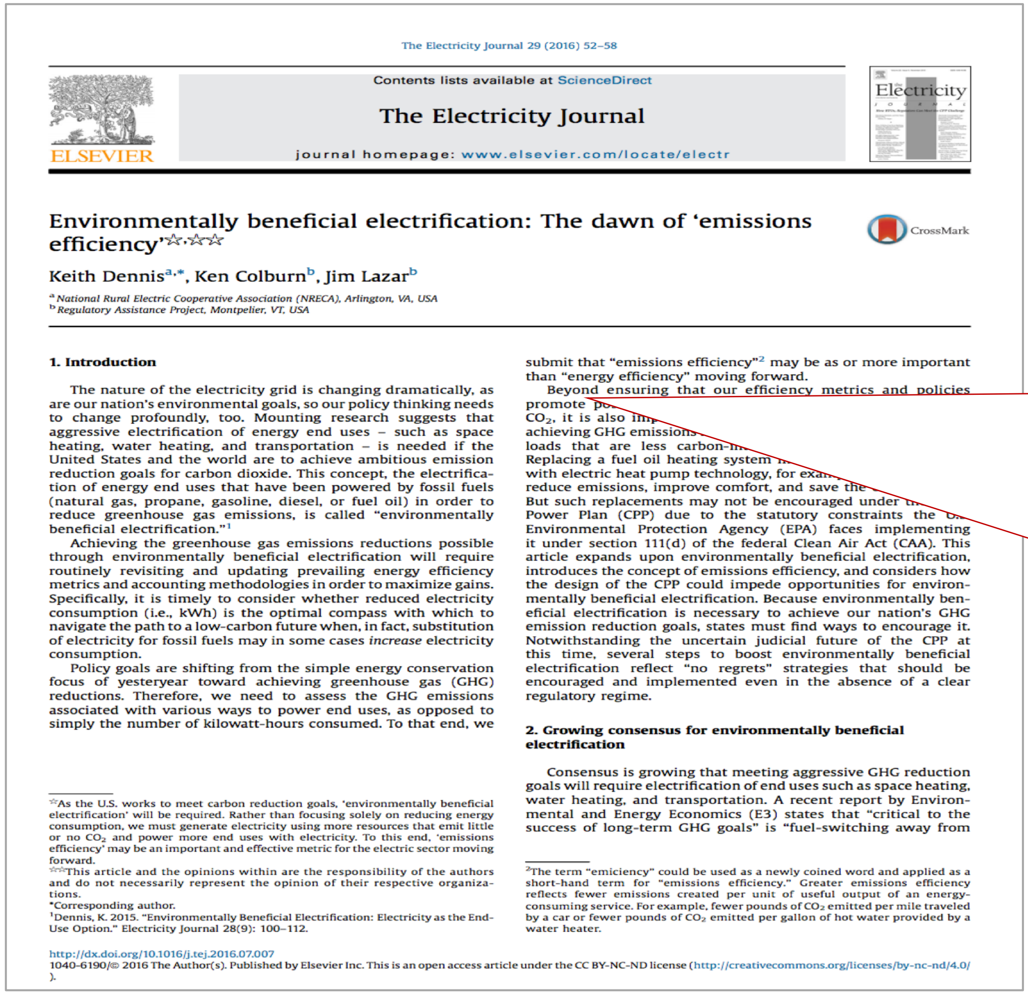


America's Electric Cooperative Network
Legend
The map is compiled from GIS data and images provided by Rural Electric Cooperative Distribution Systems, Generation and Transmissions Systems, and state Public Utilities Commissions. These images varied widely in precision, projection and scale. Accordingly, some territorial boundaries have been generalized in order to accommodate source materials.
N
0 150 300
miles
Alaska
Hawaii
American Samoa
Cartographic design by Louise Williams
Strategic Analysis Unit, NRECA
National Rural Electric Cooperative Association
January 2012

Environmentally Beneficial Electrification: The Dawn of "Emissions Efficiency"

The Electricity Journal
September 1, 2016

Research by Keith Dennis, NRECA
and Jim Lazar and Ken Colburn, Regulatory Assistance Project (RAP)



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Environmentally beneficial electrification: The dawn of 'emissions efficiency'☆,☆☆

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1. Introduction

The nature of the electricity grid is changing dramatically, as are our nation's environmental goals, so our policy thinking needs to change profoundly, too. Mounting research suggests that aggressive electrification of energy end uses – such as space heating, water heating, and transportation – is needed if the United States and the world are to achieve ambitious emission reduction goals for carbon dioxide. This concept, the electrification of energy end uses that have been powered by fossil fuels (natural gas, propane, gasoline, diesel, or fuel oil) in order to reduce greenhouse gas emissions, is called "environmentally beneficial electrification."[1]

Achieving the greenhouse gas emissions reductions possible through environmentally beneficial electrification will require routinely revisiting and updating prevailing energy efficiency metrics and accounting methodologies in order to maximize gains. Specifically, it is timely to consider whether reduced electricity consumption (i.e., kWh) is the optimal compass with which to navigate the path to a low-carbon future when, in fact, substitution of electricity for fossil fuels may in some cases *increase* electricity consumption.

Policy goals are shifting from the simple energy conservation focus of yesteryear toward achieving greenhouse gas (GHG) reductions. Therefore, we need to assess the GHG emissions associated with various ways to power end uses, as opposed to simply the number of kilowatt-hours consumed. To that end, we submit that "emissions efficiency"[2] may be as or more important than "energy efficiency" moving forward.

Beyond ensuring that our efficiency metrics and policies
promote po
CO_2, it is also im
achieving GHG emissions
loads that are less carbon-in
Replacing a fuel oil heating system
with electric heat pump technology, for exa
reduce emissions, improve comfort, and save the
But such replacements may not be encouraged under th
Power Plan (CPP) due to the statutory constraints the U.
Environmental Protection Agency (EPA) faces implementing it under section 111(d) of the federal Clean Air Act (CAA). This article expands upon environmentally beneficial electrification, introduces the concept of emissions efficiency, and considers how the design of the CPP could impede opportunities for environmentally beneficial electrification. Because environmentally beneficial electrification is necessary to achieve our nation's GHG emission reduction goals, states must find ways to encourage it. Notwithstanding the uncertain judicial future of the CPP at this time, several steps to boost environmentally beneficial electrification reflect "no regrets" strategies that should be encouraged and implemented even in the absence of a clear regulatory regime.

2. Growing consensus for environmentally beneficial electrification

Consensus is growing that meeting aggressive GHG reduction goals will require electrification of end uses such as space heating, water heating, and transportation. A recent report by Environmental and Energy Economics (E3) states that "critical to the success of long-term GHG goals" is "fuel-switching away from

☆As the U.S. works to meet carbon reduction goals, 'environmentally beneficial electrification' will be required. Rather than focusing solely on reducing energy consumption, we must generate electricity using more resources that emit little or no CO_2 and power more end uses with electricity. To this end, 'emissions efficiency' may be an important and effective metric for the electric sector moving forward.

☆☆This article and the opinions within are the responsibility of the authors and do not necessarily represent the opinion of their respective organizations.

*Corresponding author.

[1] Dennis, K. 2015. "Environmentally Beneficial Electrification: Electricity as the End-Use Option." Electricity Journal 28(9): 100–112.

[2] The term "emiciency" could be used as a newly coined word and applied as a short-hand term for "emissions efficiency." Greater emissions efficiency reflects fewer emissions created per unit of useful output of an energy-consuming service. For example, fewer pounds of CO_2 emitted per mile traveled by a car or fewer pounds of CO_2 emitted per gallon of hot water provided by a water heater.

http://dx.doi.org/10.1016/j.tej.2016.07.007

What the heck is BE, and what is "Emissions Efficiency"?

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Introduction: What is "Beneficial Electrification?"

The use of electricity in end-uses that would otherwise be powered by fossil fuels (natural gas, propane, fuel oil, or gasoline) to reduce greenhouse gas (GHG) emissions.

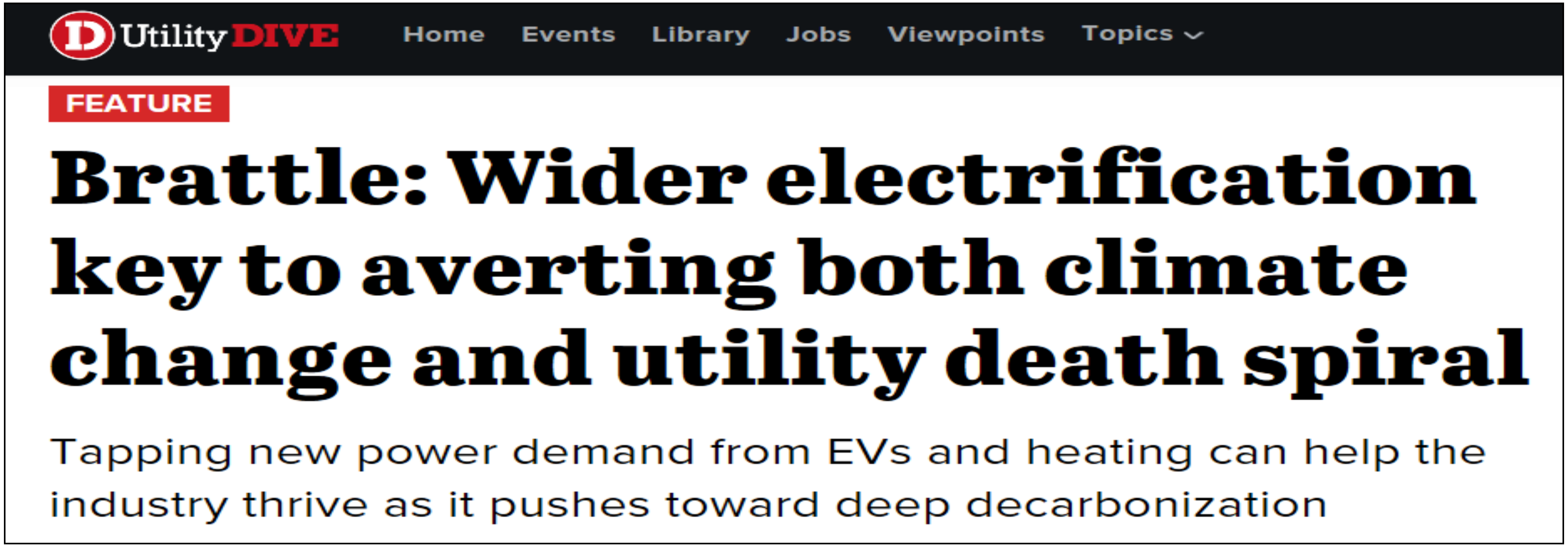
Growing Consensus for BE

Lawrence Berkeley National Lab finds:

The key to meeting GHG goals is *"widespread electrification of passenger vehicles, building heating, and industry heating."*

- United Nations, E3, Acadia Center, Stanford and Columbia Universities, California Pathways Project, DOE's QER, Bill Nye the Science Guy and many more are all adding to the chorus.
- ***Consensus on benefits of renewed electrification***

People Are Talking … The Chorus is Growing



FEATURE

Brattle: Wider electrification key to averting both climate change and utility death spiral

Tapping new power demand from EVs and heating can help the industry thrive as it pushes toward deep decarbonization

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There is a path to zero-carbon electricity. …

The same cannot yet be said of combustion fuels.

- David Roberts, Vox, Sept 19, 2016

Vox TOPICS ▾ TRENDING

The key to tackling climate change: electrify everything

Updated by David Roberts · @drvox · david@vox.com · Sep 19, 2016, 8:50a

TWEET SHARE

Vox EXPLAINERS POLITICS & POLICY MORE ▾

Power companies have resisted climate policy. Now it might be their only hope.

Electrification (to reduce carbon emissions) could be a lifeline for utilities.

By David Roberts | @drvox | david@vox.com | Mar 13, 2018, 9:30am EDT

Electrification (to reduce carbon emissions) could be a lifeline for utilities.

- David Roberts, Vox, March 13, 2018

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Why is BE Possible Now?

1. Adoption of GHG reduction public policy goals
2. Declining electricity sector GHG emissions
3. Increased efficiency of end-use equipment
4. Technology advances in other sectors
5. Need for “flexiwatts” to integrate renewable energy

But current metrics, policies, and even conventional wisdom need to change in order to enable EBE…


RenewableEnergy
E-DRIVE 100


STEFFES
HYDRO

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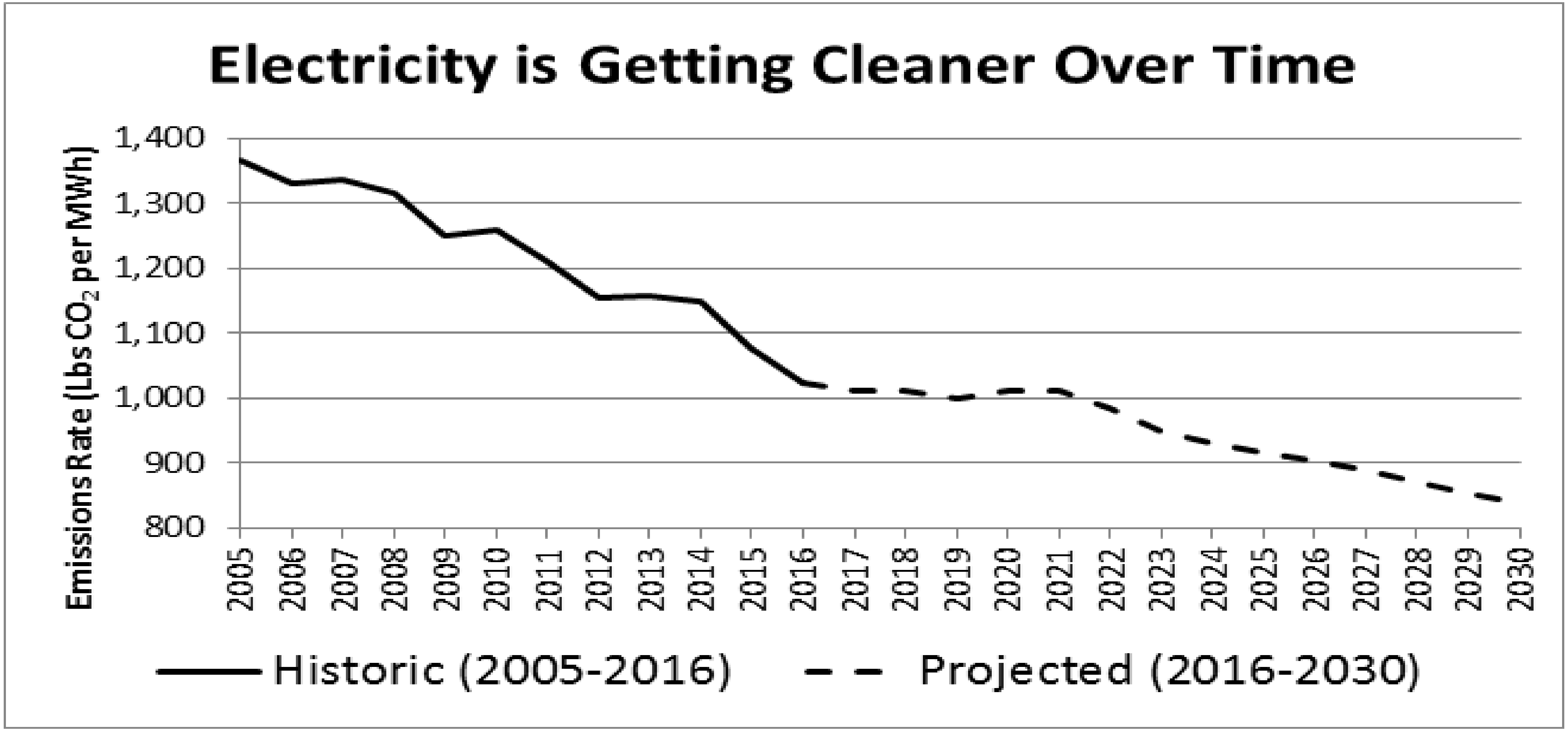
We Are in an Evolutionary Industry!

“Emissions Efficiency” Is Improving



- While the energy efficiency of devices will not change once installed, the ***emissions efficiency*** (or “***emiciency***”) will improve over time..

Metrics Matter!

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- Emissions Efficiency ("Emiciency"):
  - Greater emissions efficiency reflects fewer emissions created per unit of useful output of an energy-consuming service.
  - For example, fewer pounds of CO_2 emitted per mile traveled by a car or fewer pounds of CO_2 emitted per gallon of hot water provided by a HPWH or GIWH

- Three examples from *The Electricity Journal* paper illustrate the importance of aligning metrics and accounting practices with policy goals…

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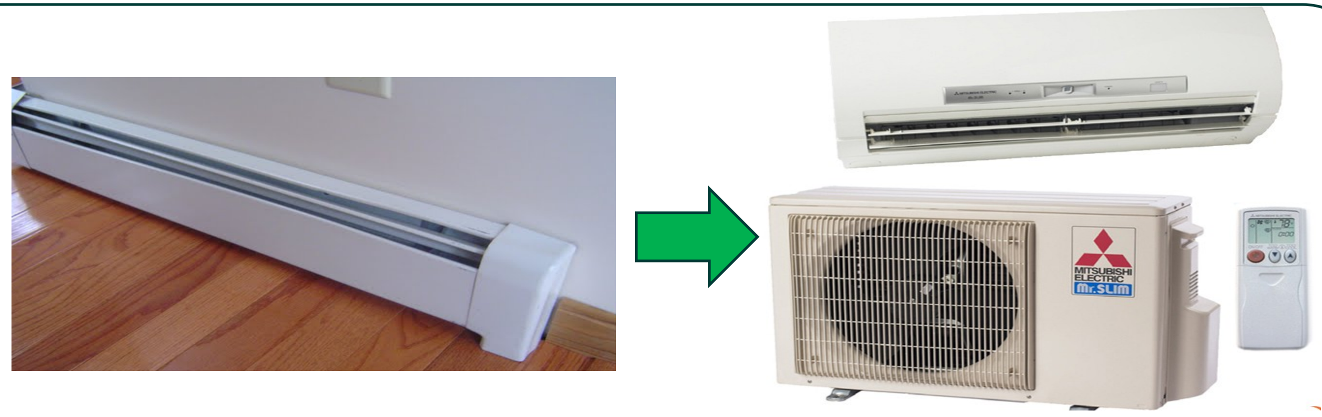
Illustrative Example Hypothetical Utility with 100,000 consumers; 50% Gas; 50% Coal

Summary Data	Pre Shift	
With 50% Coal, 50% Gas	**0.715 tons/MWh**	
Space Heat	Number	Emissions
Oil	20,000	111,297
Propane	10,000	54,998
Electric Resistance	30,000	303,582
Electric Heat Pump	20,000	80,952
Natural gas	20,000	108,468
Subtotal	100,000	659,297
Water Heat		
Propane	30,000	48,920
Electric Resistance	49,000	137,127
Electric Heat Pump	1,000	1,063
Natural Gas	20,000	23,985
Subtotal	100,000	211,095
Vehicles		
Electricity	10	14
Gasoline	179,990	475,346
Diesel	20,000	59,358
Subtotal	200,000	534,719
Total Emissions @ 50% Coal 50% Gas		**1,405,111**

Step 1: Implement Efficiency

Convert most electric space and water heat to heat pumps or

grid-interactive ETS



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Result after Step 1

Summary Data	Pre Shift		Post Shift	
With 50% Coal, 50% Gas	**0.715 tons/MWh**			
Space Heat	Number	Emissions	Number	Emissions
Electric Resistance	30,000	303,582	10,000	101,194
Water Heat				
Electric Resistance	49,000	137,127	10,000	27,985

Step 2:
Use Efficiency Dividend for Fuel Conversions

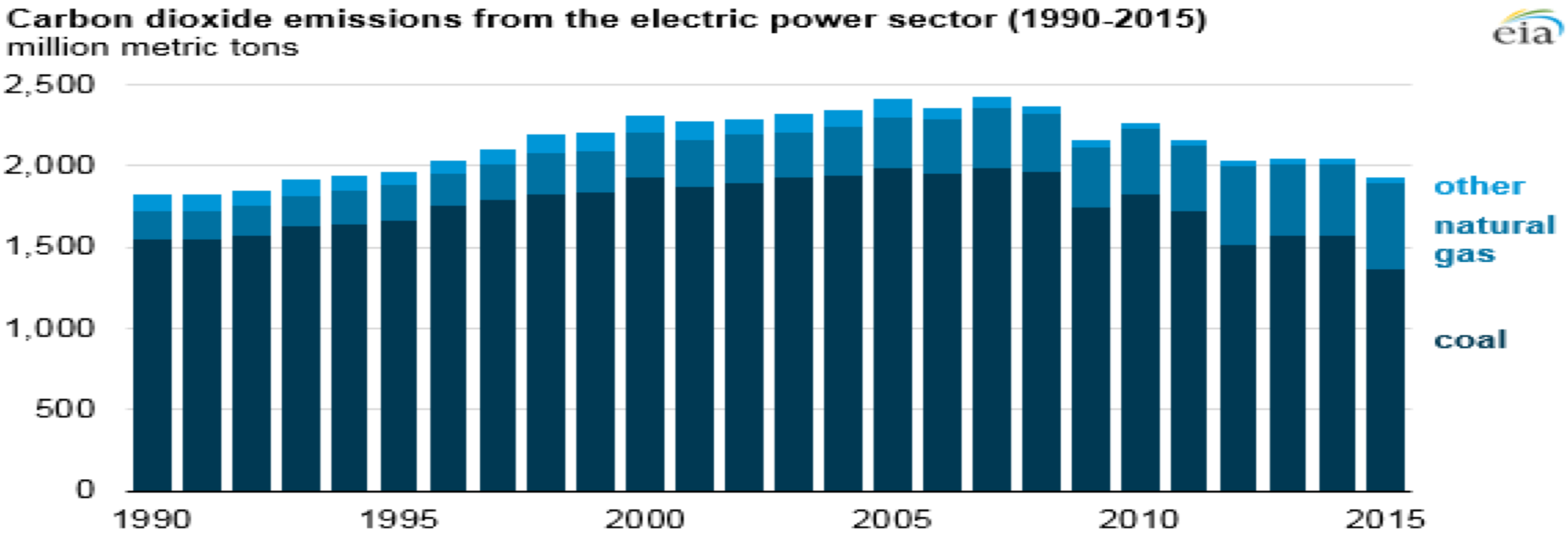




Result after Step 2

Summary Data	**Pre Shift**		**Post Shift**	
With 50% Coal, 50% Gas	**0.715 tons/MWh**			
Space Heat	Number	Emissions	Number	Emissions
Subtotal	100,000	659,297	100,000	508,549
Water Heat				
Subtotal	100,000	211,095	100,000	130,709
Vehicles				
Subtotal	200,000	534,719	200,000	466,869
Total Emissions @ 50% Coal 50% Gas		**1,405,111**		**1,106,127**
Change				**-21%**

CO2 Accounting and Emissions Efficiency



- Electric sector CO2 at ~1993 levels (1st half 2016 = 1991!)
- With ~2.5% per year GDP growth
- 890 billion kWh more today than 1993; enough to power all 253 million vehicles run by gasoline and diesel in US today!

Incremental "Emiciency" Factor

Type	New Capacity (GW)	2015 Average Capacity Factor	Estimated Generation (MWh)	Emissions Rate (Short Tons/MWh)	Emissions (Short Tons)
Solar	9.50	28.6%	23,800,920	0.00	0.00
Natural Gas	8.00	56.3%	39,455,040	0.45	17,754,752
Wind	6.80	32.5%	19,359,600	0.00	0.00
Nuclear	1.10	92.2%	8,884,392	0.00	0.00
Petroleum and Other	0.30	1.3%	34,164	1.08	37,068
Hydro	0.30	35.9%	943,452	0.00	0.00
Total	**26.00**	**40.6%**	**92,477,568**	**0.19**	**17,791,820**

- EIA: More than 26 gigawatts of generating capacity will be added in 2016, mostly from renewables and natural gas
- Emission rate of new generation is very low

Key Take-Aways

1. For decades, a strategy to meet environmental goals has been to reduce use of electricity.
2. Major trends have caused this to change, and now a strategy is to use electricity in more places to reduce GHG – a ***pro-growth*** and ***pro-environmental*** strategy.
3. Beneficial Electrification may lead to scenarios where more electricity is used, but fewer overall GHG emissions are produced
4. Let's get started ASAP!