

Regulation and Innovation

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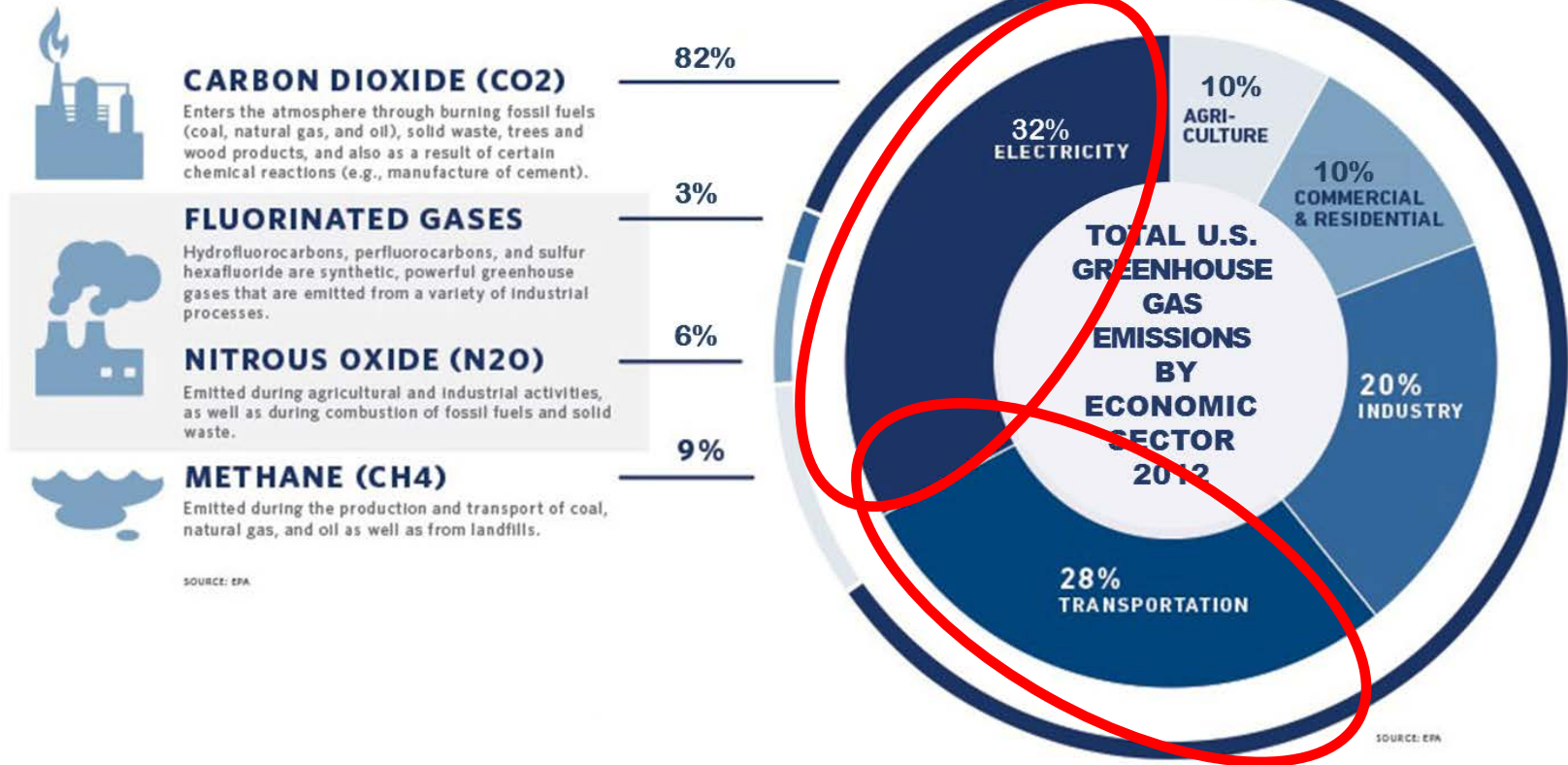
CHINA, THE WEST, AND THE CHALLENGE OF
ALTERNATIVE ENERGY INNOVATION

PETERSON INSTITUTE FOR INTERNATIONAL
ECONOMICS

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Why Regulate the Power Sector through the Clean Air Act?



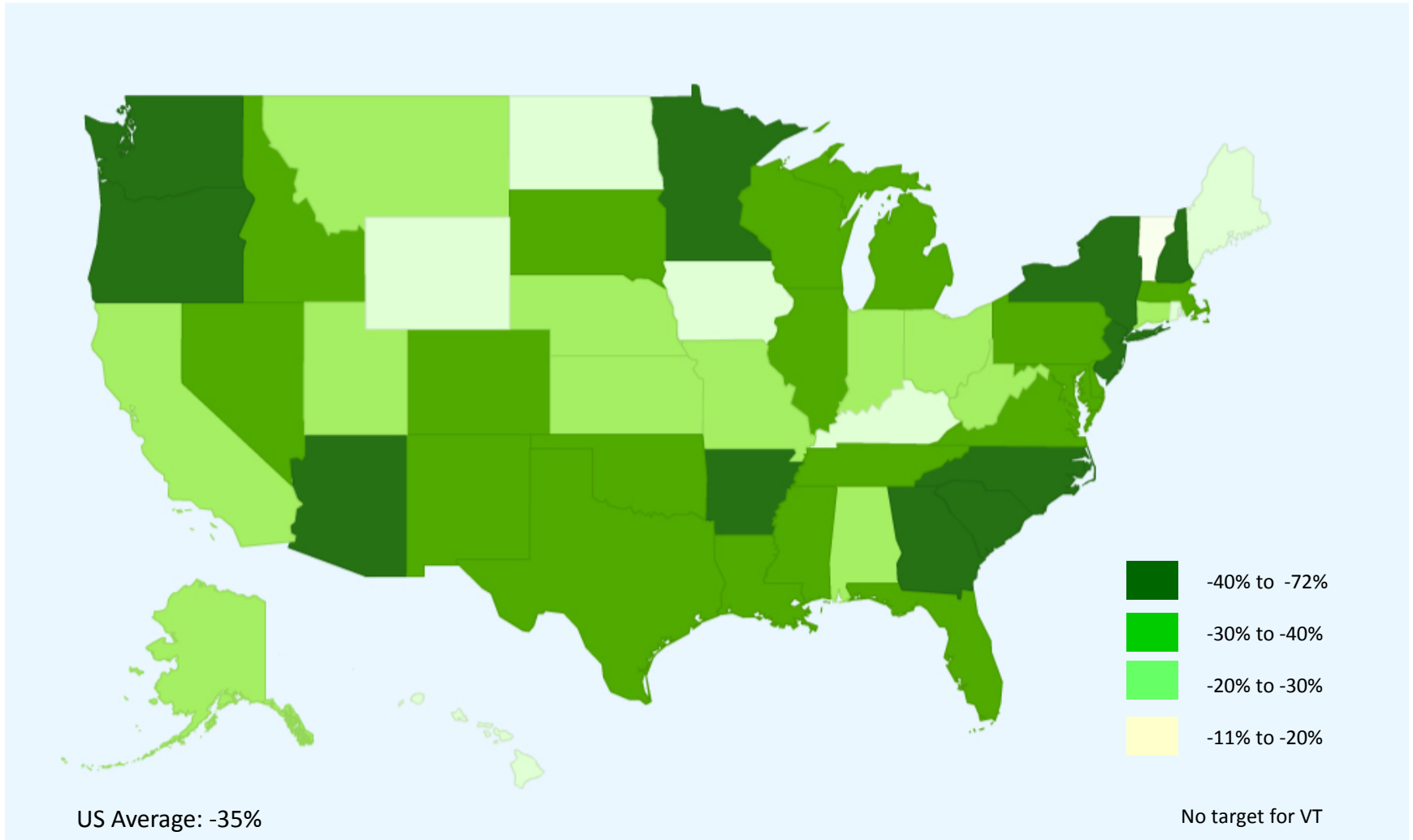
Regulatory Approach

- Targets based on Best System of Emission Reduction (BSER)
- Emission intensity goals set at state level
- States given wide flexibility in policies and measures to achieve goals
 - Regional and market based approaches acceptable
 - Averaging over time
 - Build on existing programs (e.g. RGGI, AB32)

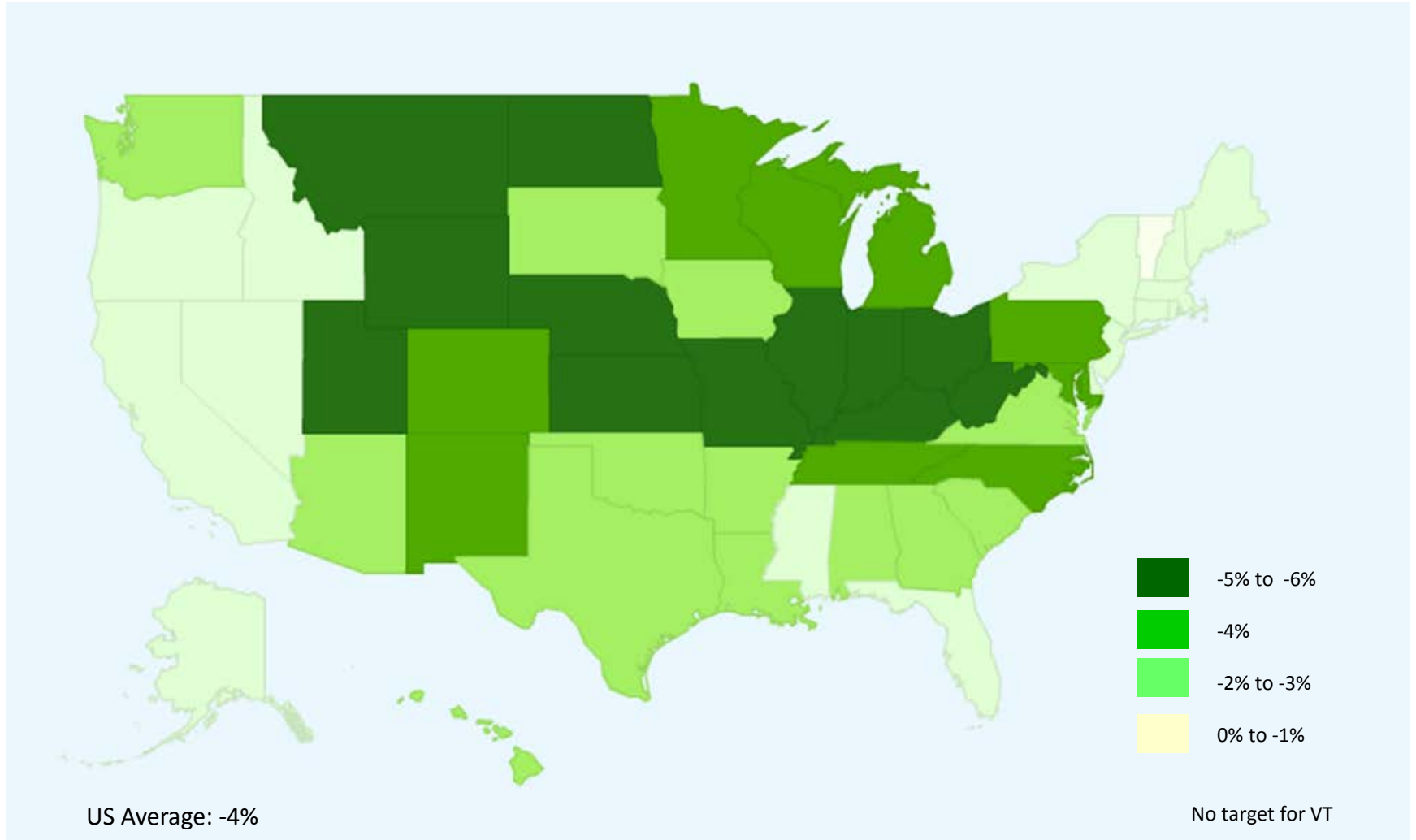
BSER: Building Block Technologies Translated to State Goals

<i>Technology/Building Block</i>	Proposed Option 1	Alternative Option 2
1. Heat rate improvement (Avg. Reduction for Coal)	6%	4%
2. Dispatch to existing and under-construction NGCC	Utilization of NGCC up to 70% capacity factor	Utilization of NGCC up to 65% capacity factor
3. Dispatch to new clean electric generation	Includes new nuclear generation under construction, moderate deployment of new renewable generation, and continued use of existing nuclear generation	
4. Demand-side Energy Efficiency (% reduction in demand from BAU MWh sales)	3.0% / 10.7% (2020 / 2030)	2.4% / 5.2% (2020 / 2025)
<i>Goal</i>	Proposed Option 1	Proposed Option 2
Average nationwide goal for covered sources (lbs/MWh)	25% to 30% below 2005 levels	20% to 25% below 2005 levels

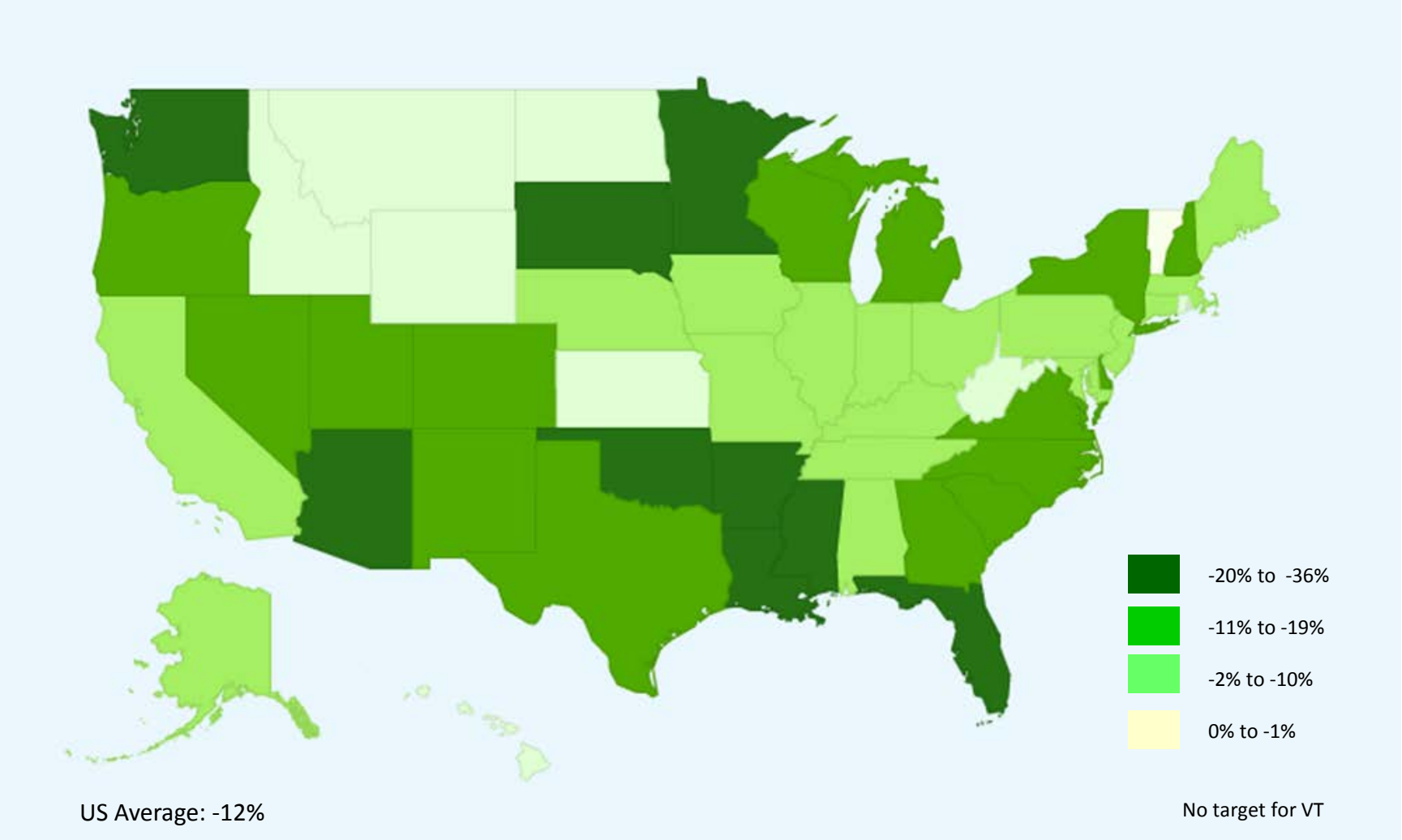
Emission Intensity Reductions: 2030



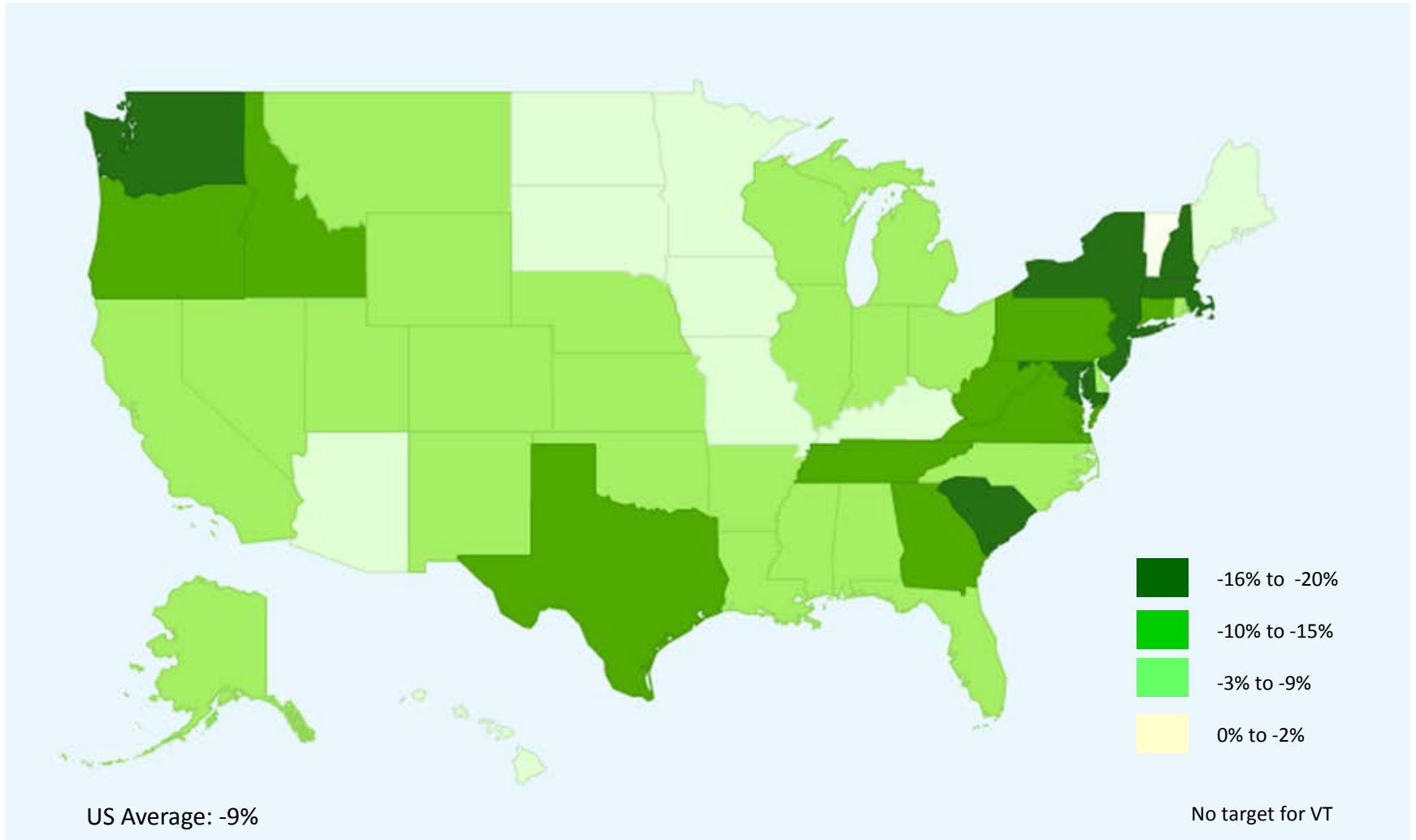
Heat Rate Improvement



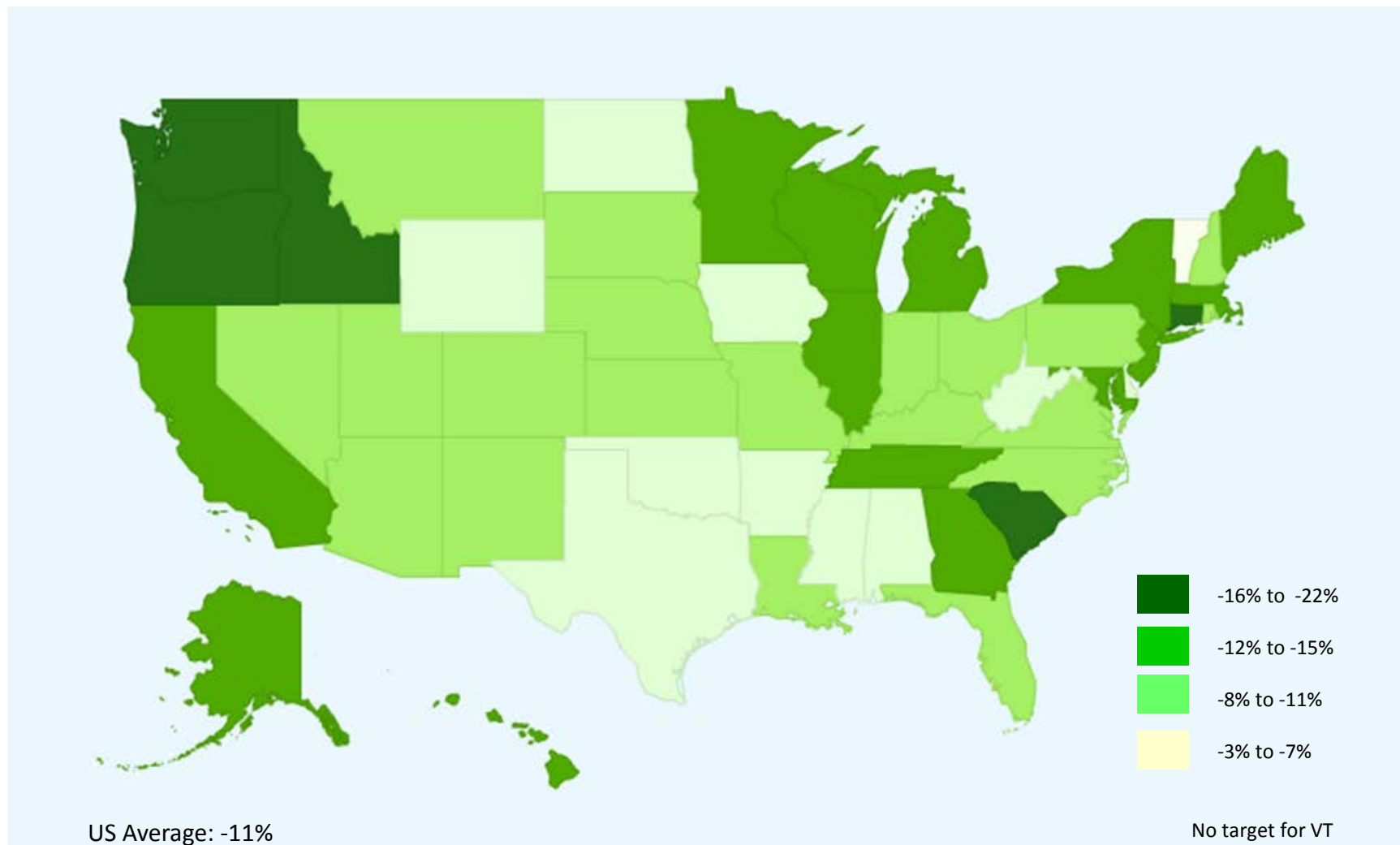
Redispatch



Renewable Generation



Energy Efficiency



Impact of Program

- Power sector CO₂ emissions fall 25-30% below 2005 levels in 2025 – a reduction of 18-25% relative to business-as-usual baseline.

	Climate Change Impacts		Co-Benefits of Correlated Pollutants plus ...	
	Domestic	Global	Domestic Climate Impacts	Global Climate Impacts
Benefits				
Climate Change	\$ 3	\$ 31	\$3	\$31
Health Co-Benefits			\$45	\$45
Total Benefits	\$ 3	\$ 31	\$48	\$76
Total Compliance Costs	\$ 9	\$ 9	\$ 9	\$ 9
Net Benefits	- \$ 6	\$ 22	\$ 39	\$ 67

Economic Impacts: Energy Markets

Table 5-1. Estimated Percentage Changes in Average Energy Prices, by Energy Type and Regulatory Option

Option 1 Regional Compliance	2020	2025	2030
Electricity Price Change	5.9%	2.7%	2.7%
Delivered Natural Gas Price Change	9.3%	-3.3%	-0.9%
Delivered Coal Price Change	-16.3%	-18.3%	-18.1%
Option 2 Regional Compliance	2020	2025	2030
Electricity Price Change	3.6%	2.4%	n/a
Delivered Natural Gas Price Change	7.5%	0.2%	n/a
Delivered Coal Price Change	-13.8%	-14.4%	n/a
Option 1 State Compliance:	2020	2025	2030
Electricity Price Change	6.5%	2.9%	3.1%
Delivered Natural Gas Price Change	11.5%	-3.5%	0.0%
Delivered Coal Price Change	-16.5%	-17.9%	-18.2%
Option 2 State Compliance	2020	2025	2030
Electricity Price Change	4.0%	2.7%	n/a
Delivered Natural Gas Price Change	8.1%	0.8%	n/a
Delivered Coal Price Change	-13.6%	-14.1%	n/a

Impacts: Employment

A. One time changes

	<u>2017-2020</u>	<u>2021-2025</u>	<u>2026-2030</u>
Heat Rate Improvements*	32,200	0	0
New Capacity Construction*	28,200	-38,000	-36,100

B. Recurring changes

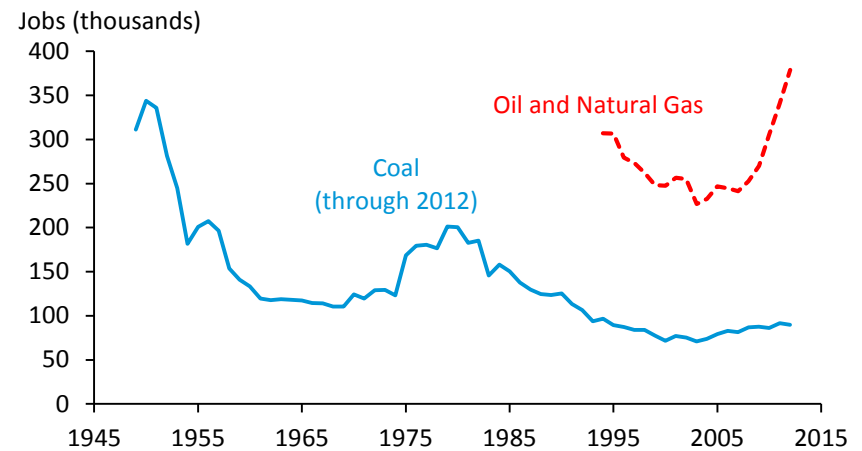
	<u>2020</u>	<u>2025</u>	<u>2030</u>
Operation & Maintenance*	-24,100	-25,300	-24,900
Coal Mining*	-14,300	-17,800	-18,000
Gas Extraction*	6,000	3,200	-1,400
Energy Efficiency Sector**	78,800	112,000	111,800

* = job years

** = number of jobs (full or part time;

1 job \approx .91 job-years)

Natural Resource Extraction Employment, 1949-2013



Cost Effective?

- State goals set as a rate improvement
 - Penalty to coal; subsidy to natural gas
 - Dampens impact on final price
- Differential shadow price on emissions across states?
- State implementation flexibility a bonus in this second best world

How Will CPP Impact Innovation?

- How will states implement SIPs?
- Rate based approach dampens consumer price and incentives for EE innovation
 - But goals predicated on EE
 - Impact on EE innovation depends on marginal cost of EE innovation versus RE deployment and redispatch
- No drivers for fundamental R&D

Regulation and Innovation

- Well developed theory (and empirics) on induced innovation
 - Final price impact dampened by intensity goal
 - Lack of a clear price signal (explicit or implicit)
 - Salience effects of policy
- Shale gas revolution weakens innovation impact
 - Not specific to regulation; but regulation building on shale gas revolution
- What is the policy counterfactual?

Thank you!



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Table 3-23. 2030 Projected Contiguous U.S. and Regional Retail Electricity Prices (cents/kWh)

	2030 Projected Retail Price (cents/kWh)					Percent Change from Base Case			
	Base Case	Option 1 Regional	Option 1 State	Option 2 Regional	Option 2 State	Option 1 Regional	Option 1 State	Option 2 Regional	Option 2 State
ERCT	11.6	12.0	12.0	n/a	n/a	3.6%	3.9%	n/a	n/a
FRCC	10.9	11.5	11.5	n/a	n/a	4.7%	5.6%	n/a	n/a
MROE	10.5	10.9	11.1	n/a	n/a	4.0%	5.9%	n/a	n/a
MROW	9.4	9.8	9.8	n/a	n/a	4.3%	4.3%	n/a	n/a
NEWE	15.1	15.1	15.3	n/a	n/a	-0.1%	1.0%	n/a	n/a
NYCW	19.9	20.1	20.1	n/a	n/a	1.0%	0.8%	n/a	n/a
NYLI	16.9	16.5	16.3	n/a	n/a	-2.3%	-3.3%	n/a	n/a
NYUP	14.2	14.2	14.2	n/a	n/a	0.0%	-0.4%	n/a	n/a
RFCE	12.4	12.8	12.9	n/a	n/a	3.4%	4.2%	n/a	n/a
RFCM	10.8	11.2	11.2	n/a	n/a	3.8%	4.5%	n/a	n/a
RFCW	11.2	11.3	11.3	n/a	n/a	0.4%	0.6%	n/a	n/a
SRDA	9.5	9.9	9.9	n/a	n/a	4.6%	4.5%	n/a	n/a
SRGW	10.4	10.3	10.2	n/a	n/a	-1.2%	-1.6%	n/a	n/a
SRSE	10.4	10.7	10.8	n/a	n/a	3.2%	4.0%	n/a	n/a
SRCE	8.1	8.4	8.4	n/a	n/a	2.6%	2.7%	n/a	n/a
SRVC	10.4	10.7	10.6	n/a	n/a	3.0%	2.5%	n/a	n/a
SPNO	10.2	11.5	10.5	n/a	n/a	12.7%	3.1%	n/a	n/a
SPSO	9.1	9.7	9.9	n/a	n/a	7.2%	9.2%	n/a	n/a
AZNM	11.5	11.4	11.7	n/a	n/a	-0.2%	2.1%	n/a	n/a
CAMX	14.1	14.7	14.7	n/a	n/a	4.2%	3.9%	n/a	n/a
NWPP	7.4	7.7	7.7	n/a	n/a	2.8%	2.8%	n/a	n/a
RMPA	9.9	9.9	10.3	n/a	n/a	0.7%	4.7%	n/a	n/a
Contiguous U.S.	10.9	11.2	11.3	n/a	n/a	2.7%	3.1%	n/a	n/a

