9. Other Fuels and Fuel Emission Factor Assumptions

Besides coal (Chapter 7) and natural gas (Chapter 8), EPA Platform v6 also includes assumptions for residual fuel oil, distillate fuel oil, biomass, nuclear, and waste fuels. This chapter describes the assumptions pertaining to characteristics, market structures, and prices of these other fuels. As reported in previous chapters, natural gas is represented by an exogenous supply curve along with a basis differential approach informed by a resource fundamentals model. Coal is represented by a robust set of supply curves and a detailed representation of the associated coal transport network. Together they are designed to capture the intricacies of the resource base and market for these fuels which accounted for about 64% of U.S. electric generation in 2016[82]. As with coal, the price and quantity of biomass combusted is determined by balancing supply and demand using a set of geographically differentiated supply curves. In contrast, fuel oil, nuclear, and waste fuel prices are exogenously determined and entered into IPM during model set-up as constant price points that apply to all levels of supply. The following treats each of these remaining fuels in turn and concludes with a discussion of the emission factors for all the fuels represented in EPA Platform v6.

9.1 Fuel Oil

Two petroleum derived fuels are included in EPA Platform v6. Distillate fuel oil is distilled from crude oil, and residual fuel oil is a residue of the distillation process. The fuel oil prices are from AEO 2017 and are shown in Table 9-1. They are regionally differentiated according to the NEMS (National Energy Modeling System) regions used in AEO 2017. These prices are mapped to their corresponding IPM regions for use in EPA Platform v6.

Table 9-1 Fuel Oil Prices by NEMS Region in EPA Platform v6

Residual Fuel Oil Prices (2016$/MMBtu)								
AEO NEMS Region	**2021**	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
ERCT	12.86	13.56	14.22	15.34	16.50	17.69	18.02	18.93
FRCC	11.35	12.05	11.26	12.40	13.45	14.48	14.81	15.71
MROE	11.32	11.94	12.60	13.70	14.79	15.79	16.12	16.85
MROW	4.30	5.00	5.65	6.77	7.94	9.13	9.46	10.37
NEWE	11.75	11.94	12.60	13.72	14.88	16.08	16.40	17.31
NYCW	14.19	14.89	15.54	16.66	17.82	19.02	19.35	20.25
NYLI	11.03	11.01	11.67	12.77	13.86	14.86	15.19	15.92
NYUP	9.60	10.30	10.95	12.07	13.23	14.43	14.76	15.66
RFCE	10.47	10.60	11.26	12.36	13.45	14.45	14.87	15.78
RFCM	9.55	10.25	10.90	12.02	13.18	14.38	14.71	15.61
RFCW	10.67	11.37	12.03	13.14	14.31	15.50	15.83	16.74
SRDA	12.16	12.86	13.51	14.63	15.80	16.99	17.32	18.23
SRGW	8.51	9.20	9.86	10.98	12.14	13.34	13.66	14.57
SRSE	9.59	10.28	10.94	12.06	13.22	14.42	14.74	15.65
SRCE	8.58	9.28	9.94	11.05	12.22	13.41	13.74	14.65
SRVC	10.47	10.60	11.26	12.37	13.54	14.73	15.06	15.97
SPNO	8.58	9.28	9.94	11.05	12.22	13.41	13.74	14.65
SPSO	10.83	11.52	12.18	13.30	14.46	15.66	15.99	16.89
AZNM	11.48	12.18	12.84	13.95	15.12	16.31	16.64	17.55
CAMX	11.26	11.95	12.61	13.73	14.89	16.09	16.41	17.32

[82] EIA. Detailed EIA-923 monthly and annual survey data back to 1990. Available at https://www.eia.gov/electricity/data.php#generation

Residual Fuel Oil Prices (2016$/MMBtu)								
AEO NEMS Region	**2021**	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
NWPP	10.43	11.94	12.60	13.70	14.79	15.79	16.12	16.85
RMPA	7.91	8.61	9.27	10.38	11.55	12.74	13.07	13.98

Distillate Fuel Oil Prices (2016$/MMBtu)								
NEMS Region	**2021**	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
ERCT	16.57	16.85	17.65	18.96	20.26	21.58	21.95	22.89
FRCC	18.58	19.39	20.17	21.46	22.73	24.12	24.45	25.39
MROE	17.61	18.08	18.88	20.19	21.49	22.81	23.18	24.11
MROW	17.00	17.27	18.07	19.38	20.68	22.00	22.37	23.31
NEWE	16.98	17.38	18.16	19.46	20.72	22.11	22.44	23.38
NYCW	19.92	21.02	21.80	23.09	24.35	25.75	26.07	27.02
NYLI	19.92	21.02	21.80	23.09	24.35	25.75	26.07	27.02
NYUP	19.92	21.02	21.80	23.09	24.35	25.75	26.07	27.02
RFCE	19.57	20.55	21.33	22.59	23.86	25.23	25.56	26.49
RFCM	17.61	18.08	18.88	20.19	21.49	22.81	23.18	24.11
RFCW	17.96	18.54	19.33	20.63	21.92	23.26	23.62	24.56
SRDA	16.57	16.85	17.65	18.96	20.26	21.58	21.95	22.89
SRGW	17.31	17.68	18.48	19.80	21.11	22.48	22.86	23.80
SRSE	17.77	18.37	19.17	20.24	21.53	22.93	23.31	24.23
SRCE	16.65	16.89	17.69	19.00	20.31	21.63	22.00	22.93
SRVC	18.58	19.39	20.17	21.46	22.73	24.12	24.45	25.39
SPNO	16.98	17.26	18.05	19.36	20.66	21.99	22.36	23.29
SPSO	16.61	16.88	17.68	18.99	20.29	21.62	21.99	22.92
AZNM	19.25	20.11	20.90	22.21	23.52	24.84	25.27	26.21
CAMX	19.18	19.95	19.83	21.15	22.45	23.77	24.20	25.14
NWPP	19.18	20.01	20.81	22.22	23.51	24.84	25.27	26.21
RMPA	19.25	20.11	20.90	22.22	23.52	24.84	25.27	26.21

9.2 Biomass Fuel

Biomass is offered as a fuel for existing dedicated biomass power plants and potential (new) biomass direct fired boilers. In addition to its use as the prime mover fuel for these plants, it is also offered for co-firing to those coal fired plants that have co-fired biomass in the recent past. Section 5.3 provides further details of these selected coal plants.

EPA Platform v6 uses biomass supply curves based on those in the Department of Energy's 2016 Billion-Ton Report (DOE Report). Biomass supply curves at the IPM region and state level are generated by aggregating county level supply curves from the DOE Report. Power plants demand biomass from the supply curve corresponding to the IPM region and state in which they are located. No inter-region trading of biomass is allowed. Each biomass supply curve depicts the price-quantity relationship for biomass and varies over time. There is a separate curve for each model run year. The supply component of the curve represents the aggregate supply in each region of agricultural residues, forestry residues, energy crops, waste, and trees. The price component of the curve includes transportation costs of $15 per dry ton. The supply curves represent the IPM region and state-specific delivered biomass fuel cost at the plant gate. A storage cost of $20 per dry ton is added to each step of the agricultural residue supply curves to

reflect the limited agricultural growing season[83]. The biomass supply curves are summarized in Table 9-4. The biomass prices are derived endogenously based on the aggregate power sector demand for biomass in each IPM region and state. The results are unique market-clearing prices for each IPM region and state. All plants using biomass from that IPM region and state face the same market-clearing price.

9.3 Nuclear Fuel

The AEO 2018 price for nuclear fuel is used as the nuclear fuel price assumption for 2021-2050 in EPA Platform v6. The 2021, 2023, 2025, 2030, 2035, 2040, 2045, and 2050 prices are 0.64, 0.64, 0.65, 0.65, 0.66, 0.67, 0.68, and 0.69 2016 $/MMBtu, respectively.

9.4 Waste Fuels

The waste fuels include waste coal, petroleum coke, fossil waste, non-fossil waste, tires, and municipal solid waste (MSW). Table 9-2 describes the characteristics of these fuels, the extent to which they are represented in NEEDS, and the assumptions pertaining to their use and pricing. Furthermore, the fuels are provided to only existing and planned committed units. Potential (new) generating units that the model "builds" are not given the option to burn these fuels. In IPM model output, tires, MSW, and non-fossil waste are included under existing non-fossil other, while waste coal and petroleum coke are included under coal.

Table 9-2 Waste Fuels in NEEDS v6 and EPA Platform v6

Modeled Fuel in NEEDS	Number of Units in NEEDS	Total Capacity in NEEDS	Description	Supply and Cost	
				Modeled By	Assumed Price
Waste Coal	24	1,597 MW	"Usable material that is a byproduct of previous coal processing operations. Waste coal is usually composed of mixed coal, soil, and rock (mine waste). Most waste coal is burned as-is in unconventional fluidized-bed combustors. For some uses, waste coal may be partially cleaned by removing some extraneous noncombustible constituents. Examples of waste coal include fine coal, coal obtained from a refuse bank or slurry dam, anthracite culm, bituminous gob, and lignite waste." https://www.eia.gov/tools/glossary/index.php?id=W	Supply Curve Based on AEO 2017	AEO 2017
Petroleum Coke	14	1,213 MW	A residual product, high in carbon content and low in hydrogen, from the cracking process used in crude oil refining.	Price Point	$42.60/Ton
Fossil Waste	81	1,049 MW	Waste products of petroleum or natural gas including blast furnace and coke oven gas. They do not include petroleum coke or waste coal which are specified separately among the "Modeled Fuels".	Price Point	0
Non-Fossil Waste	224	2,087 MW	Non-fossil waste products that do not qualify as biomass. These include waste products of liquid and gaseous renewable fuels (e.g., red and black liquor from pulping processes, digester gases from waste water treatment). They do not include urban wood waste which is included in biomass.	Price Point	0

[83] http://www.extension.iastate.edu/agdm/crops/pdf/a1-22.pdf , http://www.rand.org/content/dam/rand/pubs/technical_reports/2011/RAND_TR876.pdf

Modeled Fuel in NEEDS	Number of Units in NEEDS	Total Capacity in NEEDS	Description	Supply and Cost	
				Modeled By	Assumed Price
Tires	2	52 MW	Discarded vehicle tires.	Price Point	0
Municipal Solid Waste	166	2,133 MW	"Residential solid waste and some nonhazardous commercial, institutional, and industrial wastes." https://www.eia.gov/tools/glossary/index.php?id=M	Price Point	0

9.5 Fuel Emission Factors

Table 9-3 brings together all the fuel emission factor assumptions implemented in EPA Platform v6. For sulfur dioxide, chlorine, and mercury in coal, where emission factors vary widely based on the rank, grade, and supply source of the coal, cross references are given to tables that provide more detailed treatment of the topic. Nitrogen oxides (NO_x) are not included in Table 9-3 because NO_x emissions are a factor of the combustion process, and are not primarily fuel based.

Table 9-3 Fuel Emission Factor Assumptions in EPA Platform v6

Fuel Type		Carbon Dioxide (lbs/MMBtu)	Sulfur Dioxide (lbs/MMBtu)	Mercury (lbs/TBtu)	HCl (lbs/MMBtu)
Coal					
	Bituminous	202.8 - 216.1	0.67 - 7.78	1.82 - 34.71	0.005 - 0.214
	Subbituminous	209.2 - 216.1	0.52 - 2.22	2.03 - 8.65	0.006 - 0.023
	Lignite	212.6 - 219.3	1.51 - 5.67	7.32 - 30.23	0.011 - 0.036
Natural Gas		117.08	0	0.00014	0
Fuel Oil					
	Distillate	161.39	0 - 2.65	0.48	0
	Residual	173.91	1.04	0.48	0
Biomass		195	0.08	0.57	0
Waste Fuels					
	Waste Coal	204.7	8.22	63.9	0.0921
	Petroleum Coke	225.1	7.27	2.66	0.0213
	Fossil Waste	321.1	0.08	0	0
	Non-Fossil Waste	0	0	0	0
	Tires	189.6	1.65	3.58	0
	Municipal Solid Waste	91.9	0.35	71.85	0

Note: Table 7-4 has coal emission factor on a coal supply region level.

List of tables that are uploaded directly to the web.

Table 9-4 Table Biomass Supply Curves in EPA Platform v6