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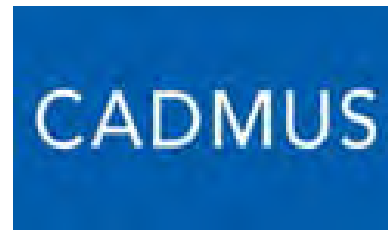
Impacts of Model Building Energy Codes

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Washington DC

Objectives

- ▶ Analyze impacts of overall energy codes
 - National benefits attributed from the overall model energy codes
 - Focus on the future impact for 2010-2040
 - *Not just the attributions from DOE's Codes Program*
- ▶ Conduct external peer reviews



For each state when adopting a new code:

Step 1: Determine code in place in 2010

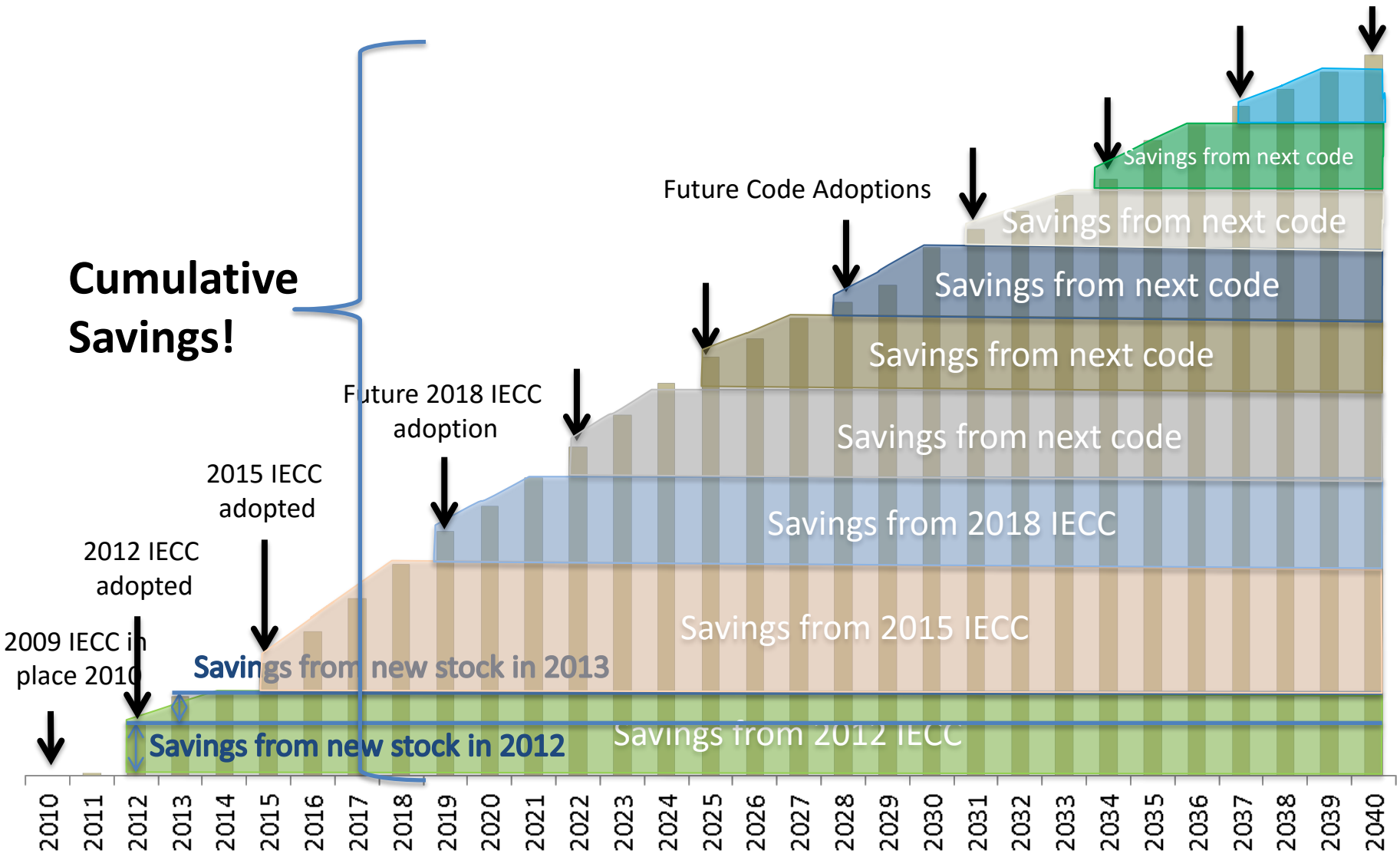
Step 2: When new code is adopted after 2010, calculate change in energy consumption per sf for commercial and per home for residential (Delta EUI)

Step 3: Estimate percent of potential savings realized in the field (Energy Compliance Rate)

Step 4: Estimate sf (commercial) and number of homes (residential) impacted by new code (Floor space forecast)

Code Impact = Delta EUI x Energy Compliance Rate x Floor space forecast

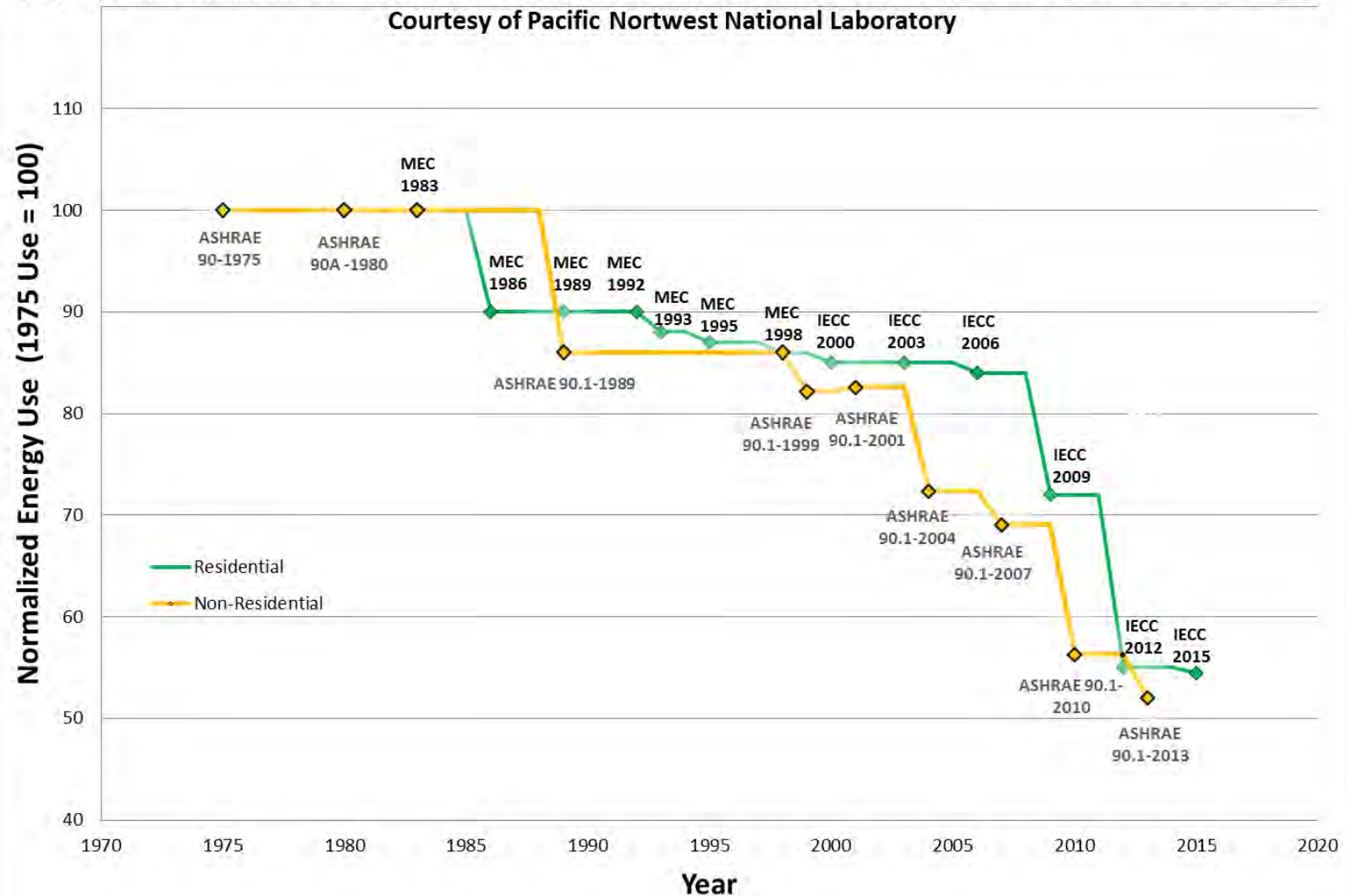
Example: Maryland Commercial Codes Impact



Development: Historic

Improvement in Residential and Non-Residential Model Energy Codes (Year 1975-2015)

Courtesy of Pacific Northwest National Laboratory



Development: Projection

- ▶ Savings based on DOE's Building Technology Roadmaps
 - Opaque envelope and fenestration
 - Solid-state Lighting
 - HVAC
- ▶ Savings adjusted upwards slightly for next two cycles of commercial codes
 - 90.1-2016 is on course to achieve at least 5% savings
- ▶ Penetration of renewables not included

Commercial Code Edition	% Savings compared to previous code	Residential Code Edition	% Savings compared to previous code
90.1-2016	5%	2018 IECC	4%
90.1-2019	5%	2021 IECC	4%
90.1-2022	4%	2024 IECC	4%
90.1-2025	4%	2027 IECC	4%
90.1-2028	5%	2030 IECC	5%
90.1-2031	5%	2033 IECC	5%
90.1-2034	5%	2026 IECC	5%
90.1-2037	5%	2039 IECC	5%

Adoption Pattern

- ▶ Used historical adoption scenario to inform future adoption pattern
- ▶ Collected input from REEOs for future state adoption pattern
- ▶ Implicit adoption: for states with no code in place and home rule states
 - Adoption is based on codes in effect in major population centers
 - Includes input from REEOs

Adoption Classifications

1. Timely. States adopts new code within one code cycle.

Future adoption lag = 1 year

2. Medium Slow. States adopts new code within two code cycles.

Future adoption lag = 4 year

3. Very Slow. States adopts new code after two code cycles.

Future adoption lag = 7 year

4. Not Applicable.

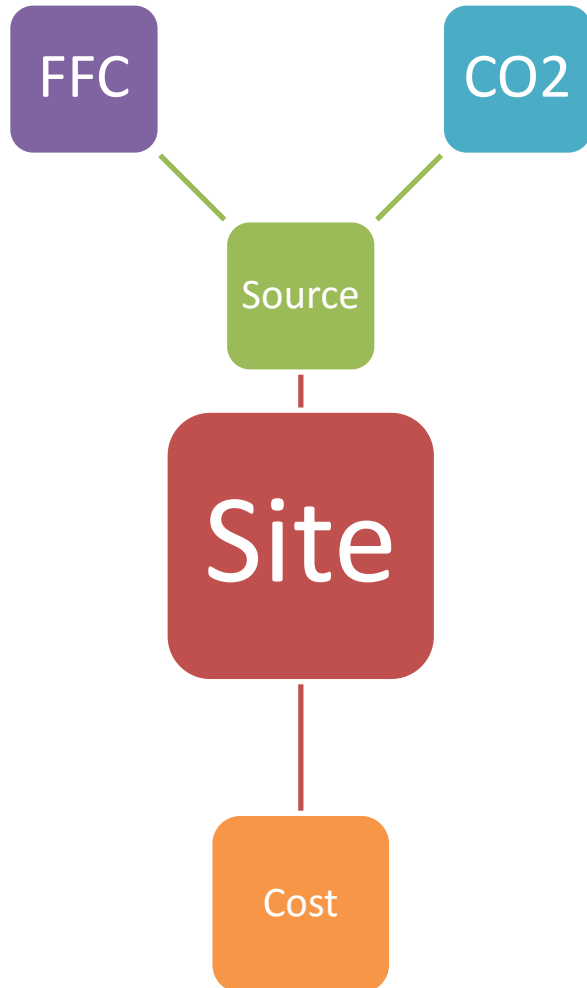
State with no state-wide code, no code enforced in jurisdictions within the state or with minimal relationship to the national model codes.

Savings Realized in the Field

- ▶ 100% energy realization rate means we will get full savings.
- ▶ 50% energy realization rate means our savings are cut by half.

- ▶ Commercial
 - Very little data available
 - Use conservative assumptions
 - First year of 50% realization rate and then increase to 80% in year 10

- ▶ Residential
 - DOE's Residential Field study data
 - States on 2009 IECC close to 100% realization rate
 - States on 2015 IECC about 80% realization rate
 - First year of 80% and then increase to 100% in year 10



- ▶ User friendly and transparent spreadsheet format
- ▶ Impacts for individual state and aggregated national level
- ▶ Flexible analyzed time period
 - User can select any years between 2010 and 2040
- ▶ Multiple results
 - Annual and communitive savings
 - Site, source, full-fuel-cycle, energy cost, and CO2

Table ES.1. Summary of Impact of Energy Codes

Sector	Site Energy Savings (Quads)	Primary Energy Savings (Quads)	Full-Fuel-Cycle Savings (Quads)	Energy Cost Savings (2016 \$ billion)	CO₂ Reduction (MMT)
Commercial					
Annual 2030	0.10	0.26	0.28	2.24	17.57
Annual 2040	0.13	0.32	0.34	2.54	21.48
Cumulative 2010-2030	1.18	3.14	3.30	27.53	208.78
Cumulative 2010-2040	2.34	6.10	6.41	51.59	405.51
Residential					
Annual 2030	0.15	0.28	0.30	3.14	18.38
Annual 2040	0.17	0.33	0.35	3.45	21.46
Cumulative 2010-2030	1.87	3.62	3.86	41.19	234.52
Cumulative 2010-2040	3.48	6.72	7.17	74.34	435.43
Total					
Annual 2030	0.25	0.55	0.58	5.37	35.96
Annual 2040	0.30	0.66	0.69	5.98	42.93
Cumulative 2010-2030	3.06	6.76	7.16	68.72	443.30
Cumulative 2010-2040	5.82	12.82	13.58	125.93	840.94

Note: The following states are excluded from the analysis: AK, CA, HI, KS, MO, MS (residential only), ND, OR, SD, and WA. See section 2.1.3 for details.

Avoided Carbon Emissions

Table 8. Avoided CO₂ Emissions (MMT)

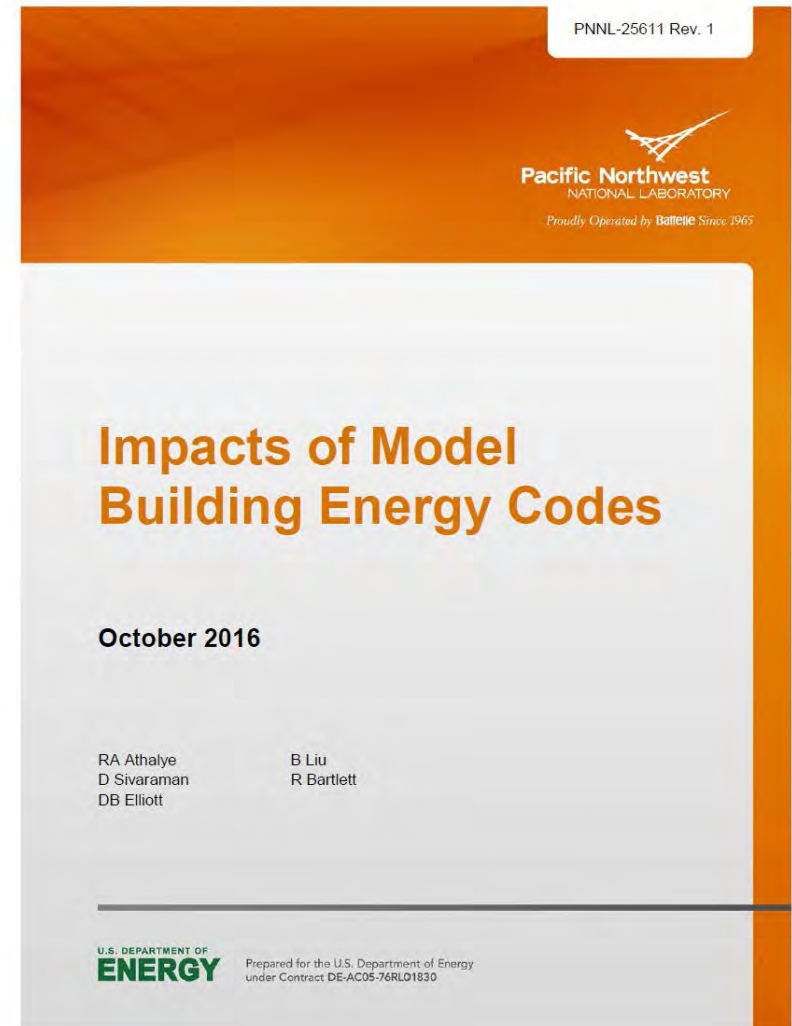
State	Commercial				Residential				Total			
	Annual 2030	Annual 2040	Cumulative 2010-2030	Cumulative 2010-2040	Annual 2030	Annual 2040	Cumulative 2010-2030	Cumulative 2010-2040	Annual 2030	Annual 2040	Cumulative 2010-2030	Cumulative 2010-2040
Alabama	0.46	0.54	5.49	10.51	0.47	0.51	5.35	10.29	0.93	1.05	10.84	20.79
Arizona	1.27	1.44	16.81	30.42	0.70	0.83	9.26	17.00	1.97	2.27	26.08	47.42
Arkansas	0.26	0.30	2.98	5.76	0.18	0.21	2.13	4.12	0.44	0.51	5.12	9.88
Colorado	0.76	0.86	9.44	17.58	0.73	0.84	8.98	16.91	1.49	1.70	18.42	34.48
Connecticut	0.18	0.23	2.07	4.13	0.12	0.14	1.51	2.80	0.30	0.37	3.59	6.94
Delaware	0.04	0.06	0.51	1.02	0.11	0.13	1.43	2.67	0.16	0.19	1.93	3.69
District of Columbia	0.08	0.10	0.96	1.87	0.04	0.04	0.46	0.86	0.12	0.14	1.42	2.74
Florida	1.78	2.20	20.42	40.45	1.07	1.36	14.23	26.57	2.85	3.56	34.64	67.02
Georgia	0.81	1.02	9.27	18.47	0.66	0.78	9.05	16.30	1.46	1.80	18.33	34.78
Idaho	0.11	0.14	1.34	2.61	0.19	0.23	2.53	4.64	0.30	0.37	3.87	7.25
Illinois	0.48	0.62	5.83	11.39	0.22	0.28	2.77	5.29	0.69	0.90	8.60	16.68
Indiana	0.45	0.59	3.96	9.20	0.48	0.54	5.96	11.10	0.93	1.13	9.92	20.29
Iowa	0.14	0.19	1.63	3.27	0.14	0.18	1.71	3.30	0.28	0.36	3.34	6.58
Kentucky	0.26	0.32	3.17	6.09	0.20	0.24	2.47	4.68	0.46	0.56	5.64	10.76
Louisiana	0.26	0.33	2.99	5.99	0.29	0.35	3.33	6.52	0.55	0.68	6.32	12.51
Maine	0.08	0.10	0.90	1.78	0.08	0.10	1.02	1.96	0.16	0.20	1.92	3.74
Maryland	0.24	0.32	2.91	5.71	0.20	0.26	2.80	5.16	0.44	0.58	5.71	10.88
Massachusetts	0.17	0.23	2.03	4.08	0.18	0.24	2.07	4.17	0.35	0.47	4.11	8.26
Michigan	0.58	0.69	7.69	14.08	0.70	0.78	8.97	16.41	1.29	1.46	16.66	30.49
Minnesota	0.32	0.39	3.81	7.40	0.59	0.66	7.85	14.13	0.91	1.05	11.65	21.53
Mississippi	0.46	0.50	5.68	10.51	0.00	0.00	0.00	0.00	0.46	0.50	5.68	10.51
Montana	0.04	0.04	0.40	0.80	0.08	0.10	1.01	1.92	0.12	0.14	1.40	2.72
Nebraska	0.27	0.31	3.27	6.18	0.19	0.22	2.40	4.44	0.46	0.53	5.67	10.62
Nevada	0.38	0.47	4.35	8.63	0.27	0.32	3.65	6.64	0.65	0.79	8.00	15.27
New Hampshire	0.07	0.09	0.75	1.54	0.06	0.07	0.70	1.38	0.13	0.16	1.45	2.92
New Jersey	0.45	0.52	5.14	10.00	0.69	0.76	8.70	16.00	1.13	1.28	13.85	25.99
New Mexico	0.13	0.16	1.26	2.72	0.12	0.14	1.49	2.80	0.25	0.30	2.75	5.52
New York	0.45	0.59	5.51	10.78	0.61	0.70	8.36	14.93	1.06	1.28	13.87	25.71
North Carolina	0.61	0.77	6.90	13.85	0.76	0.93	10.16	18.70	1.37	1.70	17.06	32.55
Ohio	0.77	0.95	7.60	16.27	0.43	0.49	5.11	9.74	1.19	1.45	12.72	26.01
Oklahoma	0.34	0.41	3.87	7.66	0.53	0.59	6.78	12.39	0.87	1.00	10.65	20.05
Pennsylvania	0.51	0.65	5.53	11.39	0.33	0.41	3.84	7.58	0.83	1.06	9.37	18.97
Rhode Island	0.04	0.05	0.49	0.96	0.01	0.02	0.16	0.32	0.05	0.07	0.65	1.27
South Carolina	0.32	0.40	3.59	7.20	0.46	0.55	6.18	11.24	0.77	0.95	9.76	18.44
Tennessee	0.56	0.67	6.59	12.77	0.54	0.64	6.09	12.07	1.11	1.31	12.67	24.84
Texas	2.21	2.69	29.05	53.74	4.01	4.56	52.44	95.59	6.22	7.24	81.50	149.33
Utah	0.15	0.20	1.77	3.57	0.76	0.83	7.99	15.97	0.91	1.03	9.76	19.53
Vermont	0.02	0.02	0.17	0.36	0.09	0.10	1.14	2.08	0.11	0.12	1.31	2.43
Virginia	0.57	0.71	6.74	13.19	0.64	0.75	8.92	15.97	1.21	1.46	15.66	29.16
West Virginia	0.11	0.13	1.25	2.45	0.07	0.08	0.78	1.50	0.18	0.20	2.03	3.95
Wisconsin	0.34	0.43	3.97	7.89	0.36	0.42	3.99	7.93	0.71	0.85	7.96	15.82
Wyoming	0.05	0.06	0.69	1.27	0.05	0.06	0.76	1.35	0.11	0.13	1.45	2.62

Codes Impact Summary



Cumulative impacts for 2010-2040:

- Reduce primary energy use by 12.8 quads
- Save consumers more than \$126 billion
- Avoid carbon emissions over 841 MMT
 - = 177 million cars driven for one year
 - = 245 coal power plants for one year





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Discussions

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