Net-Zero America - alabama state report v2

Larson et al. 2020

February 2021

Reading guide

IN DRAFT

List of Tables

Table 1: *E- scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	3.855	4.571	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.341	0.488	0.806	0.878	0.881	0.88	0.88
Sale of space heating units by type - Electric Resistance	0.326	0.304	0.128	0.088	0.086	0.087	0.088
Sale of space heating units by type - Fossil	0.063	0.063	0.022	0.013	0.012	0.012	0.012
Sale of space heating units by type - Gas	0.27	0.144	0.044	0.022	0.021	0.021	0.02
Sales of cooking units - Electric Resistance	0.837	0.871	0.978	0.999	1	1	1
Sales of cooking units - Gas	0.163	0.129	0.022	0.001	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.121	0.643	0.759	0.764	0.764	0.764
Sales of water heating units by type - Electric Resistance	0.725	0.728	0.308	0.214	0.21	0.21	0.21
Sales of water heating units by type - Gas Furnace	0.235	0.125	0.023	0.001	0	0	0
Sales of water heating units by type - Other	0.039	0.026	0.026	0.026	0.026	0.026	0.026

Table 2: *E- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.972	0.921	0.67	0.233	0.042	0.006	0
End-use technology sales by technology - HDV - EV	0.006	0.038	0.19	0.456	0.574	0.596	0.6
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.002	0.001	0	0	0
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0	0	0	0
End-use technology sales by technology - HDV - hydrogen FC	0.004	0.025	0.127	0.304	0.382	0.397	0.4
End-use technology sales by technology - HDV - other	0.015	0.012	0.011	0.006	0.002	0	0
End-use technology sales by technology - LDV - diesel	0.015	0.018	0.012	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.04	0.156	0.47	0.82	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.897	0.776	0.482	0.163	0.033	0.006	0
End-use technology sales by technology - LDV - hybrid	0.045	0.046	0.033	0.012	0.003	0.001	0
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.003	0.002	0.001	0	0	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0	0	0	0
End-use technology sales by technology - MDV - diesel	0.647	0.597	0.423	0.144	0.026	0.004	0
End-use technology sales by technology - MDV - EV	0.008	0.051	0.253	0.608	0.765	0.795	0.8
End-use technology sales by technology - MDV - gasoline	0.337	0.333	0.255	0.093	0.018	0.003	0
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.003	0.001	0	0	0
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.013	0.063	0.152	0.191	0.199	0.2
End-use technology sales by technology - MDV - other	0.003	0.003	0.002	0.001	0	0	0
Light-duty vehicle capital costs - Cumulative 5-yr	0	1019516383	2604742844	4234473852	6409018983	6981221145	6653026071
Number of public EV charging plugs - DC Fast Charging	70	0	2034.1	0	9050.6	0	14657.5
Number of public EV charging plugs - L2 Charging	285	0	48856.7	0	217382.2	0	352052.1

Table 3: *E- scenario - PILLAR 2: Clean Electricity - Generating capacity*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation capital investment - biomass power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0.009	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	11.918	0	0
Power generation capital investment - Solar PV - Base	0	0	8.49	8.296	8.809	17.649	21.621
Power generation capital investment - Solar PV - Constrained	0	0.546	5.407	8.666	9.987	17.432	20.847

Table 4: *E- scenario - PILLAR 2: Clean Electricity - Generation*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation by technology - biomass power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	8.943	8.943	8.943
Power generation by technology - biomass w/ccu power plant	0	0	0	0	13375.9	13375.9	13375.9

Table 5: *E- scenario - PILLAR 2: Clean Electricity - Transmission*

variable_name	2020	2025	2030	2035	2040	2045	2050
HV transmission for wind and solar - base all	0	94.518	600.361	1394.2	2361.5	5616.1	8949.5
HV transmission for wind and solar - base other intra-state	0	55.953	199.956	495.179	803.476	2225.7	3809.9
HV transmission for wind and solar - base spur intra-state	0	15.286	377.126	875.737	1534.8	2690.6	4352.7
HV transmission for wind and solar - constrained all	0	94.023	391.736	1176.7	2006.8	6441.7	9972.7
HV transmission for wind and solar - constrained other intra-state	0	55.953	159.786	487.103	860.588	2725.4	4450.5
HV transmission for wind and solar - constrained spur intra-state	0	15.286	209.166	666.848	1123.4	2465.2	4245.7

Table 6: *E- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion*

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0.173	0.641	0.989	0.989
Capital investment	0	0	0	0	13.62	0	6.617
Number of facilities - allam power w ccu	0	0	0	0	1	1	1
Number of facilities - beccs hydrogen	0	0	0	4	4	11	11
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	1	1	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	10	10	10
Number of facilities - pyrolysis	0	0	0	0	0	0	0

Table 6: *E- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion (continued)*

variable_name	2020	2025	2030	2035	2040	2045	2050
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 7: *E- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	3.24	10.32	22.68	35.97	37.51
Annual - BECCS	0	0	4.51	17.29	26.36	26.34
Annual - Cement	0	3.24	3.35	3.32	6.84	7.07
Annual - NGCC	0	0	2.46	2.07	2.77	4.1
Cumulative - All	0	3.24	13.56	36.24	72.21	109.72
Cumulative - BECCS	0	0	4.51	21.8	48.16	74.5
Cumulative - Cement	0	3.24	6.59	9.91	16.75	23.82
Cumulative - NGCC	0	0	2.46	4.53	7.3	11.4

Table 8: *E- scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage*

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	2.19	8.81	16.26	27.54	35.41
Injection wells	0	2	10	18	32	38
Resource characterization, appraisal and permitting costs cumulative	14.63	263.43	417.39	417.39	417.39	417.39
Wells and facilities construction costs cumulative	0	80.76	314.74	560.88	937.85	1164.4

Table 9: *E- scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	2094505.958	4993994	6152264.1	6905114.7	7109094.3
CO2 pipelines - Spur	0	222495.288	1249971.6	2408241.8	3161092.3	3365073
CO2 pipelines - Trunk	0	1872010.67	3744022.341	3744022.341	3744022.341	3744022.341

Table 10: *E- scenario - IMPACTS - Jobs*

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	179.955	207.464	421.226	538.982	1339.2	1627.4	1339.1
Jobs by economic sector - construction	5969.3	5928.9	12363.6	14209.9	16054.2	22563.1	29736.5
Jobs by economic sector - manufacturing	5035.2	8955.9	10678.4	13714.4	13719.9	12169.3	15203.7
Jobs by economic sector - mining	6889.9	5168.5	3824.1	2874.6	1978.6	1427.8	977.319
Jobs by economic sector - other	318.598	292.37	1572.8	1917.7	2529.4	4410.1	6741
Jobs by economic sector - pipeline	673.096	667.368	817.499	855.579	628.282	561.188	568.351
Jobs by economic sector - professional	4179.8	3843.1	5608.2	6120.3	7886.5	11429.7	14821.9
Jobs by economic sector - trade	3609.6	2898.3	3909	4098.1	4795.5	7082.8	9797.9
Jobs by economic sector - utilities	10842.9	10656.3	12381.9	13961.3	15065.3	18245.8	22436.4
Jobs by resource sector - Biomass	745.961	890.41	1161.4	1535.1	4031.4	5935.1	5718.3
Jobs by resource sector - CO2	0	5.693	2217.4	3545.7	2622.3	3152.4	3826.7
Jobs by resource sector - Coal	5624.8	3136.1	1714.5	1496	1309.1	1184.7	1051
Jobs by resource sector - Grid	10195.8	10559.2	13543.6	18082.2	21852.7	29969	39049.7
Jobs by resource sector - Natural Gas	9255.2	9131.9	8036.3	6637.7	7116.3	5083.5	3801.4
Jobs by resource sector - Nuclear	2703.7	2660.1	2382.7	1364.7	251.869	0	0
Jobs by resource sector - Oil	6986.7	6244.4	5176.6	4041	2741	1845.7	1054.3
Jobs by resource sector - Solar	1595	3090.2	13258.5	16139.3	19082.9	28813.2	42413.8
Jobs by resource sector - Wind	591.181	2900.3	4085.8	5449.1	4989.2	3533.4	4707
Median wages - All	57021.5	57322.9	56551	56786.2	57255.7	57934.7	58613.4
Required Level of Education - Associates degree or some college	11511.5	11930	16253.4	18586	20353.8	25339.1	32663.2
Required Level of Education - Bachelors degree	8165.4	8304.6	10434.2	11478.6	12439.9	15349.9	19570.4
Required Level of Education - Doctoral degree	264.884	251.705	332.963	349.986	404.279	548.61	705.574
Required Level of Education - High school diploma or less	15785.4	16181.8	22092	25196.6	27828.6	34487.5	43829.9
Required Level of Education - Masters or professional degree	1971.2	1950.1	2464.2	2679.6	2970.2	3792	4853.1
Wage income - All	2149692965	2213778726	2916966964	3310411858	3664576406	4607483319	5957450909

Table 11: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	595.424
Carbon sink enhancement potential - All (not counting overlap)	97741.7
Carbon sink enhancement potential - Avoid deforestation	3011.8
Carbon sink enhancement potential - corn-ethanol to energy grasses	-114.27
Carbon sink enhancement potential - cropland measures	-3395.361
Carbon sink enhancement potential - Extend rotation length	19593.3
Carbon sink enhancement potential - Improve plantations	10748.8
Carbon sink enhancement potential - Increase retention of HWP	37420.1
Carbon sink enhancement potential - Increase trees outside forests	991.943
Carbon sink enhancement potential - permanent conservation cover	-87.158
Carbon sink enhancement potential - Reforest cropland	5333.3
Carbon sink enhancement potential - Reforest pasture	10773.9
Carbon sink enhancement potential - Restore productivity	9273.1
Carbon sink enhancement potential - total	-3596.79

Table 11: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture (continued)*

variable_name	2050
Land impacted for carbon sink enhancement - Accelerate regeneration	239.978
Land impacted for carbon sink enhancement - All (not counting overlap)	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	808.477
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	66.08
Land impacted for carbon sink enhancement - cropland measures	1530.763
Land impacted for carbon sink enhancement - Extend rotation length	10793.5
Land impacted for carbon sink enhancement - Improve plantations	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	279.817
Land impacted for carbon sink enhancement - permanent conservation cover	158.524
Land impacted for carbon sink enhancement - Reforest cropland	1775.665
Land impacted for carbon sink enhancement - Reforest pasture	814.683
Land impacted for carbon sink enhancement - Restore productivity	5232.9
Land impacted for carbon sink enhancement - total	1755.344
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	13715.8

Table 12: *E- scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492

Table 13: *E- scenario - IMPACTS - Fossil fuel industries*

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	571958.8	580453.1	489289.2	392430.1	295415.5	185865.5	128911.5
Oil consumption	93446.5	87079	73878.9	54901.4	37276.4	23444.4	12580.5

Table 14: *E- scenario - PILLAR 1: Efficiency/Electrification - Overview*

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.116	0.116	0.112	0.106	0.101	0.099	0.1
Final energy demand by sector - industry	0.551	0.582	0.615	0.609	0.632	0.649	0.656
Final energy demand by sector - residential	0.163	0.153	0.141	0.126	0.114	0.108	0.105
Final energy demand by sector - transportation	0.546	0.508	0.443	0.364	0.294	0.25	0.232

Table 15: *E- scenario - PILLAR 1: Efficiency/Electrification - Commercial*

variable_name	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr	0	13557430804	15391130112	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.553	0.834	0.889	0.892	0.892	0.891
Sales of cooking units - Gas	0.565	0.447	0.166	0.111	0.108	0.108	0.108
Sales of space heating units - Electric Heat Pump	0.117	0.294	0.77	0.908	0.919	0.92	0.92
Sales of space heating units - Electric Resistance	0.058	0.046	0.049	0.063	0.066	0.066	0.066
Sales of space heating units - Fossil	0	0.029	0.006	0	0	0	0
Sales of space heating units - Gas Furnace	0.825	0.631	0.175	0.03	0.015	0.014	0.014
Sales of water heating units - Electric Heat Pump	0.002	0.106	0.556	0.656	0.661	0.661	0.661
Sales of water heating units - Electric Resistance	0.071	0.101	0.281	0.322	0.323	0.323	0.323
Sales of water heating units - Gas Furnace	0.908	0.777	0.147	0.006	0	0	0
Sales of water heating units - Other	0.02	0.016	0.016	0.016	0.016	0.016	0.016

Table 16: *E- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	3.722	3.8	5.831	6.142	4.996	5.133

Table 17: *RE- scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	3.813	4.306	0	0	0	0

Table 17: *RE- scenario - PILLAR 1: Efficiency/Electrification - Residential (continued)*

variable_name	2020	2025	2030	2035	2040	2045	2050
Sale of space heating units by type - Electric Heat Pump	0.341	0.427	0.463	0.569	0.729	0.832	0.868
Sale of space heating units by type - Electric Resistance	0.326	0.338	0.317	0.258	0.17	0.114	0.094
Sale of space heating units by type - Fossil	0.063	0.071	0.067	0.052	0.031	0.018	0.013
Sale of space heating units by type - Gas	0.27	0.164	0.152	0.121	0.07	0.037	0.025
Sales of cooking units - Electric Resistance	0.836	0.84	0.855	0.895	0.95	0.984	0.996
Sales of cooking units - Gas	0.164	0.16	0.145	0.105	0.05	0.016	0.004
Sales of water heating units by type - Electric Heat Pump	0	0.021	0.08	0.251	0.513	0.684	0.743
Sales of water heating units by type - Electric Resistance	0.725	0.809	0.762	0.623	0.412	0.274	0.226
Sales of water heating units by type - Gas Furnace	0.235	0.144	0.132	0.1	0.049	0.016	0.004
Sales of water heating units by type - Other	0.039	0.026	0.026	0.026	0.027	0.026	0.026

Table 18: *RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.974	0.96	0.913	0.798	0.582	0.321	0.137
End-use technology sales by technology - HDV - EV	0.005	0.015	0.041	0.108	0.236	0.394	0.51
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.002	0.002	0.002	0.001	0.001
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0.001	0.001	0.001	0
End-use technology sales by technology - HDV - hydrogen FC	0.003	0.01	0.027	0.072	0.157	0.263	0.34
End-use technology sales by technology - HDV - other	0.015	0.013	0.015	0.019	0.022	0.02	0.011
End-use technology sales by technology - LDV - diesel	0.015	0.019	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.019	0.048	0.121	0.262	0.487	0.723	0.877
End-use technology sales by technology - LDV - gasoline	0.916	0.873	0.793	0.663	0.458	0.246	0.109
End-use technology sales by technology - LDV - hybrid	0.047	0.055	0.062	0.056	0.042	0.025	0.012
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.002	0.002	0.001	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0.001	0.001	0	0
End-use technology sales by technology - MDV - diesel	0.648	0.622	0.577	0.494	0.356	0.196	0.084
End-use technology sales by technology - MDV - EV	0.007	0.019	0.055	0.143	0.314	0.526	0.68
End-use technology sales by technology - MDV - gasoline	0.338	0.347	0.347	0.319	0.244	0.142	0.063
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.005	0.005	0.004	0.003	0.001
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.005	0.014	0.036	0.079	0.132	0.17
End-use technology sales by technology - MDV - other	0.003	0.003	0.003	0.003	0.003	0.002	0.001
Light-duty vehicle capital costs - Cumulative 5-yr	0	0	163446919	346727897	1167728330	3684585215	5364596569
Number of public EV charging plugs - DC Fast Charging	70	0	612.341	0	3343.5	0	9388.1
Number of public EV charging plugs - L2 Charging	285	0	14707.5	0	80306.7	0	225489.1

Table 19: *RE- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	595.424
Carbon sink enhancement potential - All (not counting overlap)	97741.7
Carbon sink enhancement potential - Avoid deforestation	3011.8
Carbon sink enhancement potential - corn-ethanol to energy grasses	-114.27
Carbon sink enhancement potential - cropland measures	-3395.361
Carbon sink enhancement potential - Extend rotation length	19593.3
Carbon sink enhancement potential - Improve plantations	10748.8
Carbon sink enhancement potential - Increase retention of HWP	37420.1
Carbon sink enhancement potential - Increase trees outside forests	991.943
Carbon sink enhancement potential - permanent conservation cover	-87.158
Carbon sink enhancement potential - Reforest cropland	5333.3
Carbon sink enhancement potential - Reforest pasture	10773.9
Carbon sink enhancement potential - Restore productivity	9273.1
Carbon sink enhancement potential - total	-3596.79
Land impacted for carbon sink enhancement - Accelerate regeneration	239.978
Land impacted for carbon sink enhancement - All (not counting overlap)	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	808.477
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	66.08
Land impacted for carbon sink enhancement - cropland measures	1530.763
Land impacted for carbon sink enhancement - Extend rotation length	10793.5
Land impacted for carbon sink enhancement - Improve plantations	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	279.817
Land impacted for carbon sink enhancement - permanent conservation cover	158.524
Land impacted for carbon sink enhancement - Reforest cropland	1775.665
Land impacted for carbon sink enhancement - Reforest pasture	814.683
Land impacted for carbon sink enhancement - Restore productivity	5232.9
Land impacted for carbon sink enhancement - total	1755.344
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	13715.8

Table 20: *RE- scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492

Table 21: *RE- scenario - PILLAR 1: Efficiency/Electrification - Overview*

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.116	0.116	0.115	0.113	0.11	0.107	0.105
Final energy demand by sector - industry	0.551	0.582	0.616	0.613	0.638	0.655	0.66
Final energy demand by sector - residential	0.163	0.154	0.147	0.14	0.131	0.121	0.113
Final energy demand by sector - transportation	0.546	0.513	0.465	0.427	0.397	0.363	0.322

Table 22: *RE- scenario - PILLAR 1: Efficiency/Electrification - Commercial*

variable_name	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr	0	13550758454	15374331876	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.471	0.513	0.616	0.761	0.85	0.88
Sales of cooking units - Gas	0.565	0.529	0.487	0.384	0.239	0.15	0.12
Sales of space heating units - Electric Heat Pump	0.117	0.203	0.257	0.415	0.661	0.832	0.896
Sales of space heating units - Electric Resistance	0.058	0.046	0.047	0.048	0.053	0.059	0.063
Sales of space heating units - Fossil	0	0.033	0.032	0.024	0.012	0.004	0.001
Sales of space heating units - Gas Furnace	0.825	0.717	0.665	0.513	0.274	0.105	0.039
Sales of water heating units - Electric Heat Pump	0.002	0.02	0.071	0.218	0.444	0.592	0.643
Sales of water heating units - Electric Resistance	0.071	0.066	0.085	0.145	0.236	0.295	0.316
Sales of water heating units - Gas Furnace	0.908	0.899	0.829	0.621	0.304	0.097	0.025
Sales of water heating units - Other	0.02	0.016	0.016	0.016	0.016	0.016	0.016

Table 23: *RE- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	3.04	3.038	3.839	3.932	5.22	5.455

Table 24: *REF scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	3.764	3.8	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.321	0.57	0.578	0.591	0.604	0.621	0.647
Sale of space heating units by type - Electric Resistance	0.336	0.268	0.264	0.256	0.245	0.23	0.203
Sale of space heating units by type - Fossil	0.065	0.04	0.041	0.04	0.039	0.039	0.039
Sale of space heating units by type - Gas	0.278	0.121	0.117	0.113	0.112	0.111	0.111
Sales of cooking units - Electric Resistance	0.835	0.835	0.835	0.835	0.835	0.835	0.835
Sales of cooking units - Gas	0.165	0.165	0.165	0.165	0.165	0.165	0.165
Sales of water heating units by type - Electric Heat Pump	0	0	0	0	0	0	0
Sales of water heating units by type - Electric Resistance	0.725	0.826	0.827	0.825	0.824	0.824	0.823
Sales of water heating units by type - Gas Furnace	0.235	0.148	0.147	0.149	0.15	0.15	0.15
Sales of water heating units by type - Other	0.039	0.026	0.026	0.026	0.027	0.027	0.027

Table 25: *REF scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.981	0.982	0.979	0.97	0.956	0.935	0.916
End-use technology sales by technology - HDV - EV	0	0	0	0	0	0	0
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.003	0.003	0.003	0.003	0.003
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0.001	0.002	0.002	0.002
End-use technology sales by technology - HDV - hydrogen FC	0.001	0.001	0.002	0.002	0.002	0.002	0.003
End-use technology sales by technology - HDV - other	0.015	0.013	0.016	0.024	0.037	0.057	0.076
End-use technology sales by technology - LDV - diesel	0.015	0.019	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.037	0.058	0.066	0.081	0.098	0.113	0.125
End-use technology sales by technology - LDV - gasoline	0.9	0.864	0.842	0.823	0.802	0.783	0.767
End-use technology sales by technology - LDV - hybrid	0.046	0.054	0.066	0.072	0.077	0.083	0.087
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.003	0.003	0.003	0.003
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0.001	0.001	0.001	0.001
End-use technology sales by technology - MDV - diesel	0.652	0.635	0.616	0.596	0.58	0.565	0.552
End-use technology sales by technology - MDV - EV	0	0.001	0.003	0.007	0.009	0.01	0.01
End-use technology sales by technology - MDV - gasoline	0.34	0.355	0.37	0.385	0.397	0.408	0.417
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.005	0.006	0.007	0.008	0.009
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.002	0.002	0.003	0.003	0.004	0.005
End-use technology sales by technology - MDV - other	0.003	0.003	0.003	0.003	0.004	0.005	0.007

Table 26: *REF scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2020	2030	2050
Carbon sink enhancement potential - Accelerate regeneration	0	0	595.424
Carbon sink enhancement potential - All (not counting overlap)	0	0	97741.7
Carbon sink enhancement potential - Avoid deforestation	0	0	3011.8
Carbon sink enhancement potential - Extend rotation length	0	0	19593.3
Carbon sink enhancement potential - Improve plantations	0	0	10748.8
Carbon sink enhancement potential - Increase retention of HWP	0	0	37420.1
Carbon sink enhancement potential - Increase trees outside forests	0	0	991.943
Carbon sink enhancement potential - Reforest cropland	0	0	5333.3
Carbon sink enhancement potential - Reforest pasture	0	0	10773.9
Carbon sink enhancement potential - Restore productivity	0	0	9273.1
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	239.978
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	808.477
Land impacted for carbon sink enhancement - Extend rotation length	0	0	10793.5
Land impacted for carbon sink enhancement - Improve plantations	0	0	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	279.817
Land impacted for carbon sink enhancement - Natural uptake	-56.94	-17.793	-14.42
Land impacted for carbon sink enhancement - Reforest cropland	0	0	1775.665
Land impacted for carbon sink enhancement - Reforest pasture	0	0	814.683
Land impacted for carbon sink enhancement - Restore productivity	0	0	5232.9
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-6.109	-10.189	-10.725
Land impacted for carbon sink enhancement - Total	-63.049	-27.982	-25.145
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	13715.8

Table 27: *REF scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492

Table 28: *REF scenario - PILLAR 1: Efficiency/Electrification - Overview*

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.116	0.118	0.119	0.119	0.12	0.124	0.129
Final energy demand by sector - industry	0.551	0.594	0.623	0.639	0.664	0.684	0.709
Final energy demand by sector - residential	0.163	0.154	0.151	0.149	0.149	0.15	0.153
Final energy demand by sector - transportation	0.546	0.512	0.468	0.441	0.44	0.453	0.469

Table 29: *REF scenario - PILLAR 1: Efficiency/Electrification - Commercial*

variable_name	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr	0	13308427230	13855166895	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.456	0.459	0.457	0.46	0.459	0.457
Sales of cooking units - Gas	0.565	0.544	0.541	0.543	0.54	0.541	0.543
Sales of space heating units - Electric Heat Pump	0.117	0.32	0.712	0.79	0.793	0.793	0.794
Sales of space heating units - Electric Resistance	0.058	0.064	0.12	0.158	0.187	0.192	0.192
Sales of space heating units - Fossil	0	0.027	0.005	0	0	0	0
Sales of space heating units - Gas Furnace	0.825	0.589	0.163	0.052	0.019	0.015	0.014
Sales of water heating units - Electric Heat Pump	0.002	0.002	0.002	0.002	0.002	0.001	0.002
Sales of water heating units - Electric Resistance	0.071	0.059	0.057	0.058	0.057	0.056	0.057
Sales of water heating units - Gas Furnace	0.908	0.924	0.926	0.925	0.926	0.927	0.926
Sales of water heating units - Other	0.02	0.016	0.016	0.016	0.016	0.016	0.016

Table 30: *REF scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	4.015	4.129	5.555	5.825	5.009	5.15

Table 31: *E+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

variable_name	2025	2030	2035	2040	2045	2050
Power generation capital investment - Offshore Wind - Base	0	0	0	0	0	3.294
Power generation capital investment - Solar PV - Base	2.393	5.533	18.148	24.642	35.524	53.862

Table 32: *E+ scenario - PILLAR 2: Clean Electricity - Transmission*

variable_name	2020	2025	2030	2035	2040	2045	2050
HV transmission for wind and solar - base all	0	164.157	485.559	2426.3	7214.6	13192.9	26116.4
HV transmission for wind and solar - base other intra-state	0	55.953	167.051	928.964	3025.6	5961.5	10383.2
HV transmission for wind and solar - base spur intra-state	0	84.925	295.229	1474.1	3130.8	6011.4	11750.6

Table 33: *E+ scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	595.424
Carbon sink enhancement potential - All (not counting overlap)	97741.7
Carbon sink enhancement potential - Avoid deforestation	3011.8
Carbon sink enhancement potential - corn-ethanol to energy grasses	-114.27
Carbon sink enhancement potential - cropland measures	-3395.361
Carbon sink enhancement potential - Extend rotation length	19593.3
Carbon sink enhancement potential - Improve plantations	10748.8
Carbon sink enhancement potential - Increase retention of HWP	37420.1
Carbon sink enhancement potential - Increase trees outside forests	991.943
Carbon sink enhancement potential - permanent conservation cover	-87.158
Carbon sink enhancement potential - Reforest cropland	5333.3
Carbon sink enhancement potential - Reforest pasture	10773.9
Carbon sink enhancement potential - Restore productivity	9273.1
Carbon sink enhancement potential - total	-3596.79
Land impacted for carbon sink enhancement - Accelerate regeneration	239.978
Land impacted for carbon sink enhancement - All (not counting overlap)	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	808.477
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	66.08
Land impacted for carbon sink enhancement - cropland measures	1530.763
Land impacted for carbon sink enhancement - Extend rotation length	10793.5
Land impacted for carbon sink enhancement - Improve plantations	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	279.817
Land impacted for carbon sink enhancement - permanent conservation cover	158.524
Land impacted for carbon sink enhancement - Reforest cropland	1775.665
Land impacted for carbon sink enhancement - Reforest pasture	814.683
Land impacted for carbon sink enhancement - Restore productivity	5232.9
Land impacted for carbon sink enhancement - total	1755.344
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	13715.8

Table 34: *E+ scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492

Table 35: *RE+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation capital investment - biomass power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0	0

Table 35: *RE+ scenario - PILLAR 2: Clean Electricity - Generating capacity (continued)*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation capital investment - biomass w/ccu power plant	0	0	0	7.006	16.351	0	0

Table 36: *RE+ scenario - PILLAR 2: Clean Electricity - Generation*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation by technology - biomass power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu power plant	0	0	0	7863.3	26214.6	26214.6	26214.6

Table 37: *RE+ scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion*

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0.451	2.092	2.863	2.863
Capital investment	0	0	0	0	27.413	0	9.104
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	1	10	21	21
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	0	0
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	6	20	20	20
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	1	2	2	2
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 38: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	3.24	11.24	39.08	55.02	55.84
Annual - BECCS	0	0	7.89	35.76	48.18	48.08
Annual - Cement	0	3.24	3.35	3.32	6.84	7.07
Annual - NGCC	0	0	0	0	0	0.69
Cumulative - All	0	3.24	14.48	53.56	108.58	164.42
Cumulative - BECCS	0	0	7.89	43.65	91.83	139.91
Cumulative - Cement	0	3.24	6.59	9.91	16.75	23.82
Cumulative - NGCC	0	0	0	0	0	0.69

Table 39: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage*

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	3.69	14.98	30.89	43.33	46.82
Injection wells	0	4	14	26	44	56
Resource characterization, appraisal and permitting costs cumulative	14.63	361.26	579.55	579.55	579.55	579.55
Wells and facilities construction costs cumulative	0	114.5	446.23	795.22	1329.7	1650.8

Table 40: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	2093162.958	5133030.1	6677612.9	7995572.6	8055559
CO2 pipelines - Spur	0	221151.488	1389007.7	2808355.6	4126315.2	4186301.6
CO2 pipelines - Trunk	0	1872010.67	3744022.341	3869257.341	3869257.341	3869257.341

Table 41: *RE+ scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	595.424
Carbon sink enhancement potential - All (not counting overlap)	97741.7
Carbon sink enhancement potential - Avoid deforestation	3011.8
Carbon sink enhancement potential - corn-ethanol to energy grasses	-431.708
Carbon sink enhancement potential - cropland measures	-3148.107
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	19593.3
Carbon sink enhancement potential - Improve plantations	10748.8
Carbon sink enhancement potential - Increase retention of HWP	37420.1
Carbon sink enhancement potential - Increase trees outside forests	991.943
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-79.723
Carbon sink enhancement potential - Reforest cropland	5333.3
Carbon sink enhancement potential - Reforest pasture	10773.9
Carbon sink enhancement potential - Restore productivity	9273.1
Carbon sink enhancement potential - total	-3659.537
Land impacted for carbon sink enhancement - Accelerate regeneration	239.978

Table 41: *RE+ scenario - PILLAR 6: Land carbon sinks - Agriculture (continued)*

variable_name	2050
Land impacted for carbon sink enhancement - All (not counting overlap)	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	808.477
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	236.25
Land impacted for carbon sink enhancement - cropland measures	2760.942
Land impacted for carbon sink enhancement - Cropland to woody energy crops	91.174
Land impacted for carbon sink enhancement - Extend rotation length	10793.5
Land impacted for carbon sink enhancement - Improve plantations	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	279.817
Land impacted for carbon sink enhancement - pasture to energy crops	654.158
Land impacted for carbon sink enhancement - permanent conservation cover	145.002
Land impacted for carbon sink enhancement - Reforest cropland	1775.665
Land impacted for carbon sink enhancement - Reforest pasture	814.683
Land impacted for carbon sink enhancement - Restore productivity	5232.9
Land impacted for carbon sink enhancement - total	3887.6
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	13715.8

Table 42: *RE+ scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492

Table 43: *B+ scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	595.424
Carbon sink enhancement potential - All (not counting overlap)	97741.7
Carbon sink enhancement potential - Avoid deforestation	3011.8
Carbon sink enhancement potential - corn-ethanol to energy grasses	-114.27
Carbon sink enhancement potential - cropland measures	-3395.361
Carbon sink enhancement potential - Extend rotation length	19593.3
Carbon sink enhancement potential - Improve plantations	10748.8
Carbon sink enhancement potential - Increase retention of HWP	37420.1
Carbon sink enhancement potential - Increase trees outside forests	991.943
Carbon sink enhancement potential - permanent conservation cover	-87.158
Carbon sink enhancement potential - Reforest cropland	5333.3
Carbon sink enhancement potential - Reforest pasture	10773.9
Carbon sink enhancement potential - Restore productivity	9273.1
Carbon sink enhancement potential - total	-3596.79
Land impacted for carbon sink enhancement - Accelerate regeneration	239.978
Land impacted for carbon sink enhancement - All (not counting overlap)	19687.2
Land impacted for carbon sink enhancement - Avoid deforestation	808.477
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	66.08
Land impacted for carbon sink enhancement - cropland measures	1530.763
Land impacted for carbon sink enhancement - Extend rotation length	10793.5
Land impacted for carbon sink enhancement - Improve plantations	5973.9
Land impacted for carbon sink enhancement - Increase retention of HWP	7484
Land impacted for carbon sink enhancement - Increase trees outside forests	279.817
Land impacted for carbon sink enhancement - permanent conservation cover	158.524
Land impacted for carbon sink enhancement - Reforest cropland	1775.665

Table 43: *B+ scenario - PILLAR 6: Land carbon sinks - Agriculture (continued)*

variable_name	2050
Land impacted for carbon sink enhancement - Reforest pasture	814.683
Land impacted for carbon sink enhancement - Restore productivity	5232.9
Land impacted for carbon sink enhancement - total	1755.344
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	13715.8

Table 44: *B+ scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	55.647
Business-as-usual carbon sink - Avoid deforestation	257.543
Business-as-usual carbon sink - Extend rotation length	5904.8
Business-as-usual carbon sink - Improve plantations	2268.6
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	56.259
Business-as-usual carbon sink - Reforest cropland	201.492
Business-as-usual carbon sink - Reforest pasture	199.027
Business-as-usual carbon sink - Restore productivity	1842.1
Business-as-usual carbon sink - Total impacted (over 30 years)	201.492