Online Appendix

This section presents additional details pertinent to our analysis.

Table A1 – Correlations

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Ln (Carbon Dioxide Emissions per MWh)	1.0000													
2	Possesses Fuel Flexibility – PFF	-0.0924*	1.0000												
3	Posesses Volume Flexibility - PVF	-0.1839*	0.2752*	1.0000											
4	Usage of Fuel Flexibility – UFF	0.0536*	0.2251*	0.1069*	1.0000										
5	Usage of Volume Flexibility – UVF	0.1057*	0.1353*	0.3283*	0.0454*	1.0000									
6	Fuel Cost per MMBtu (USD)	-0.2229*	0.1741*	0.2724*	0.0681*	0.1915*	1.0000								
7	Fuel Emission Intensity (CO_2/MMBtu)	0.6666*	-0.2962*	-0.5353*	-0.0200*	-0.1979*	-0.3800*	1.0000							
8	Generating Hours	0.1928*	-0.2842*	-0.7019*	-0.1258*	-0.3663*	-0.3168*	0.6068*	1.0000						
9	Age (months)	0.5158*	-0.1805*	-0.5505*	-0.0241*	-0.1774*	-0.2804*	0.6173*	0.4238*	1.0000					
10	Capacity (in MW)	-0.0392*	-0.1936*	-0.4907*	-0.0743*	-0.1898*	-0.1353*	0.2867*	0.4584*	0.0131*	1.0000				
11	Fraction - Renewable	-0.1294*	-0.0605*	0.0488*	-0.0419*	0.0046*	-0.0114*	-0.1466*	-0.0760*	-0.0097*	-0.0440*	1.0000			
12	SO_2 Control Equipment	-0.2053*	0.0428*	0.1911*	-0.0091*	0.0695*	0.1051*	-0.1551*	-0.1243*	-0.3889*	0.1500*	0.0524*	1.0000		
13	NOX Control Equipment	0.3099*	-0.1759*	-0.2577*	-0.0532*	-0.1009*	-0.1791*	0.4688*	0.3007*	0.1729*	0.3034*	0.0181*	0.1342*	1.0000	
14	Mercury Control Equipment	0.1112*	-0.0591*	-0.0946*	-0.0118*	-0.0380*	-0.0583*	0.1692*	0.1005*	0.1062*	0.1204*	0.1132*	0.0754*	0.1664*	1.0000
15	CO_2 Control Equipment	0.0235*	-0.0118*	-0.0225*	-0.0021	-0.0083*	-0.0112*	0.0350*	0.0222*	0.0197*	0.0335*	-0.0100*	0.0131*	0.0770*	0.0070*

Notes: * indicates significance at $p < 0.05$

Table A2: Data Sources

Variable	Source
Carbon Dioxide Emissions per MWh	ABB Velocity Suite
Possesses Fuel Flexibility	ABB Velocity Suite
Possesses Volume Flexibility	EIA Form-860
Usage of Fuel Flexibility	ABB Velocity Suite
Usage of Volume Flexibility	ABB Velocity Suite
Fuel Cost per MMBtu (USD)	ABB Velocity Suite
Generating Hours	ABB Velocity Suite
Age	ABB Velocity Suite
Capacity	ABB Velocity Suite
Fuel Category	ABB Velocity Suite
Steam turbine primary mover fixed effects	ABB Velocity Suite
Gas turbine primary mover fixed effects	ABB Velocity Suite
Combined cycle primary mover fixed effects	ABB Velocity Suite
SO2 control technology fixed effect	ABB Velocity Suite
NOx control technology fixed effect	ABB Velocity Suite
Hg control technology fixed effect	ABB Velocity Suite
CO2 control technology fixed effect	ABB Velocity Suite

Table A3: Carbon Emissions per MWH for Different Levels of Volume Flexibility

Time to Start	Column 1	Column 2	Column 3	Column 4
1/6 hour	1763.47	1765.61	1498.51	1499.63
1 hour	1736.97	1738.96	1478.64	1479.66
12 hour	1573.80	1574.18	1335.56	1335.41
24 hour	1751.71	1750.26	1399.52	1397.88

Table A3 provides the carbon emissions estimated at different levels of "Time to Start" for columns 1 through 4 of Table 5. We observe that, in Columns 1 and 2, the carbon emissions for power generating units with 24 hours "Time to Start" is noticeably higher than the carbon emissions for power generating units with 12 hours "Time to Start." The estimated increase in carbon emissions can be traced to differences in the proportions of gas and coal power generating units with 12 and 24 hours of starting times. Our data for power generating units with 12 hour "Time to Start" includes 765 gas and 172 coal plants, but for power generating units with 24 hour "Time to Start" we have 230 gas and 643 coal plants. By contrast, for the analysis with only gas power generating units shown in Columns 3 and 4, we do not see noticeable differences in the emission of power generating units with 12 hours and 24 hours of "Time to Start."

Table A4: Fuel Type Usage When Gas and Coal Units Exercise Fuel Flexibility

Fuel Type (Percentage)	Gas Units	Coal Units
Gas	65.83	2.72
Coal	3.34	92.23
Light Oil	21.3	0.61
Heavy Oil	1.99	0.28
Mixed Fuel	5.29	0.38
Others	2.26	3.81

Table A4, above, provides details of the various fuel types used by coal and gas power generating unit when they exercise fuel flexibility. When gas units exercise fuel flexibility they use light oil as an alternative fuel for 21.3% of power generation. On the other hand, coal units use smaller percentages of other fuel types. The largest alternative fuel used by coal units when they exercise fuel flexibility is "others", which accounts for 3.81% of power generation.

We evaluated our regression models by retaining the "mainstream" cases as suggested (i.e., retaining data for gas units which only use gas and light oil when they exercise fuel flexibility and for coal units which only use coal and "others" when they exercise fuel flexibility). The results presented in Table A5, below, are aligned with the main results in Table 2 of the paper.

Table A5: Results for the "mainstream" cases when gas and coal units exercise fuel flexibility.

		Dependent Variable: ln(Carbon Dioxide Emissions per MWH)					
		All Plants		Gas Plants		Coal Plants	
		(1)	(2)	(3)	(4)	(5)	(6)
H1a	Possesses Fuel Flexibility – PFF (β_1)	0.0316***	0.0321***	0.0379***	0.0382***	-0.0067	-0.0065
		(0.0076)	(0.0075)	(0.0082)	(0.0082)	(0.0101)	(0.0101)
H1b	Posesses Volume Flexibility - PVF ($\beta 2$)	0.0930***	0.0937***	0.1051***	0.1057***	0.003	0.0037
		(0.0130)	(0.0130)	(0.0147)	(0.0146)	(0.0342)	(0.0343)
H2a	Usage of Fuel Flexibility - UFF (β_3)	0.0970***	0.1160***	0.0588***	0.0895***	0.1044+	0.0521
		(0.0148)	(0.0157)	(0.0147)	(0.0160)	(0.0555)	(0.0502)
H2b	Usage of Volume Flexibility - UVF (β_4)	0.0015***	0.0015***	0.0014***	0.0014***	0.0048***	0.0047***
		0.0000	(0.0001)	(0.0001)	(0.0001)	(0.0006)	(0.0006)
H3	Usage of Volume Flexibility - UVF X Usage of Fuel Flexibility - UFF (β_5)						
			-0.0007+		-0.0009**		0.0092+
			(0.0003)		(0.0003)		(0.0052)
Controls							
	Fuel Cost per MMBtu (USD)	0.0007*	0.0007*	0.0006+	0.0006+	0.0095*	0.0094*
		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0037)	(0.0037)
	Fuel Emission Intensity (CO_2/MMBtu)	0.0048***	0.0049***	0.0052***	0.0052***	0.0009	0.001
		(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0011)	(0.0011)
	Generating Hours	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Age (months)	0.0006***	0.0006***	0.0007***	0.0007***	0	0
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Capacity (in MW)	-0.0001***	-0.0001***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Fraction - Renewable	0.0473*	0.0472*	0.0887**	0.0884**	-0.0199	-0.0199
		(0.0225)	(0.0225)	(0.0328)	(0.0328)	(0.0306)	(0.0305)
	Constant	6.5889***	6.5883***	6.5085***	6.5108***	7.7209***	7.7135***
		(0.0353)	(0.0352)	(0.0466)	(0.0463)	(0.2309)	(0.2297)
Other Fixed Effects							
	SO_2 Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	NOX Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	Mercury Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	CO_2 Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	State	Yes	Yes	Yes	Yes	Yes	Yes
	Year, Month	Yes	Yes	Yes	Yes	Yes	Yes
	R-Square	0.6160***	0.6162***	0.4586***	0.4587***	0.203	0.2041
	Number of Generating Units	3133	3133	2314	2314	819	819
	Number	419619	419619	262273	262273	157346	157346

Notes: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Coefficient estimates reported with robust standard errors clustered at the power generating unit level in parentheses.

Table A6: Regression Results without controls for carbon control equipment

		Dependent Variable: ln(Carbon Dioxide Emissions per MWH)					
		All Plants		Gas Plants		Coal Plants	
		(1)	(2)	(3)	(4)	(5)	(6)
H1a	Possesses Fuel Flexibility – PFF (β_1)	0.0269***	0.0276***	0.0352***	0.0355***	-0.0025	-0.0022
		(0.0073)	(0.0073)	(0.0080)	(0.0080)	(0.0098)	(0.0098)
H1b	Possesses Volume Flexibility - PVF (β_2)	0.0920***	0.0930***	0.1055***	0.1063***	0.0046	0.0049
		(0.0130)	(0.0130)	(0.0147)	(0.0146)	(0.0329)	(0.0329)
H2a	Usage of Fuel Flexibility - UFF (β_3)	0.0677***	0.0883***	0.0450***	0.0733***	0.0434	0.0185
		(0.0114)	(0.0118)	(0.0121)	(0.0128)	(0.0389)	(0.0352)
H2b	Usage of Volume Flexibility - UVF (β_4)	0.0014***	0.0014***	0.0014***	0.0014***	0.0048***	0.0047***
		0.0000	0.0000	0.0000	0.0000	(0.0006)	(0.0006)
H3	Usage of Volume Flexibility - UVF X Usage of Fuel Flexibility - UFF (β_5)		-0.0009**		-0.0011***		0.0047
			(0.0003)		(0.0003)		(0.0040)
Controls							
	Fuel Cost per MMBtu (USD)	0.0007*	0.0007*	0.0006*	0.0006*	0.0091*	0.0091*
		(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0036)	(0.0035)
	Fuel Emission Intensity (CO_2/MMBtu)	0.0047***	0.0047***	0.0049***	0.0049***	0.0016+	0.0017+
		(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0009)	(0.0009)
	Generating Hours	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Age (months)	0.0006***	0.0006***	0.0007***	0.0007***	-0.0001	-0.0001
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Capacity (in MW)	-0.0001***	-0.0001***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Fraction - Renewable	0.0452*	0.0446*	0.0829*	0.0813*	-0.0141	-0.0146
		(0.0225)	(0.0225)	(0.0330)	(0.0329)	(0.0298)	(0.0298)
	Constant	6.6188***	6.6169***	6.5542***	6.5546***	7.5842***	7.5755***
		(0.0333)	(0.0332)	(0.0438)	(0.0435)	(0.1881)	(0.1875)
Other Fixed Effects							
	SO_2 Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	NOX Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	Mercury Control Equipment	Yes	Yes	Yes	Yes	Yes	Yes
	State	Yes	Yes	Yes	Yes	Yes	Yes
	Year, Month	Yes	Yes	Yes	Yes	Yes	Yes
	R-Square	0.6100***	0.6103***	0.4630***	0.4634***	0.2058	0.2063
	Number of Generating Units	3,135	3,135	2,316	2,316	819	819
	Number	436,312	436,312	275,266	275,266	161,046	161,046

Notes: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Coefficient estimates reported with robust standard errors clustered at the power generating unit level in parentheses.