Energy policy overview

1. Trends in emissions
2. Trends in energy generation and consumption
3. US grid architecture
4. State policy trends
5. Emerging issues – storage, EVs, grid modernization.
6. VW Settlement
7. Our Three Breakouts
Trends in Emissions
Comparison of Growth Areas and Emissions, 1970-2016

- Gross Domestic Product: 253%
- Vehicles Miles Traveled: 190%
- Population: 58%
- Energy Consumption: 44%
- CO₂ Emissions: 25%
- Aggregate Emissions (Six Common Pollutants): -73%
Number of People Living in Counties with Air Quality Concentrations Above the Level of the NAAQS in 2016

- One or more NAAQS: 122.5M
- Ozone (8-hour): 116.3M
- PM10 (24-hour): 14.3M
- PM2.5 (annual and/or 24-hour): 12.1M
- SO2 (1-hour): 2.1M
- Lead (3-month): 0.3M
- CO (8-hour): 0.0M
- NO2 (annual and/or 1-hour): 0.0M
Total US GHG emissions declined 10% from 2005 to 2015.
EIA projects an 8% decrease in total US CO2 emissions from 2015 to 2030.
US Electricity Sector without CPP

MMTCO2 - EIA

Electricity Reference Case
Electricity No Clean Power Plan
Western Coal EGU Retirements by State and Retirement Year

Remaining coal units

Assumed retirement at 50 years or +20 years from installation of SCRs
Other Multi-State and Local Initiatives

• Under 2 MOU
• United States Climate Alliance
• Climate Mayors
• Sierra Club’s Mayors For 100% Clean Energy Initiative
• “We Are Still In” Coalition
Trends in Energy Generation & Consumption
Electricity has followed a pattern of resource ‘ages’

[Diagram showing U.S. utility-scale electric generating capacity by initial operating year (as of Dec 2016), with categories including other, petroleum, solar, wind, nuclear, natural gas, coal, and hydro.]
Wind and solar expected to characterize next decade, then solar and natural gas.
Unsubsidized Levelized Cost of Energy Comparison

Certain Alternative Energy generation technologies are cost-competitive with conventional generation technologies under some scenarios; such observation does not take into account potential social and environmental externalities (e.g., social costs of distributed generation, environmental consequences of certain conventional generation technologies, etc.), reliability or intermittency-related considerations (e.g., transmission and back-up generation costs associated with certain Alternative Energy technologies).

<table>
<thead>
<tr>
<th>Technology</th>
<th>ALTERNATIVE ENERGY</th>
<th>Levelized Cost ($/MWh)</th>
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<tbody>
<tr>
<td>Solar PV—Rooftop Residential</td>
<td>$138</td>
<td>$222</td>
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<td>Solar PV—Rooftop C&amp;I</td>
<td>$88</td>
<td>$193</td>
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<td>Solar PV—Community</td>
<td>$78</td>
<td>$135</td>
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<td>Solar PV—Crystalline Utility Scale</td>
<td>$61</td>
<td>$92(6)</td>
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<td>Solar PV—Thin Film Utility Scale</td>
<td>$56</td>
<td>$92(6)</td>
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<td>Solar Thermal Tower with Storage</td>
<td>$119</td>
<td>$237(6)</td>
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<td>Fuel Cell</td>
<td>$76</td>
<td>$85</td>
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<tr>
<td>Microturbine</td>
<td>$79</td>
<td>$117</td>
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<tr>
<td>Geothermal</td>
<td>$77</td>
<td>$110</td>
</tr>
<tr>
<td>Biomass Direct</td>
<td>$32</td>
<td>$18(6)</td>
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<tr>
<td>Wind</td>
<td>$10</td>
<td>$167</td>
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<tr>
<td>Diesel Reciprocating Engine</td>
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<td>$212</td>
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<td>Natural Gas Reciprocating Engine</td>
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<td>Gas Peaking</td>
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<td>IGCC</td>
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<td>Nuclear</td>
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<td>$143</td>
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<tr>
<td>Coal</td>
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<td>$210</td>
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<td>Gas Combined Cycle</td>
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</table>

Source: Lazard estimates.

Note: Here and throughout this presentation, unless otherwise indicated, analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Reflects global, illustrative costs of capital, which may be significantly higher than OECD country costs of capital. See page 15 for additional details on cost of capital. Analysis does not reflect potential impact of recent climate change policy. Should be read with Section 111(q). See page 18-20 for fuel costs for each technology. See following page for footnotes.

† Denotes distributed generation technology.
## Schedule of Wind and Solar Tax Credits

**Consolidated Appropriations Act of 2016**

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<tr>
<td></td>
<td>Full</td>
<td>Full</td>
<td>80%</td>
<td>60%</td>
<td>40%</td>
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<td></td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>26%</td>
<td>22%</td>
<td>10%</td>
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The “Full” (100%) wind PTC value is 2.3¢/kWh for electricity production over the first ten years.

The schedules reflect “commenced-construction” dates for all categories except Solar ITC Residential Host-Owned for which “placed-in-service” dates are shown.
Consumption is expected to remain relatively flat. Coal, natural gas and renewables are the big movers.
The U.S. likely to become a net energy exporter.

Carbon Dioxide Emissions by Sector Moving 12-Month Total

3,000 Million Metric Tonnes of Carbon Dioxide

Source: DOE, EIA, May 2016 Monthly Energy Review
U.S. electric system is made up of interconnections and balancing authorities

Source: U.S. Energy Information Administration
Note: The locations of the electric systems are illustrative and are not geographically accurate. The sizes of the circles are roughly indicative of electric system size.
Federal Land as a Percentage of Total State Land Area

U.S. Energy Mapping System
https://www.eia.gov/state/maps.php
Photovoltaic Solar Resource: United States - Spain - Germany

Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1996-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2002). The data for Germany and Spain were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1990. States and countries are shown to scale, except for Alaska.
SOLAR\textsuperscript{10} 23,000 per year

World energy use 16 TW-yr per year

TIDES \textsuperscript{1} 0.3 per year

Geothermal\textsuperscript{1,7} 0.3 - 2 per year

HYDRO \textsuperscript{1,6} 3 - 4 per year

Biomass \textsuperscript{1,5} 2 - 6 per year

OTEC \textsuperscript{1,4} 3 - 11 per year

WIND\textsuperscript{1,2} 25 - 70 per year

Natural Gas \textsuperscript{1,8} 215 total

Petroleum \textsuperscript{1,8} 240 total

Uranium \textsuperscript{1,9} 90 - 300 Total

COAL \textsuperscript{1,8} 900 Total reserve

Source: Dr. Richard Perez, U. of Albany
“Utilities get about 90% of their cost recovery from the states and only 10% from Washington. If you want to implement innovative policy, focus on what happens in the states.”

~ CEO of a Western Utility
Trends in State Energy Policy
* States with a voluntary goal.
EERS Target Dates

- DE
- AR*
- AZ
- CO
- CT
- ME
- NH
- NM
- VA*
- CA
- FL*
- OH
- HI

* States with a voluntary goal.
Policy design increases in sophistication as new building blocks are added.
Figure 1: Net load on the CAISO system

Net Load – March 31

Ramp needs
~13,000 MW
in three hours

Potential over-generation

Source: CAISO
Illustration of Clean Peak Standard (CPS)

- Peak hours calculated using net load
- Compliance measured using gross load

CPS obligation (e.g. 30%)

Strategen consulting, llc: Evolving the RPS: A Clean Peak Standard for a Smarter Renewable Future
Electric Load Growth Projections (over planning horizon)

- Average: 1.3%
- EIA National Average: 0.6%
Utility forecasts are often aggressively optimistic

South Carolina Electric & Gas electricity demand forecasts since 2008

Source: Bloomberg New Energy Finance, Federal Energy Regulatory Commission
Utility forecasts are often aggressively optimistic

Arizona Public Service Company electricity demand forecasts since 2006

45 Terawatt-hours per year

2006 (2.9%)
2007 (2.3%)
2008 (2%)
2009 (1.3%)
2010 (1.3%)
2011 (1.3%)
2012 (1.4%)
2013 (1.8%)
2014 (1.7%)
2015 (1.6%)

Actual: -0.8% per year

Source: Bloomberg New Energy Finance, Federal Energy Regulatory Commission
Total Economic Electricity Savings Potential (2035) by State (million MWh)

Source: DOE and EPRI, 2017
Cities and Corporations
Western State RPSs and City RE Targets
(in relation to population)

Sources: City websites, ICLEI, and CarbonN Registry, 2016 Census Bureau. Population size, unless noted, does not include surrounding metro area.
Western City GHG Targets
(in relation to population)

Sources: City websites, ICLEI, and CarbonN Registry, 2016 Census Bureau. Population size, unless noted, does not include surrounding metro area.
<table>
<thead>
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<th>Group</th>
<th>Goals</th>
<th>Members</th>
<th>Notable US Companies</th>
<th>Founder</th>
<th>Est.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE100</td>
<td>Encourage companies to set 100% RE procurement goal</td>
<td>100+ large int’l companies</td>
<td>Bank of America (2020)</td>
<td>We Mean Business coalition</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>General Motors (2050)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Microsoft (2014)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Walmart (2020)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WE ARE STILL IN</td>
<td>Support action to meet Paris Agreement</td>
<td>1,500+ US business and investors</td>
<td>Apple, Amazon, Google, Target</td>
<td>Michael Bloomberg &amp; Gov Jerry Brown</td>
<td>2017</td>
</tr>
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</tr>
<tr>
<td>REBA</td>
<td>Add 60GW of RE to US grid by 2030</td>
<td>200+ companies, developers, and intermediaries</td>
<td>Disney, Facebook, FedEx, Lockheed Martin</td>
<td>Rocky Mountain Institute</td>
<td>2015</td>
</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Help companies buy 60GW of RE by 2025</td>
<td>Buyers associations (eg BRC, Future of Internet Power)</td>
<td>N/A</td>
<td>BRC, WRI, BSR, WWF</td>
<td>2016</td>
</tr>
</tbody>
</table>
Corporate Renewable Deals
2012 – 2017

Publicly announced contracted capacity of corporate Power Purchase Agreements, Green Power Purchases, Green Tariffs, and Ought Project Ownership in the US and Mexico, 2012-2017. Excludes on-site generation (e.g., rooftop solar PV) and deals with operating plants. Last updated: May 12, 2017.

Copyright 2016 by Rocky Mountain Institute
For more information, please visit http://www.businessrenewables.org/ or contact RFC@RMI.org
Summary of Electrify America Investment Plan

VW Settlement
VW Settlement - $15 Billion

- Customer Buyback: $10.3
- State Allocations for Environmental Remediation: $2.7
- National/California Investment: $2.0
- California Investment in EV Infrastructure, education/awareness, green cities: $0.8
- National Investment in EV Infrastructure, education/awareness: $1.2
State allocations

<table>
<thead>
<tr>
<th>STATE</th>
<th>MILLION$</th>
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<tbody>
<tr>
<td>Arizona</td>
<td>$53.01</td>
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<tr>
<td>Colorado</td>
<td>$61.31</td>
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<tr>
<td>Connecticut</td>
<td>$51.64</td>
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<tr>
<td>Delaware</td>
<td>$9.05</td>
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<tr>
<td>Hawaii</td>
<td>$7.50</td>
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<tr>
<td>Illinois</td>
<td>$97.70</td>
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<tr>
<td>Michigan</td>
<td>$60.33</td>
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<td>Minnesota</td>
<td>$43.64</td>
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<tr>
<td>Montana</td>
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<td>Nevada</td>
<td>$22.26</td>
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<tr>
<td>New Jersey</td>
<td>$65.33</td>
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<tr>
<td>New York</td>
<td>$117.40</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$87.18</td>
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- $2.7 B Distributed to States for Remediation
- Up to 15% of allocation in each state can be spent on light duty vehicle EV Infrastructure
- 85% is spent on heavy duty vehicle emission reductions (can include electrification, diesel upgrades, natural gas, etc...)
National allocation

$1.2 B will be spent in $300M increments over 30 Month Cycles

<table>
<thead>
<tr>
<th>Cycle 1 (Q1 2017 - Q2 2019)</th>
<th>Cycle 2 (Q3 2019 - Q4 2021)</th>
<th>Cycle 3 (Q1 2022 - Q2 2024)</th>
<th>Cycle 4 (Q3 2024 - Q4 2026)</th>
<th>Full 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>$300M</td>
<td>$300M</td>
<td>$300M</td>
<td>$300M</td>
<td>$1,200M</td>
</tr>
</tbody>
</table>
Cycle 1 Investment plan ($300M)

Overview of Cycle 1 National Investment Plan
Possible Questions

• How can states leverage the EA investment?
• Are these investments a part of commission planning?
• Are PUCs empowered to consider Electric Vehicles?
Our Three Breakouts

- Electrification of the Transportation Sector
- Energy Storage
- Grid Modernization/Utility Business Models
Figure 6: Long-term EV sales penetration by country

Source: Bloomberg New Energy Finance
A changing utility model?

Many utilities, commissions and staffs adhere to fifty year old regulatory principles outlined by James Bonbright in his 700 page text, *Principles of Public Utility Rates (1961).*

\[ R = O + (V - D)r; \] where \( R \) is the rate level, \( O \) is the utility’s operating expenses, \( V \) is the gross value of the utility’s property, \( D \) is depreciation and \( r \) is the rate of return allowed on capital investments.
Utilities have changed since the 1960’s

“The Bonbright Era”
- Most vertically integrated
- Increasing electric load
- High credit ratings
- Economies of scale for large new generation
- Natural monopolies warranting regulation of efficiency (least cost) versus equity (consumer protection).

Today
- Wide diversity in business structures (regulated/unregulated)
- Declining load
- Declining credit ratings
- “Disruptive technologies” challenging traditional revenue model
- A trend toward service rather than just commodity sales
A few key pieces of the puzzle.

1. Utilities recognize their challenge.
   “Technology is 10 years ahead of utilities and regulation is 10 years behind utilities.”

2. Most utilities are willing explore long-term performance-based regulation.

3. The rules of regulatory engagement are a barrier to innovation.
CNEE Resources
UTAH - ENERGY SAVINGS PERFORMANCE CONTRACTING

POLICY COMPONENTS QUESTIONS

1. Is there clear legislative or executive authorization?  YES
2. Is there a program/project administered by a state agency?  YES
3. Is a third party involved in oversight for the program?  YES
4. Are model contracts available?  NO
5. Is a list of pre-approved energy service companies available?  YES

DESCRIPTION

Energy Savings Performance Contracting (ESPC) sometimes also referred to as Utility Energy Service Contracting (UESC) or simply Performance Contracting is mainly a financing mechanism for retrofitting commercial buildings with more efficient technologies (HVAC, lighting, building controls, etc) and, more recently, distributed renewable technologies (solar, ground source heat pumps, etc). The new equipment is paid for over time through the utility bill savings of the measures themselves. “Performance Contract” means that the savings from the performance of the energy investment is committed to repayment of the loan. While this method of financing could be applied in any application, the target market for investors is generally large institutions where risk is low and the investment timeframe is generally longer than in the private sector. For more information, see the full policy brief.

For more information on the components of the policy see the full policy brief.

DOWNLOAD FULL POLICY BRIEF

Policy Component information last updated June 16 2017
Pennsylvania - HB 557 - 2017

Amending the act of July 20, 1979 (P.L.183, No.60), known as the Oil and Gas Lease Act, further providing for definitions; and providing for minimum royalty for unconventional oil or gas well production and for remedy for failure to pay the minimum royalty on unconventional oil or gas wells.

Natural Gas Development

Added On: 04-11-2017
Updated On: 06-30-2017

Status: Introduced
Primary Sponsor: Garth D Everett (House/Republican)

Actions (2)
Sponsors (38)
News (3)
myTracker (39 Bills)

UPDATE LOG IN INFORMATION

Email
katherine.hoffer@colostate.edu

New password

Re-type new password

UPDATE LOGIN INFO

NOTIFICATION PREFERENCES

How often would you like to receive notifications via email?

hourly

What would you like to trigger a notification for any given bill?

- New Actions
- New Votes
- New News
- New Versions
- New Status

DISTRIBUTION OF BILLS ACROSS STATES

CHANGES FROM THE PAST MONTH

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## Enacted Legislation by Category

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<td>Electricity Generation</td>
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<td>Emissions</td>
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<td>Energy Efficiency</td>
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<td>53</td>
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<td>Infrastructure</td>
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<td>Natural Gas Development</td>
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<td>Transportation</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>430</strong></td>
<td><strong>489</strong></td>
<td><strong>344</strong></td>
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<td>Incentives</td>
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<td>Workforce</td>
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<tr>
<td></td>
<td></td>
<td>(10 bills)</td>
<td>(8 bills)</td>
<td>(12 bills)</td>
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<td>RPS</td>
<td>23 bills</td>
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<td>RPS</td>
<td>NEM, FIT, &amp; Interconnection</td>
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<td></td>
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<td></td>
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<td>(11 bills)</td>
<td>(11 bills)</td>
<td>(9 bills)</td>
</tr>
<tr>
<td>Lead by Example</td>
<td>10 bills</td>
<td>Lead by Example</td>
<td>Buildings &amp; Appliances</td>
<td>ESPC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(7 bills)</td>
<td>(8 bills)</td>
<td>(7 bills)</td>
</tr>
<tr>
<td>Tax Incentives</td>
<td>44 bills</td>
<td>Tax Incentives</td>
<td>Tax Incentives</td>
<td>Loans &amp; Grants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(30 bills)</td>
<td>(24 bills)</td>
<td>(23 bills)</td>
</tr>
<tr>
<td>Siting &amp; Planning*</td>
<td>36 bills</td>
<td>Siting &amp; Planning*</td>
<td>Siting &amp; Planning*</td>
<td>Siting &amp; Planning*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(24 bills)</td>
<td>(26 bills)</td>
<td>(21 bills)</td>
</tr>
<tr>
<td>Split Estate</td>
<td>15 bills</td>
<td>Split Estate &amp; Taxes</td>
<td>Taxes</td>
<td>Taxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(tied: 9 bills)</td>
<td>(11 bills)</td>
<td>(13 bills)</td>
</tr>
<tr>
<td>State Agencies</td>
<td>61 bills</td>
<td>State Agencies</td>
<td>State Agencies</td>
<td>State Agencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(36 bills)</td>
<td>(47 bills)</td>
<td>(23 bills)</td>
</tr>
<tr>
<td>Lead by Example</td>
<td>11 bills</td>
<td>Natural Gas Vehicles</td>
<td>Multiple Vehicle Types</td>
<td>Electric Vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(18 bills)</td>
<td>(12 bills)</td>
<td>(6 bills)</td>
</tr>
</tbody>
</table>

* Does not include natural gas pipelines.
Because commercial loans are not backed by Fannie Mae and Freddie Mac, the Federal Housing Finance Agency (FHFA) guidance issued in 2010 does not impact C-PACE, which has allowed it to flourish while Residential PACE has stalled (outside of California).

### EXAMPLE STATE PROGRAMS
- **PACE Nation**: Full list of existing PACE programs
- **California**: California First
- **Connecticut**: Clean Energy Finance and Investment Authority
- **Florida**: Florida PACE Funding Agency
Powering Forward: What Everyone Should Know About America's Energy Revolution

Paperback – March 15, 2016
by Bill Ritter Jr. (Author)

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EPISODE 32: INTRODUCING THE CLEAN ENERGY POLICY GUIDE (E-BOOK)

EPISODE 31: 2016 – LEGISLATIVE YEAR END SUMMARY