PNAS
www.pnas.org

Supplementary Information for

Why Marginal CO_2 Emissions Are Not Decreasing for U.S. Electricity: Estimates and Implications for Climate Policy

Stephen P. Holland, Matthew J. Kotchen, Erin T. Mansur, Andrew J. Yates

Corresponding Author: Matthew J. Kotchen.
E-mail: matthew.kotchen@yale.edu

This PDF file includes:

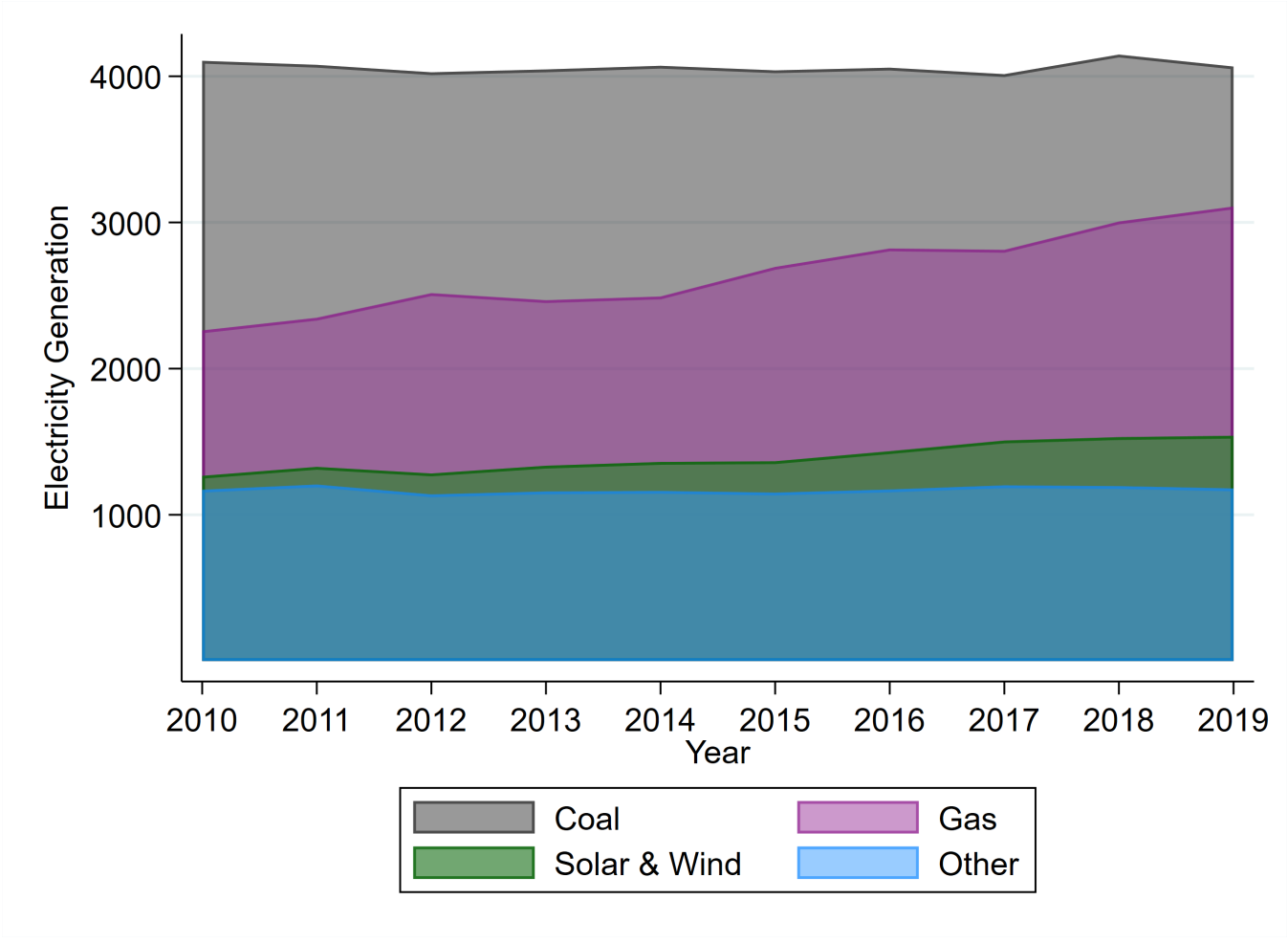


Fig. S1. U.S Electricity Generation By Fuel Type, 2010-2019. Electricity generation is reported in Terawatt-hours. Data are from the Energy Information Administration (EIA) form 923, and those for 2019 were considered "Early Release" at the time they were accessed. The Other category includes generation from nuclear, hydro, and all other sources. Data underlying the figure are reported in Table S1, which includes a further breakdown by grid interconnection.

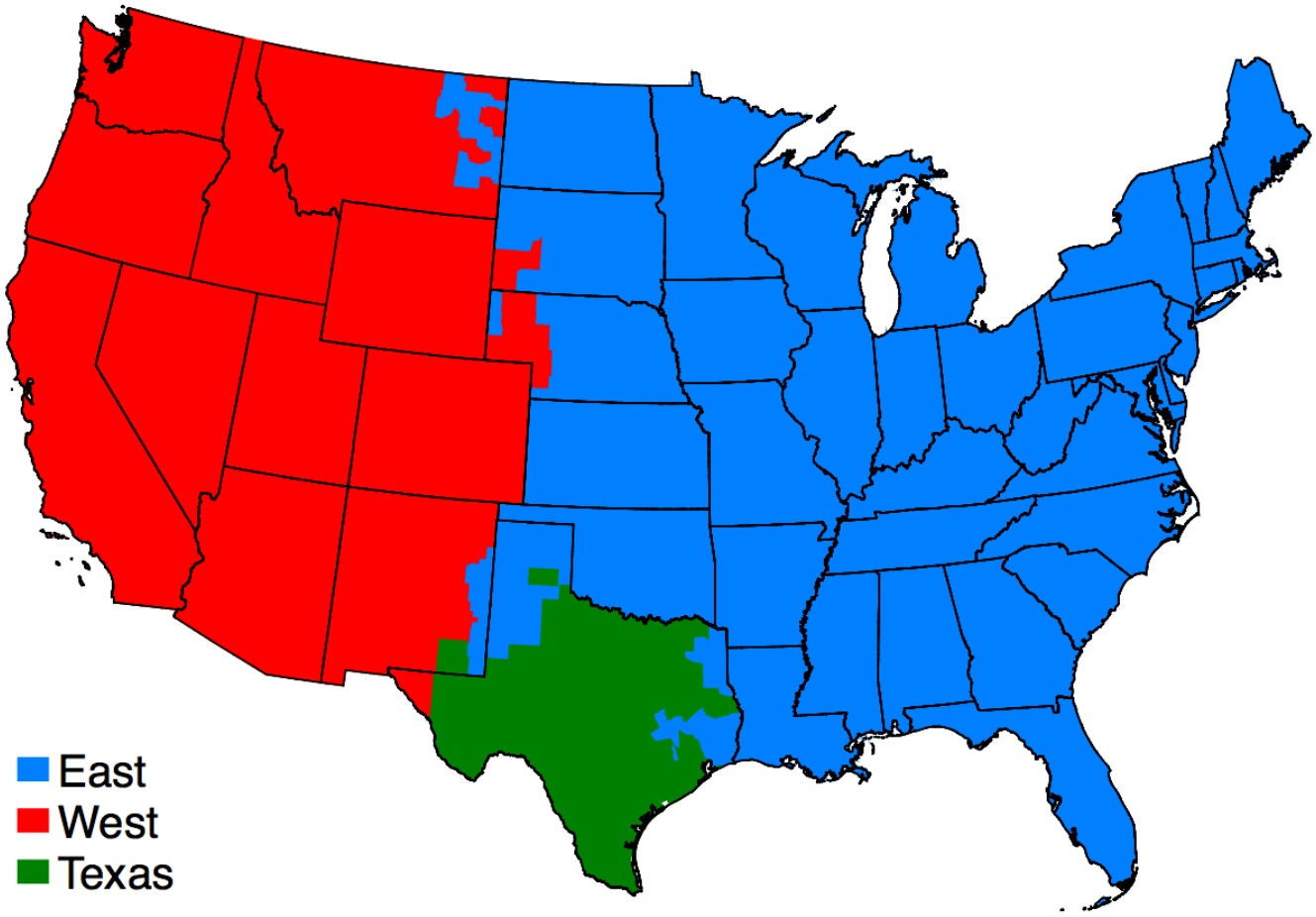


Fig. S2. Electric Power Interconnections in the United States. The figure is based on the authors' concatenation of U.S. counties with their associated grid interconnection.

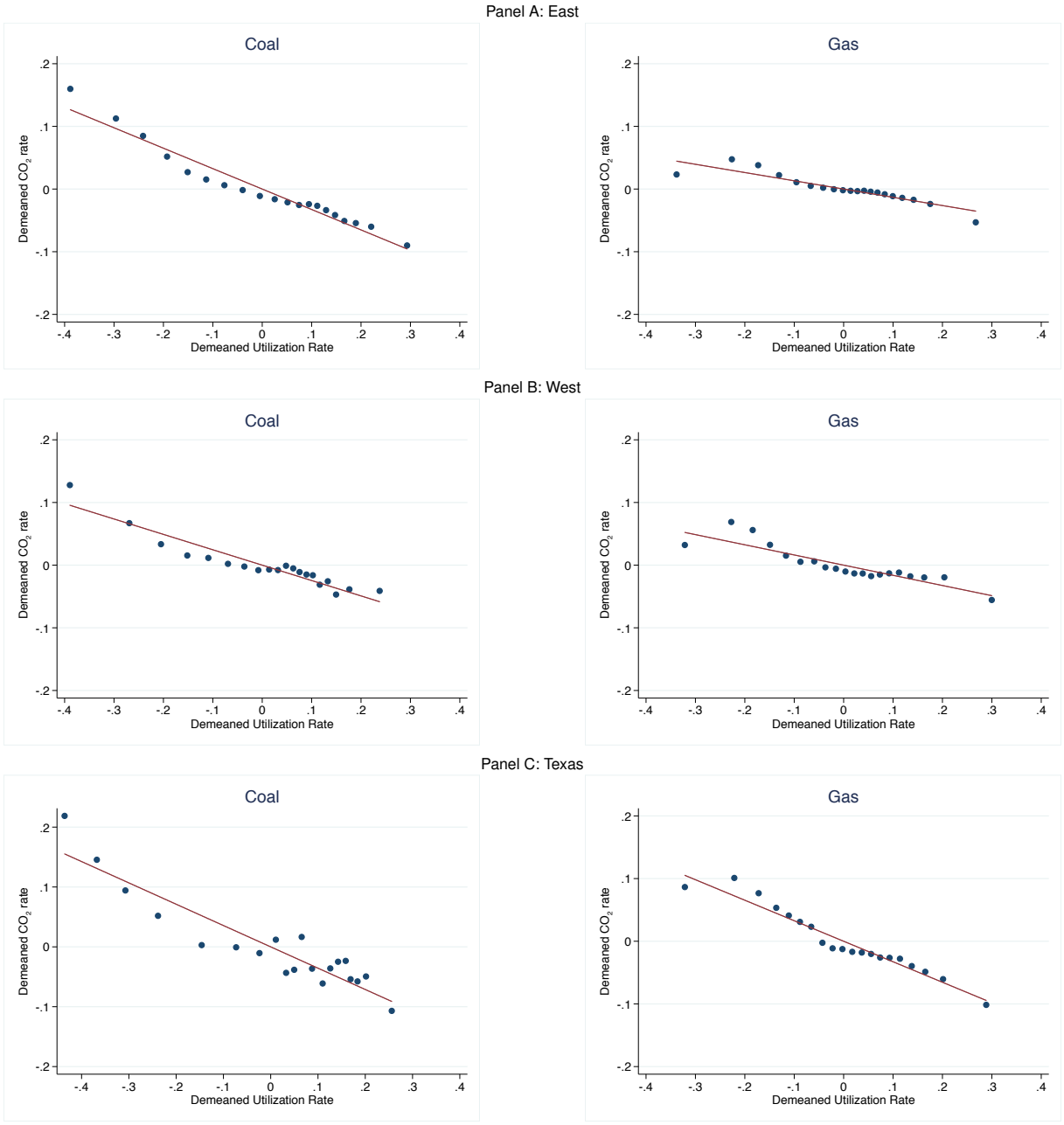
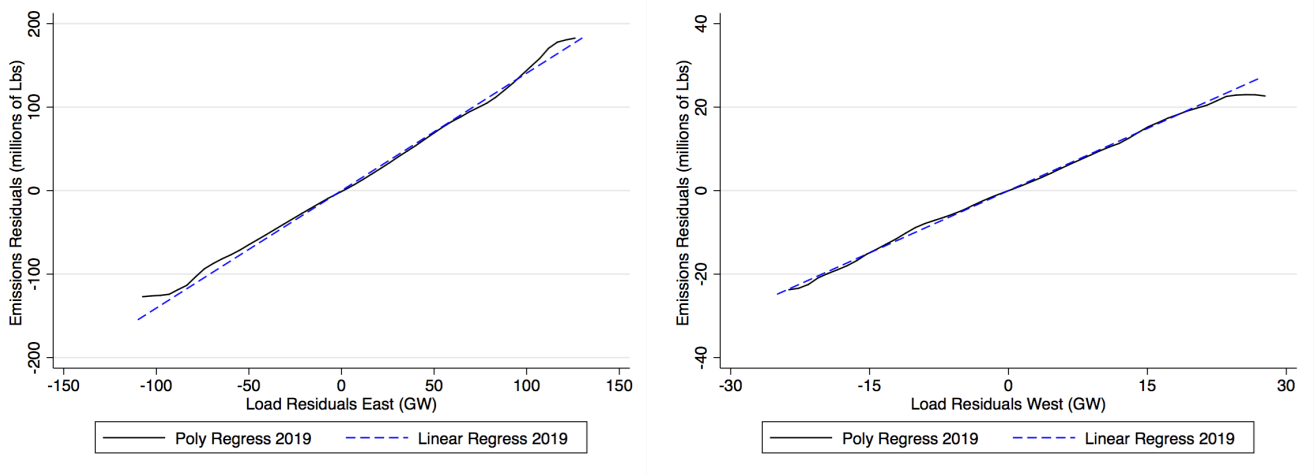
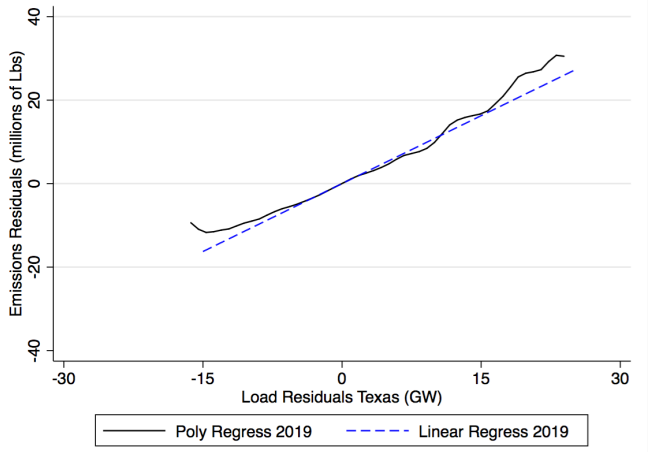


Fig. S3. Demeaned CO_2 Emission Rates *vs.* Demeaned Utilization Rates, 2010-2019. The figure shows a binned scatterplot of the data that have been demeaned within a generating unit. The lines predict the linear relationship through these data. See Table S15 for the coefficients of their slopes.



(a) East

(b) West



(c) Texas

Fig. S4. Linear Relationship Between CO_2 Emissions and Load. The analysis here uses data from the most recent year 2019. We first separately regress emissions and load on hour of day with month of sample fixed effects and retain the residuals. The solid line is a local polynomial regression of the residuals for emissions on the residuals for load, and the dashed line is the fitted line from a linear regression of the residual for emissions on the residuals for load. The slopes of the dashed lines are equal to the marginal emissions given in Table S2. The slope (i.e., marginal emissions) for the total U.S. is the load-weighted average of the slopes across interconnections.

Table S1. Electricity Generation (By Fuel Type, Interconnection, and U.S. Total) and CO_2 emissions, 2010-2019

Fuel	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
					Panel A: U.S. Total					
Coal	1,845	1,731	1,511	1,579	1,579	1,345	1,237	1,202	1,142	957
Gas	995	1,020	1,234	1,132	1,132	1,330	1,387	1,305	1,475	1,569
Solar & Wind	95	121	143	176	198	215	262	307	335	360
Other	1,171	1,207	1,139	1,160	1,164	1,152	1,173	1,202	1,196	1,180
Total	4,106	4,079	4,028	4,047	4,072	4,041	4,059	4,015	4,149	4,067
					Panel B: East Interconnnection					
Coal	1,504	1,392	1,202	1,244	1,251	1,059	968	919	891	729
Gas	625	687	842	739	739	898	981	932	1,053	1,123
Solar & Wind	45	58	71	90	99	109	129	155	165	185
Other	864	846	820	869	871	873	866	877	888	886
Total	3,038	2,983	2,935	2,941	2,960	2,939	2,944	2,883	2,997	2,923
					Panel C: West Interconnnection					
Coal	221	210	199	213	205	189	168	169	159	150
Gas	215	174	222	231	227	236	222	203	224	236
Solar & Wind	26	35	42	54	63	66	79	87	97	96
Other	263	319	278	250	251	237	262	283	264	251
Total	725	737	742	748	745	727	731	742	743	733
					Panel D: Texas Interconnnection					
Coal	120	129	110	122	123	98	101	115	93	78
Gas	155	159	170	162	167	195	184	169	198	210
Solar & Wind	24	28	29	33	37	40	54	64	73	80
Other	44	42	42	41	41	42	45	41	44	44
Total	343	358	351	358	367	375	384	390	408	412
					Panel E: CO_2 Emissions					
East	1,724	1,642	1,519	1,515	1,526	1,417	1,362	1,290	1,313	1,183
West	295	268	279	298	288	283	252	246	246	244
Texas	203	214	199	206	206	194	190	199	188	177
Total	2,221	2,124	1,997	2,019	2,020	1,893	1,804	1,735	1,747	1,604

Notes: Annual net generation reported in terawatt-hours (TW-hr) per year. All generation data are based on U.S. Energy Information Administration form 923. Data for 2019 were "Early Release" at the time they were accessed. CO_2 emissions are based on CEMS data, reported in millions of metric tons.

Table S2. Average and Marginal Emissions and the Social Cost of Carbon, 2010-2019.

	Average Emissions				Marginal Emissions				
	East	West	Texas	US	East	West	Texas	US	SCC
2010	1.248	0.892	1.392	1.196	1.332	0.804	1.129	1.218	38.550
					(0.013)	(0.032)	(0.027)	(0.011)	
2011	1.211	0.797	1.400	1.151	1.345	0.938	1.043	1.244	39.793
					(0.014)	(0.029)	(0.029)	(0.012)	
2012	1.136	0.823	1.332	1.094	1.353	0.892	1.190	1.255	41.037
					(0.017)	(0.027)	(0.033)	(0.014)	
2013	1.132	0.881	1.360	1.104	1.315	0.977	1.250	1.247	42.280
					(0.015)	(0.029)	(0.032)	(0.013)	
2014	1.127	0.857	1.322	1.094	1.372	0.963	1.132	1.276	43.524
					(0.018)	(0.030)	(0.027)	(0.015)	
2015	1.067	0.824	1.224	1.035	1.422	1.009	1.325	1.338	44.767
					(0.019)	(0.029)	(0.034)	(0.015)	
2016	1.005	0.741	1.191	0.973	1.416	1.069	1.137	1.329	47.255
					(0.023)	(0.029)	(0.038)	(0.018)	
2017	0.972	0.712	1.217	0.945	1.336	1.039	1.109	1.262	48.498
					(0.024)	(0.028)	(0.046)	(0.018)	
2018	0.950	0.717	1.089	0.921	1.397	0.950	1.188	1.297	49.741
					(0.023)	(0.036)	(0.057)	(0.019)	
2019	0.879	0.722	0.996	0.862	1.407	0.993	1.085	1.303	50.984
					(0.025)	(0.025)	(0.057)	(0.019)	

Notes: Average and marginal emissions are reported in pounds per kWh. Reported in parentheses for marginal emissions are Newey-West standard errors with a 48-hour lag, based on estimates of regression model (1). The U.S. column is the load-weighted average of the quantities in the East, West, and Texas columns. The social cost of carbon is reported in 2019 dollars per metric ton.

Table S3. Marginal Emissions Trend Regressions

Variable	East	West	Texas	US
Load (β)	1.333	0.889	1.157	1.237
	(0.009)	(0.017)	(0.022)	(0.008)
Load Trend (γ)	0.008	0.017	-0.000	0.009
	(0.002)	(0.003)	(0.005)	(0.002)

Notes: Coefficient estimates of regression model (2). Newey-West standard errors with a 48-hour lag are reported in parentheses. The coefficient on Load is interpreted as pounds of CO_2 per kWh. The coefficient on Load Trend is interpreted as pounds of CO_2 per year. The U.S. Total estimates are a load-weighted average across the interconnection results.

Table S4. Hourly Marginal CO_2 Emissions for the East Interconnection

Hour	2010-11	2012-13	2014-15	2016-17	2018-2019
1	1.51	1.44	1.56	1.47	1.48
2	1.52	1.43	1.54	1.44	1.43
3	1.51	1.42	1.53	1.43	1.46
4	1.51	1.41	1.51	1.43	1.46
5	1.49	1.40	1.49	1.43	1.47
6	1.45	1.36	1.43	1.43	1.44
7	1.34	1.28	1.34	1.32	1.33
8	1.27	1.25	1.32	1.25	1.27
9	1.28	1.29	1.36	1.29	1.33
10	1.31	1.36	1.41	1.39	1.43
11	1.33	1.38	1.42	1.44	1.48
12	1.33	1.36	1.40	1.44	1.47
13	1.32	1.34	1.37	1.43	1.45
14	1.31	1.32	1.35	1.39	1.41
15	1.30	1.30	1.34	1.37	1.39
16	1.29	1.29	1.33	1.35	1.37
17	1.29	1.29	1.34	1.33	1.36
18	1.28	1.29	1.34	1.32	1.36
19	1.28	1.30	1.35	1.33	1.36
20	1.29	1.31	1.36	1.36	1.38
21	1.30	1.34	1.39	1.38	1.40
22	1.34	1.37	1.44	1.40	1.42
23	1.40	1.42	1.50	1.44	1.46
24	1.47	1.44	1.54	1.47	1.48

Notes: Emissions are reported in pounds per kWh. Coefficients are based on estimating regression model (3) using data for the East interconnection.

Table S5. Hourly Marginal CO_2 Emissions for the West Interconnection

Hour	2010-11	2012-13	2014-15	2016-17	2018-2019
1	1.08	0.90	1.18	1.25	1.18
2	1.14	1.08	1.22	1.29	1.21
3	1.17	1.12	1.27	1.35	1.27
4	1.20	1.15	1.32	1.39	1.28
5	1.17	1.19	1.31	1.36	1.21
6	1.01	1.07	1.16	1.16	1.02
7	0.83	0.91	0.98	0.97	0.86
8	0.76	0.85	0.91	0.92	0.83
9	0.80	0.89	0.95	0.99	0.92
10	0.85	0.94	1.01	1.07	1.01
11	0.87	0.96	1.02	1.09	1.04
12	0.88	0.96	1.01	1.08	1.04
13	0.89	0.96	1.00	1.07	1.03
14	0.87	0.94	0.96	1.04	0.99
15	0.86	0.93	0.93	1.02	0.97
16	0.84	0.91	0.92	1.01	0.93
17	0.83	0.90	0.90	0.99	0.91
18	0.82	0.91	0.91	0.99	0.90
19	0.83	0.93	0.95	1.00	0.91
20	0.85	0.94	0.97	1.03	0.93
21	0.85	0.92	0.97	1.05	0.93
22	0.88	0.90	0.99	1.09	0.96
23	0.95	0.93	1.05	1.15	1.04
24	1.02	0.99	1.14	1.21	1.11

Notes: Emissions are reported in pounds per kWh. Coefficients are based on estimating regression model (3) using data for the West interconnection.

Table S6. Hourly Marginal CO_2 Emissions for the Texas Interconnection

Hour	2010-11	2012-13	2014-15	2016-17	2018-2019
1	1.19	1.36	1.27	1.00	1.19
2	1.23	1.37	1.28	1.01	1.20
3	1.24	1.38	1.29	1.01	1.20
4	1.24	1.39	1.29	1.05	1.22
5	1.23	1.39	1.30	1.11	1.25
6	1.19	1.36	1.31	1.22	1.27
7	1.16	1.32	1.27	1.27	1.23
8	1.10	1.25	1.22	1.23	1.20
9	1.05	1.26	1.22	1.23	1.21
10	1.03	1.25	1.24	1.27	1.22
11	1.04	1.24	1.27	1.31	1.23
12	1.05	1.23	1.28	1.31	1.21
13	1.05	1.21	1.27	1.28	1.18
14	1.04	1.19	1.24	1.23	1.14
15	1.03	1.17	1.22	1.17	1.10
16	1.02	1.16	1.19	1.12	1.06
17	1.01	1.15	1.16	1.08	1.02
18	1.01	1.14	1.12	1.03	0.99
19	0.99	1.11	1.09	1.00	1.00
20	1.00	1.12	1.11	1.00	1.05
21	1.01	1.14	1.14	1.02	1.09
22	1.03	1.16	1.15	1.00	1.10
23	1.06	1.22	1.20	1.00	1.13
24	1.13	1.29	1.25	1.02	1.17

Notes: Emissions are reported in pounds per kWh. Coefficients are based on estimating regression model (3) using data for the Texas interconnection.

Table S7. Hourly Marginal CO_2 Emissions for the U.S. Total

Hour	2010-11	2012-13	2014-15	2016-17	2018-2019
1	1.41	1.33	1.46	1.39	1.40
2	1.42	1.36	1.46	1.38	1.37
3	1.43	1.36	1.46	1.38	1.41
4	1.43	1.36	1.46	1.39	1.41
5	1.41	1.36	1.44	1.39	1.40
6	1.35	1.31	1.37	1.36	1.35
7	1.23	1.22	1.27	1.25	1.23
8	1.16	1.18	1.23	1.19	1.18
9	1.17	1.22	1.27	1.23	1.24
10	1.20	1.27	1.32	1.32	1.33
11	1.22	1.29	1.33	1.36	1.38
12	1.22	1.28	1.32	1.36	1.37
13	1.21	1.26	1.30	1.35	1.35
14	1.20	1.24	1.27	1.31	1.31
15	1.19	1.22	1.25	1.29	1.28
16	1.19	1.21	1.24	1.27	1.27
17	1.18	1.20	1.24	1.25	1.25
18	1.17	1.21	1.25	1.24	1.24
19	1.17	1.22	1.26	1.24	1.25
20	1.18	1.23	1.27	1.26	1.27
21	1.20	1.24	1.29	1.29	1.29
22	1.23	1.27	1.33	1.31	1.31
23	1.29	1.31	1.39	1.35	1.35
24	1.36	1.35	1.44	1.38	1.38

Notes: Emissions are reported in pounds per kWh. Coefficients are a load-weighted average across the estimates of regression model (3) for the three interconnections.

Table S8. The Effects of Coal-Gas Price Ratio and Coal Capacity Share on Average and Marginal Emissions

	Average Emissions		Marginal Emissions	
	Interconnection	Total U.S.	Interconnection	Total U.S.
Coal-Gas Price Ratio (ρ)	-0.218	-0.173	0.112	0.087
	(0.042)	(0.024)	(0.069)	(0.060)
Coal Capacity Share (ψ)	4.002	3.847	-0.150	-0.536
	(0.301)	(0.144)	(0.565)	(0.353)

Notes: The Interconnection columns show results for the pooled data across all interconnections, where the models include interconnection fixed effects and month-of-year fixed effects. The Total U.S. columns show results for the nation as a whole, where we aggregate the interconnections and still include month-of-year fixed effects. Newey-West standard errors assuming a 2-month lag shown in parenthesis.

Table S9. Marginal Response to Electricity Load by Year

	East		West		Texas		Total U.S.	
Year	Coal	Gas	Coal	Gas	Coal	Gas	Coal	Gas
2010	0.361	0.467	0.103	0.603	0.159	0.807	0.296	0.521
	(0.009)	(0.011)	(0.012)	(0.029)	(0.016)	(0.021)	(0.007)	(0.010)
2011	0.401	0.433	0.147	0.648	0.128	0.814	0.331	0.505
	(0.011)	(0.008)	(0.011)	(0.019)	(0.017)	(0.021)	(0.008)	(0.007)
2012	0.413	0.408	0.158	0.575	0.216	0.709	0.349	0.464
	(0.008)	(0.008)	(0.011)	(0.016)	(0.012)	(0.021)	(0.006)	(0.007)
2013	0.382	0.453	0.120	0.709	0.218	0.766	0.320	0.527
	(0.009)	(0.009)	(0.009)	(0.021)	(0.015)	(0.024)	(0.007)	(0.008)
2014	0.405	0.436	0.146	0.658	0.172	0.789	0.338	0.507
	(0.011)	(0.009)	(0.013)	(0.023)	(0.012)	(0.025)	(0.008)	(0.008)
2015	0.438	0.412	0.161	0.656	0.268	0.764	0.372	0.487
	(0.011)	(0.010)	(0.010)	(0.022)	(0.012)	(0.024)	(0.008)	(0.009)
2016	0.432	0.441	0.201	0.651	0.212	0.675	0.371	0.500
	(0.014)	(0.012)	(0.011)	(0.022)	(0.015)	(0.032)	(0.010)	(0.010)
2017	0.379	0.461	0.173	0.674	0.224	0.633	0.328	0.515
	(0.013)	(0.014)	(0.008)	(0.020)	(0.013)	(0.030)	(0.009)	(0.011)
2018	0.378	0.488	0.177	0.589	0.218	0.703	0.327	0.525
	(0.011)	(0.011)	(0.013)	(0.018)	(0.016)	(0.041)	(0.009)	(0.010)
2019	0.414	0.473	0.197	0.568	0.200	0.671	0.356	0.507
	(0.012)	(0.013)	(0.009)	(0.018)	(0.014)	(0.041)	(0.009)	(0.011)

Notes: Coefficient estimates of regression model (1), with the dependent variable as hourly generation from coal or natural gas. Newey-West standard errors with a 48-hour lag are reported in parentheses. The total U.S estimates are load-weighted averages of the estimates for each interconnection.

Table S10. Marginal Generation of Coal and Natural Gas Trend Regressions

	Variable	Estimate East	Estimate West	Estimate Texas	Total U.S.
Coal					
	Load	0.391	0.119	0.170	0.322
		(0.006)	(0.007)	(0.010)	(0.005)
	Load Trend	0.002	0.009	0.007	0.004
		(0.001)	(0.001)	(0.002)	(0.001)
Gas					
	Load	0.430	0.648	0.810	0.503
		(0.006)	(0.014)	(0.015)	(0.005)
	Load Trend	0.004	-0.003	-0.016	0.001
		(0.001)	(0.002)	(0.004)	(0.001)

Notes: Coefficient estimates of regression model (2), with the dependent variable as hourly generation from coal or natural gas. Newey-West standard errors with a 48-hour lag are reported in parentheses. The total U.S estimates are load-weighted averages of the estimates for each interconnection.

Table S11. Coal Unit Utilization Rates for Each Two-Year Period, 2010-1019

	Utilization Rate Bins									
Years	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1.0
Panel A East										
2010-11	22.18	0.20	0.71	2.07	4.15	5.45	5.90	7.81	12.26	39.27
2012-13	29.62	0.16	0.98	2.81	5.23	6.80	6.48	7.84	10.63	29.45
2014-15	29.48	0.17	0.95	2.93	5.30	7.24	6.44	7.83	10.37	29.29
2016-17	34.01	0.24	0.99	3.62	5.52	6.91	5.88	7.42	9.16	26.26
2018-19	36.68	0.25	1.15	4.34	5.80	6.67	5.62	6.30	8.49	24.71
Panel B West										
2010-11	14.45	0.15	0.34	1.00	1.94	2.66	4.40	6.87	12.65	55.53
2012-13	14.87	0.12	0.26	1.21	2.26	3.66	6.75	9.69	16.50	44.67
2014-15	15.03	0.12	0.24	1.50	2.29	4.39	6.98	9.67	15.67	44.12
2016-17	18.80	0.12	0.32	2.83	5.98	6.11	10.42	10.35	14.71	30.36
2018-19	17.41	0.26	1.35	5.14	5.73	6.09	10.57	9.76	12.84	30.85
Panel C Texas										
2010-11	11.97	0.13	0.25	1.27	1.86	3.09	4.43	6.94	11.67	58.38
2012-13	18.00	0.22	0.34	2.94	5.72	4.79	4.81	5.70	10.05	47.42
2014-15	20.33	0.14	1.03	5.22	8.10	5.74	4.20	6.17	9.19	39.87
2016-17	18.38	0.10	2.18	8.57	8.20	5.01	4.53	6.22	9.82	36.99
2018-19	18.70	0.12	2.24	8.50	8.32	5.00	4.51	5.46	8.97	38.18

Notes: The table reports the percent of hours coal units operate at each of the binned utilization rates.

Table S12. Natural Gas Unit Utilization Rates for Each Two-Year Period, 2010-1019

	Utilization Rate Bins									
Years	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1.0
Panel A East										
2010-11	63.64	1.58	2.07	2.19	2.51	4.75	4.44	5.52	8.01	5.27
2012-13	59.64	1.27	1.94	1.88	1.85	3.99	4.94	7.00	10.36	7.12
2014-15	60.40	0.98	1.20	1.21	1.47	3.70	4.77	7.04	11.13	8.09
2016-17	57.07	0.94	1.19	1.15	1.20	3.23	4.52	6.87	12.98	10.84
2018-19	53.97	0.85	1.21	1.28	1.26	3.05	4.18	6.82	13.13	14.25
Panel B West										
2010-11	62.71	0.84	1.21	1.37	2.24	4.60	5.08	5.60	8.23	8.12
2012-13	57.89	1.08	1.49	1.25	1.98	4.70	5.67	6.65	8.73	10.55
2014-15	57.17	0.89	0.96	1.18	1.61	4.42	6.27	7.19	9.90	10.41
2016-17	60.88	0.59	0.85	1.06	1.86	4.39	6.14	6.59	8.77	8.86
2018-19	57.34	0.60	0.77	0.96	1.85	3.56	5.26	6.91	10.13	12.62
Panel C Texas										
2010-11	54.60	2.18	2.25	2.09	3.43	6.49	6.25	6.90	9.62	6.20
2012-13	52.78	1.67	1.73	1.59	3.30	6.66	6.22	7.54	11.18	7.34
2014-15	51.58	1.57	1.09	1.15	2.82	7.87	8.23	7.96	9.80	7.92
2016-17	53.95	1.15	1.10	1.20	2.63	6.20	7.93	8.12	10.83	6.89
2018-19	47.15	1.69	1.24	1.41	2.48	4.38	7.39	9.10	13.02	12.15

Notes: The table reports the percent of hours natural gas units operate at each of the binned utilization rates.

Table S13. Coal Unit Operating States for Each Two-Year Period, 2010-1019

	Off	Unconstrained	Ramp Constrained	Capacity Constrained
Panel A East				
2010-11	21.6	37.6	1.6	39.3
2012-13	29.0	39.8	1.7	29.5
2014-15	28.9	40.0	1.8	29.3
2016-17	33.4	38.3	2.0	26.3
2018-19	36.1	37.1	2.1	24.7
Panel B West				
2010-11	14.0	28.8	1.6	55.5
2012-13	14.6	39.0	1.8	44.7
2014-15	14.7	39.5	1.7	44.1
2016-17	18.5	48.8	2.4	30.4
2018-19	17.1	49.1	2.9	30.9
Panel C Texas				
2010-11	11.4	29.1	1.1	58.4
2012-13	17.5	33.4	1.7	47.4
2014-15	19.9	38.2	2.0	39.9
2016-17	17.9	42.5	2.6	37.0
2018-19	18.2	40.6	3.0	38.2

Notes: The table shows the percent of hours a unit is operating in each of the given states. A unit is off if generation is equal to zero. A unit is ramp constrained if the change in generation is either less than 0.9 times the ramp down capability or more than 0.9 times the ramp up capability (defined as the 1^{st} and 99^{th} percentile of the observed ramp distribution). A unit is capacity constrained if its utilization rate is greater than 0.9. Unconstrained is the residual.

Table S14. Natural Gas Unit Operating States for Each Two-Year Period, 2010-1019

	Off	Unconstrained	Ramp Constrained	Capacity Constrained
Panel A East				
2010-11	62.8	30.0	1.9	5.3
2012-13	58.9	32.3	1.7	7.1
2014-15	59.9	30.4	1.6	8.1
2016-17	56.5	31.0	1.6	10.8
2018-19	53.4	30.6	1.7	14.3
Panel B West				
2010-11	61.6	28.5	1.8	8.1
2012-13	56.5	31.2	1.7	10.5
2014-15	56.2	31.6	1.7	10.4
2016-17	59.9	29.4	1.8	8.9
2018-19	56.5	28.9	2.0	12.6
Panel C Texas				
2010-11	53.3	38.2	2.3	6.2
2012-13	51.8	39.1	1.8	7.3
2014-15	50.7	39.5	1.9	7.9
2016-17	53.2	38.0	1.9	6.9
2018-19	46.5	39.5	1.9	12.1

Notes: The table shows the percent of hours a unit is operating in each of the given stats. A unit is off if generation is equal to zero. A unit is ramp constrained if the change in generation is either less than 0.9 times the ramp down capability or more than 0.9 times the ramp up capability (defined as the 1^{st} and 99^{th} percentile of the observed ramp distribution). A unit is capacity constrained if its utilization rate is greater than 0.9. Unconstrained is the residual.

Table S15. Within-Unit Relationship Between Emissions Rates and Utilization Rates

Fuel	East	West	Texas
Coal	-0.326	-0.245	-0.356
	(0.011)	(0.041)	(0.034)
Gas	-0.132	-0.162	-0.327
	(0.011)	(0.017)	(0.034)

Notes: We regress unit-level, hourly emissions rates (in pounds of CO_2 per kWh) on the corresponding utilization rates, controlling for unit-level fixed effects. Standard errors are clustered by generating unit. The table reports the coefficient estimates, each from a separate regression, corresponding to the slopes of the lines shown in Figure S3.

Table S16. Annual electric Vehicle Sales, Stock, Vehicle Miles Traveled, and Cumulative Electricity Demand for Analaysis of the Biden 2030 Target

Year	EV Sales (Millions)	EV Stock (Millions)	Cumulative EV Miles (Billions)	Cumulative EV Electricity Demand (TWh)
2021	1.721	4.046	46.611	13.983
2022	2.419	6.465	74.484	22.345
2023	3.116	9.582	110.393	33.117
2024	3.814	13.396	154.338	46.301
2025	4.512	17.908	206.319	61.895
2026	5.209	23.118	266.337	79.901
2027	5.907	29.025	334.392	100.317
2028	6.604	35.63	410.482	123.144
2029	7.302	42.933	494.609	148.382
2030	8.000	50.933	586.773	176.032

Notes: The electric vehicle stock includes those part of the fleet in 2020.