Net-Zero America - north carolina 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	7.459	6.795	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.303	0.539	0.547	0.558	0.568	0.581	0.601
Sale of space heating units by type - Electric Resistance	0.233	0.202	0.199	0.193	0.185	0.173	0.152
Sale of space heating units by type - Fossil	0.118	0.101	0.073	0.061	0.06	0.059	0.06
Sale of space heating units by type - Gas	0.345	0.158	0.181	0.188	0.187	0.187	0.187
Sales of cooking units - Electric Resistance	0.751	0.751	0.751	0.751	0.751	0.751	0.751
Sales of cooking units - Gas	0.249	0.249	0.249	0.249	0.249	0.249	0.249
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	0.614	0.747	0.748	0.746	0.745	0.745	0.744
Sales of water heating units by type - Gas Furnace	0.343	0.224	0.224	0.225	0.226	0.226	0.227
Sales of water heating units by type - Other	0.043	0.029	0.029	0.029	0.029	0.029	0.029

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	0.981	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	0.038	0.059	0.067	0.083	0.1	0.115	0.127
End-use technology sales by technology - LDV - gasoline	0.898	0.862	0.84	0.82	0.799	0.78	0.765
End-use technology sales by technology - LDV - hybrid	0.047	0.055	0.067	0.073	0.078	0.084	0.088
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 3: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2020	2030	2050
Carbon sink enhancement potential - Accelerate regeneration	0	0	648.491
Carbon sink enhancement potential - All (not counting overlap)	0	0	73984.3
Carbon sink enhancement potential - Avoid deforestation	0	0	4845.9
Carbon sink enhancement potential - Extend rotation length	0	0	18320.4
Carbon sink enhancement potential - Improve plantations	0	0	4461.4
Carbon sink enhancement potential - Increase retention of HWP	0	0	29631.2
Carbon sink enhancement potential - Increase trees outside forests	0	0	1898.583
Carbon sink enhancement potential - Reforest cropland	0	0	992.889
Carbon sink enhancement potential - Reforest pasture	0	0	6599.5
Carbon sink enhancement potential - Restore productivity	0	0	6586
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	1300.822
Land impacted for carbon sink enhancement - Extend rotation length	0	0	10092.3
Land impacted for carbon sink enhancement - Improve plantations	0	0	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	535.559
Land impacted for carbon sink enhancement - Natural uptake	-30.94	-14.487	-11.74
Land impacted for carbon sink enhancement - Reforest cropland	0	0	330.572
Land impacted for carbon sink enhancement - Reforest pasture	0	0	499.025
Land impacted for carbon sink enhancement - Restore productivity	0	0	3716.549
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-4.837	-8.068	-8.493
Land impacted for carbon sink enhancement - Total	-35.777	-22.555	-20.233
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	10724.9

Table 4: *E- scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606

Table 4: *E- scenario - PILLAR 6: Land carbon sinks - Forests (continued)*

variable_name	2050
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512

Table 5: *E- scenario - PILLAR 1: Efficiency/Electrification - Overview*

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.253	0.258	0.261	0.264	0.267	0.276	0.291
Final energy demand by sector - industry	0.344	0.359	0.375	0.389	0.406	0.422	0.442
Final energy demand by sector - residential	0.355	0.338	0.334	0.334	0.339	0.348	0.357
Final energy demand by sector - transportation	0.917	0.863	0.796	0.756	0.756	0.778	0.806

Table 6: *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	33828779648	35142578052	0	0	0	0
Sales of cooking units - Electric Resistance	0.32	0.343	0.343	0.343	0.344	0.343	0.343
Sales of cooking units - Gas	0.68	0.657	0.657	0.657	0.656	0.657	0.657
Sales of space heating units - Electric Heat Pump	0.081	0.268	0.564	0.702	0.72	0.722	0.723
Sales of space heating units - Electric Resistance	0.074	0.092	0.138	0.202	0.251	0.258	0.258
Sales of space heating units - Fossil	0.061	0.044	0.03	0.014	0.002	0	0
Sales of space heating units - Gas Furnace	0.784	0.596	0.268	0.083	0.027	0.02	0.019
Sales of water heating units - Electric Heat Pump	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Sales of water heating units - Electric Resistance	0.064	0.069	0.068	0.068	0.068	0.068	0.068
Sales of water heating units - Gas Furnace	0.888	0.885	0.885	0.885	0.885	0.885	0.885
Sales of water heating units - Other	0.046	0.044	0.045	0.044	0.045	0.045	0.045

Table 7: *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	6.289	6.462	8.19	8.548	7.992	8.242

Table 8: *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	7.62	7.556	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.323	0.477	0.811	0.889	0.893	0.893	0.892
Sale of space heating units by type - Electric Resistance	0.227	0.223	0.095	0.065	0.063	0.064	0.065
Sale of space heating units by type - Fossil	0.115	0.131	0.045	0.026	0.025	0.024	0.024
Sale of space heating units by type - Gas	0.335	0.169	0.048	0.02	0.019	0.019	0.019
Sales of cooking units - Electric Resistance	0.754	0.806	0.967	0.998	1	1	1
Sales of cooking units - Gas	0.246	0.194	0.033	0.002	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.1	0.533	0.631	0.636	0.636	0.636
Sales of water heating units by type - Electric Resistance	0.614	0.683	0.405	0.343	0.34	0.34	0.34
Sales of water heating units by type - Gas Furnace	0.343	0.189	0.037	0.002	0	0	0
Sales of water heating units by type - Other	0.043	0.028	0.025	0.024	0.024	0.024	0.024

Table 9: *RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.972	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	0.042	0.159	0.475	0.822	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.895	0.772	0.477	0.161	0.032	0.006	0
End-use technology sales by technology - LDV - hybrid	0.046	0.047	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	1571749143	4040154612	6528125256	9896306262	10762679773	10266013091
Number of public EV charging plugs - DC Fast Charging	286	0	3070.4	0	13322.1	0	21514.3
Number of public EV charging plugs - L2 Charging	1402	0	73784.3	0	320136.9	0	516999.1

Table 10: *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	0.041
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	0	0
Power generation capital investment - Offshore Wind - Base	0	0	0	0	7.287	3.327	0
Power generation capital investment - Offshore Wind - Constrained	0	0	0	0	6.793	2.753	0
Power generation capital investment - Solar PV - Base	0	0.319	11.514	13.402	8.859	6.873	4.825
Power generation capital investment - Solar PV - Constrained	0	2.296	9.858	12.904	9.886	4.44	3.525
Power generation capital investment - Wind - Base	0	0	0.15	0	0.121	0	0
Power generation capital investment - Wind - Constrained	0	0	0.252	0	0	0	0.037

Table 11: *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	41.05
Power generation by technology - biomass w/ccu power plant	0	0	0	0	0	0	0

Table 12: *RE- scenario - PILLAR 2: Clean Electricity - Transmission*

variable_name	2020	2025	2030	2035	2040	2045	2050
HV transmission for wind and solar - base all	0	700.931	2000.7	4455.5	11560.3	16787.1	18225.6
HV transmission for wind and solar - base other intra-state	0	232.751	441.49	1267	5428.7	8180	8650.5
HV transmission for wind and solar - base spur intra-state	0	107.896	683.625	1384	3533	5190.9	5613.1
HV transmission for wind and solar - constrained all	0	593.633	2457.7	4603.1	11091.4	14685.4	16401
HV transmission for wind and solar - constrained other intra-state	0	150.704	512.164	1046.1	5196.1	7231.1	7911.7
HV transmission for wind and solar - constrained spur intra-state	0	49.04	418.249	1342	3259	4430.9	5096.4

Table 13: *RE- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion*

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.206	0.206	0.206	0.206	0.867
Capital investment	0	0	0	0	0	0	13.605
Number of facilities - allam power w ccu	0	0	0	0	0	0	1
Number of facilities - beccs hydrogen	0	0	0	0	0	0	16
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	0	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	0	0	0
Number of facilities - pyrolysis	0	0	0	0	0	0	0
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 14: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	0.55	4.91	0.67	24.72
Annual - BECCS	0	0	0	0	0	18.52
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0.55	4.91	0.67	6.19
Cumulative - All	0	0	0.55	5.46	6.13	30.85
Cumulative - BECCS	0	0	0	0	0	18.52
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0.55	5.46	6.13	12.32

Table 15: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage*

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	0	0	0	0	0
Injection wells	0	0	0	0	0	0
Resource characterization, appraisal and permitting costs cumulative	0	0	0	0	0	0
Wells and facilities construction costs cumulative	0	0	0	0	0	0

Table 16: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	0	1363773.594	1366225.008	1458781.586	2605754
CO2 pipelines - Spur	0	0	9122.35	11573.464	104130.543	1251102.9
CO2 pipelines - Trunk	0	0	1354651.144	1354651.144	1354651.144	1354651.144

Table 17: *RE- scenario - IMPACTS - Jobs*

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	171.044	197.19	583.007	635.917	538.319	431.521	1265.5
Jobs by economic sector - construction	8745.5	7710.2	15129.3	19400.2	20839.2	20299.4	21047.8
Jobs by economic sector - manufacturing	7124.2	12055	22072.4	22363.2	18102.6	20208.5	16696.4
Jobs by economic sector - mining	4160.5	2824	2016.7	1297.8	784.65	442.05	248.341
Jobs by economic sector - other	750.767	605.867	2321.4	3208.2	3534.1	3696.5	4220.9
Jobs by economic sector - pipeline	637.084	624.064	528.755	579.83	306.398	214.368	266.481
Jobs by economic sector - professional	4961.4	4232.5	6771.4	8276.7	9662.8	9829.6	11784.9
Jobs by economic sector - trade	4254.4	3119.1	4611.2	5447.8	6161.3	6320.5	7178.8
Jobs by economic sector - utilities	12192.5	11454.6	12266.6	15938.9	18359.3	17676.3	17594
Jobs by resource sector - Biomass	709.021	846.317	1607.5	1811.2	1620.5	1573.8	5404.3
Jobs by resource sector - CO2	0	0	0	1361.1	15.475	132.09	1102.4
Jobs by resource sector - Coal	4162.1	1272.3	0	0	0	0	0
Jobs by resource sector - Grid	13317.3	12300.6	16441.4	24418.8	32082.8	32773.7	31856.6
Jobs by resource sector - Natural Gas	5877.8	6808.4	5311.9	4484.6	4655.3	3134.7	3013.9
Jobs by resource sector - Nuclear	2767.5	2722.9	2679.4	1990	803.569	265.461	0
Jobs by resource sector - Oil	8050.8	6905.3	5452.3	3845.7	2562.9	1651.1	1037.1
Jobs by resource sector - Solar	7983.8	11788.2	33794.8	38427.2	31804.7	30734.6	29173.4
Jobs by resource sector - Wind	129.222	178.401	1013.4	809.924	4743.6	8853.4	8715.5
Median wages - All	58064.1	58190.7	56638.2	57274.3	58525	59152.5	60278
Required Level of Education - Associates degree or some college	13319.4	13392.4	20877.8	24615.5	25196.1	25524.1	25660.6
Required Level of Education - Bachelors degree	9283.7	9152.2	13334.7	15121.1	15273.3	15435.5	15776.5
Required Level of Education - Doctoral degree	298.697	269.687	399.77	460.311	491.92	491.887	554.81
Required Level of Education - High school diploma or less	17888.8	17901.5	28670.2	33470.5	33693.6	34011.6	34450.1
Required Level of Education - Masters or professional degree	2207	2106.6	3018.2	3481.2	3633.9	3655.7	3861.1
Wage income - All	2496752362	2491985881	3755503058	4419120811	4582404642	4680659890	4841193115

Table 18: *RE- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	648.491
Carbon sink enhancement potential - All (not counting overlap)	73984.3
Carbon sink enhancement potential - Avoid deforestation	4845.9
Carbon sink enhancement potential - corn-ethanol to energy grasses	-413.538
Carbon sink enhancement potential - cropland measures	-4546.805
Carbon sink enhancement potential - Extend rotation length	18320.4
Carbon sink enhancement potential - Improve plantations	4461.4
Carbon sink enhancement potential - Increase retention of HWP	29631.2
Carbon sink enhancement potential - Increase trees outside forests	1898.583
Carbon sink enhancement potential - permanent conservation cover	-152.994
Carbon sink enhancement potential - Reforest cropland	992.889
Carbon sink enhancement potential - Reforest pasture	6599.5
Carbon sink enhancement potential - Restore productivity	6586
Carbon sink enhancement potential - total	-5113.336
Land impacted for carbon sink enhancement - Accelerate regeneration	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	1300.822
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	234.462
Land impacted for carbon sink enhancement - cropland measures	2630.145
Land impacted for carbon sink enhancement - Extend rotation length	10092.3
Land impacted for carbon sink enhancement - Improve plantations	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	535.559
Land impacted for carbon sink enhancement - permanent conservation cover	278.268
Land impacted for carbon sink enhancement - Reforest cropland	330.572
Land impacted for carbon sink enhancement - Reforest pasture	499.025
Land impacted for carbon sink enhancement - Restore productivity	3716.549
Land impacted for carbon sink enhancement - total	3142.9
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	10724.9

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512

Table 19: *RE- scenario - PILLAR 6: Land carbon sinks - Forests (continued)*

variable_name	2050
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512

Table 20: *RE- scenario - IMPACTS - Fossil fuel industries*

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	444222	450819.3	380015.2	304787.9	229439.8	144355.8	100121.4
Oil consumption	165158.1	155326.7	133651.4	102108	73265.9	50526.9	33785.2

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.253	0.254	0.245	0.233	0.223	0.22	0.224
Final energy demand by sector - industry	0.343	0.347	0.348	0.344	0.341	0.338	0.339
Final energy demand by sector - residential	0.355	0.335	0.313	0.283	0.26	0.247	0.242
Final energy demand by sector - transportation	0.917	0.853	0.749	0.62	0.504	0.431	0.398

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	34334435553	38226850755	0	0	0	0
Sales of cooking units - Electric Resistance	0.32	0.46	0.799	0.865	0.869	0.869	0.869
Sales of cooking units - Gas	0.68	0.54	0.201	0.135	0.131	0.131	0.131
Sales of space heating units - Electric Heat Pump	0.081	0.277	0.7	0.837	0.85	0.851	0.851
Sales of space heating units - Electric Resistance	0.074	0.084	0.105	0.126	0.13	0.13	0.13
Sales of space heating units - Fossil	0.061	0.04	0.008	0	0	0	0
Sales of space heating units - Gas Furnace	0.784	0.599	0.187	0.037	0.019	0.019	0.019
Sales of water heating units - Electric Heat Pump	0.003	0.104	0.539	0.64	0.645	0.645	0.645
Sales of water heating units - Electric Resistance	0.064	0.109	0.283	0.325	0.328	0.328	0.328
Sales of water heating units - Gas Furnace	0.888	0.746	0.148	0.007	0	0	0
Sales of water heating units - Other	0.046	0.041	0.03	0.027	0.027	0.027	0.027

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	6.101	6.251	10.154	10.752	10.361	10.841

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	7.576	7.447	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.323	0.413	0.451	0.561	0.73	0.84	0.879
Sale of space heating units by type - Electric Resistance	0.227	0.247	0.233	0.189	0.124	0.083	0.069
Sale of space heating units by type - Fossil	0.115	0.148	0.138	0.11	0.067	0.038	0.028
Sale of space heating units by type - Gas	0.335	0.192	0.178	0.139	0.079	0.039	0.024
Sales of cooking units - Electric Resistance	0.753	0.759	0.782	0.842	0.925	0.976	0.993
Sales of cooking units - Gas	0.247	0.241	0.218	0.158	0.075	0.024	0.007
Sales of water heating units by type - Electric Heat Pump	0	0.017	0.067	0.208	0.426	0.569	0.618
Sales of water heating units by type - Electric Resistance	0.614	0.736	0.705	0.613	0.473	0.382	0.351
Sales of water heating units by type - Gas Furnace	0.343	0.218	0.2	0.152	0.075	0.024	0.006
Sales of water heating units by type - Other	0.043	0.029	0.028	0.027	0.026	0.025	0.024

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	0.974	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	0.02	0.049	0.122	0.264	0.49	0.724	0.877
End-use technology sales by technology - LDV - gasoline	0.915	0.871	0.79	0.659	0.455	0.244	0.108
End-use technology sales by technology - LDV - hybrid	0.048	0.056	0.063	0.057	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	256276653	534021688	1807697811	5674906555	8272403791
Number of public EV charging plugs - DC Fast Charging	286	0	970.051	0	4956.7	0	13779.9
Number of public EV charging plugs - L2 Charging	1402	0	23310.8	0	119112.3	0	331137.6

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	648.491
Carbon sink enhancement potential - All (not counting overlap)	73984.3
Carbon sink enhancement potential - Avoid deforestation	4845.9
Carbon sink enhancement potential - corn-ethanol to energy grasses	-413.538
Carbon sink enhancement potential - cropland measures	-4546.805
Carbon sink enhancement potential - Extend rotation length	18320.4
Carbon sink enhancement potential - Improve plantations	4461.4
Carbon sink enhancement potential - Increase retention of HWP	29631.2
Carbon sink enhancement potential - Increase trees outside forests	1898.583
Carbon sink enhancement potential - permanent conservation cover	-152.994
Carbon sink enhancement potential - Reforest cropland	992.889
Carbon sink enhancement potential - Reforest pasture	6599.5
Carbon sink enhancement potential - Restore productivity	6586
Carbon sink enhancement potential - total	-5113.336
Land impacted for carbon sink enhancement - Accelerate regeneration	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	1300.822
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	234.462
Land impacted for carbon sink enhancement - cropland measures	2630.145
Land impacted for carbon sink enhancement - Extend rotation length	10092.3
Land impacted for carbon sink enhancement - Improve plantations	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	535.559
Land impacted for carbon sink enhancement - permanent conservation cover	278.268
Land impacted for carbon sink enhancement - Reforest cropland	330.572
Land impacted for carbon sink enhancement - Reforest pasture	499.025
Land impacted for carbon sink enhancement - Restore productivity	3716.549
Land impacted for carbon sink enhancement - total	3142.9
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	10724.9

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.253	0.255	0.252	0.248	0.242	0.237	0.235
Final energy demand by sector - industry	0.343	0.348	0.349	0.349	0.35	0.347	0.346
Final energy demand by sector - residential	0.355	0.336	0.326	0.315	0.3	0.282	0.265
Final energy demand by sector - transportation	0.918	0.861	0.785	0.722	0.672	0.613	0.544

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	34313410640	38230677570	0	0	0	0
Sales of cooking units - Electric Resistance	0.32	0.362	0.409	0.534	0.71	0.817	0.855
Sales of cooking units - Gas	0.68	0.638	0.591	0.466	0.29	0.183	0.145
Sales of space heating units - Electric Heat Pump	0.081	0.197	0.246	0.386	0.607	0.766	0.828
Sales of space heating units - Electric Resistance	0.074	0.081	0.083	0.091	0.105	0.119	0.127
Sales of space heating units - Fossil	0.061	0.047	0.043	0.033	0.016	0.005	0.001
Sales of space heating units - Gas Furnace	0.784	0.675	0.628	0.491	0.271	0.11	0.044
Sales of water heating units - Electric Heat Pump	0.003	0.02	0.07	0.213	0.432	0.576	0.627
Sales of water heating units - Electric Resistance	0.064	0.076	0.095	0.152	0.241	0.299	0.32
Sales of water heating units - Gas Furnace	0.888	0.861	0.793	0.597	0.294	0.095	0.025
Sales of water heating units - Other	0.046	0.044	0.043	0.039	0.033	0.029	0.028

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	5.28	5.333	6.713	6.924	9.802	10.33

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	11.386	17.17	57.931	14.452
Power generation capital investment - Solar PV - Base	4.49	12.159	18.972	6.472	9.135	7.801
Power generation capital investment - Wind - Base	0	0.15	0.078	0.046	0	0

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	903.707	2659.5	13149.9	28220.4	93519.6	122174
HV transmission for wind and solar - base other intra-state	0	223.179	532.393	6479.5	16452.4	53561.4	64563.4
HV transmission for wind and solar - base spur intra-state	0	243.786	944.725	4110.2	8242.3	34981.9	47894.1

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	648.491
Carbon sink enhancement potential - All (not counting overlap)	73984.3
Carbon sink enhancement potential - Avoid deforestation	4845.9
Carbon sink enhancement potential - corn-ethanol to energy grasses	-413.538
Carbon sink enhancement potential - cropland measures	-4546.805
Carbon sink enhancement potential - Extend rotation length	18320.4
Carbon sink enhancement potential - Improve plantations	4461.4
Carbon sink enhancement potential - Increase retention of HWP	29631.2
Carbon sink enhancement potential - Increase trees outside forests	1898.583
Carbon sink enhancement potential - permanent conservation cover	-152.994
Carbon sink enhancement potential - Reforest cropland	992.889
Carbon sink enhancement potential - Reforest pasture	6599.5
Carbon sink enhancement potential - Restore productivity	6586
Carbon sink enhancement potential - total	-5113.336
Land impacted for carbon sink enhancement - Accelerate regeneration	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	1300.822
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	234.462
Land impacted for carbon sink enhancement - cropland measures	2630.145
Land impacted for carbon sink enhancement - Extend rotation length	10092.3
Land impacted for carbon sink enhancement - Improve plantations	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	535.559
Land impacted for carbon sink enhancement - permanent conservation cover	278.268
Land impacted for carbon sink enhancement - Reforest cropland	330.572
Land impacted for carbon sink enhancement - Reforest pasture	499.025
Land impacted for carbon sink enhancement - Restore productivity	3716.549
Land impacted for carbon sink enhancement - total	3142.9
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	10724.9

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512

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	0.006	0.925	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	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	11.498	1827.3	1827.3	1827.3	1827.3	1827.3
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	0	0	0	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0.296	0.618	0.618	0.618	0.618	0.618
Capital investment	0	0	0.006	0	0	0	0
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	0	0
Number of facilities - diesel	0	0	0	1	1	1	1
Number of facilities - diesel ccu	0	0	0	0	0	0	0
Number of facilities - power	0	1	1	1	1	1	1
Number of facilities - power ccu	0	0	0	0	0	0	0
Number of facilities - pyrolysis	0	0	0	1	1	1	1
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	1	1	1	1	1	1
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	0	0	0	0	0
Annual - BECCS	0	0	0	0	0	0
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	0
Cumulative - BECCS	0	0	0	0	0	0
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0	0	0	0

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

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	0	0	0	0	0
Injection wells	0	0	0	0	0	0
Resource characterization, appraisal and permitting costs cumulative	0	0	0	0	0	0
Wells and facilities construction costs cumulative	0	0	0	0	0	0

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	0	1354651.144	1354651.144	1354651.144	1459605.637
CO2 pipelines - Spur	0	0	0	0	0	104954.893
CO2 pipelines - Trunk	0	0	1354651.144	1354651.144	1354651.144	1354651.144

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	648.491
Carbon sink enhancement potential - All (not counting overlap)	73984.3
Carbon sink enhancement potential - Avoid deforestation	4845.9
Carbon sink enhancement potential - corn-ethanol to energy grasses	-1278.552
Carbon sink enhancement potential - cropland measures	-3906.704
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	18320.4
Carbon sink enhancement potential - Improve plantations	4461.4
Carbon sink enhancement potential - Increase retention of HWP	29631.2
Carbon sink enhancement potential - Increase trees outside forests	1898.583
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-130.036
Carbon sink enhancement potential - Reforest cropland	992.889
Carbon sink enhancement potential - Reforest pasture	6599.5
Carbon sink enhancement potential - Restore productivity	6586

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

variable_name	2050
Carbon sink enhancement potential - total	-5315.292
Land impacted for carbon sink enhancement - Accelerate regeneration	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	1300.822
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	758.14
Land impacted for carbon sink enhancement - cropland measures	4410.017
Land impacted for carbon sink enhancement - Cropland to woody energy crops	208.09
Land impacted for carbon sink enhancement - Extend rotation length	10092.3
Land impacted for carbon sink enhancement - Improve plantations	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	535.559
Land impacted for carbon sink enhancement - pasture to energy crops	268.644
Land impacted for carbon sink enhancement - permanent conservation cover	236.511
Land impacted for carbon sink enhancement - Reforest cropland	330.572
Land impacted for carbon sink enhancement - Reforest pasture	499.025
Land impacted for carbon sink enhancement - Restore productivity	3716.549
Land impacted for carbon sink enhancement - total	5881.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	10724.9

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	648.491
Carbon sink enhancement potential - All (not counting overlap)	73984.3
Carbon sink enhancement potential - Avoid deforestation	4845.9
Carbon sink enhancement potential - corn-ethanol to energy grasses	-413.538
Carbon sink enhancement potential - cropland measures	-4546.805
Carbon sink enhancement potential - Extend rotation length	18320.4
Carbon sink enhancement potential - Improve plantations	4461.4
Carbon sink enhancement potential - Increase retention of HWP	29631.2
Carbon sink enhancement potential - Increase trees outside forests	1898.583
Carbon sink enhancement potential - permanent conservation cover	-152.994
Carbon sink enhancement potential - Reforest cropland	992.889
Carbon sink enhancement potential - Reforest pasture	6599.5
Carbon sink enhancement potential - Restore productivity	6586
Carbon sink enhancement potential - total	-5113.336
Land impacted for carbon sink enhancement - Accelerate regeneration	261.366
Land impacted for carbon sink enhancement - All (not counting overlap)	14417.1
Land impacted for carbon sink enhancement - Avoid deforestation	1300.822
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	234.462
Land impacted for carbon sink enhancement - cropland measures	2630.145
Land impacted for carbon sink enhancement - Extend rotation length	10092.3
Land impacted for carbon sink enhancement - Improve plantations	2479.549
Land impacted for carbon sink enhancement - Increase retention of HWP	5926.2
Land impacted for carbon sink enhancement - Increase trees outside forests	535.559
Land impacted for carbon sink enhancement - permanent conservation cover	278.268

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

variable_name	2050
Land impacted for carbon sink enhancement - Reforest cropland	330.572
Land impacted for carbon sink enhancement - Reforest pasture	499.025
Land impacted for carbon sink enhancement - Restore productivity	3716.549
Land impacted for carbon sink enhancement - total	3142.9
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	10724.9

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	60.607
Business-as-usual carbon sink - Avoid deforestation	414.382
Business-as-usual carbon sink - Extend rotation length	5521.2
Business-as-usual carbon sink - Improve plantations	941.606
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	107.678
Business-as-usual carbon sink - Reforest cropland	37.512
Business-as-usual carbon sink - Reforest pasture	121.912
Business-as-usual carbon sink - Restore productivity	1308.3
Business-as-usual carbon sink - Total impacted (over 30 years)	37.512