Net-Zero America - virginia state report v2

Larson et al. 2020

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Reading guide

IN DRAFT

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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	6.344	5.719	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.235	0.468	0.477	0.489	0.499	0.51	0.527
Sale of space heating units by type - Electric Resistance	0.189	0.17	0.167	0.161	0.156	0.146	0.127
Sale of space heating units by type - Fossil	0.124	0.136	0.089	0.069	0.067	0.067	0.067
Sale of space heating units by type - Gas	0.452	0.227	0.267	0.28	0.278	0.277	0.278
Sales of cooking units - Electric Resistance	0.701	0.701	0.701	0.701	0.701	0.701	0.701
Sales of cooking units - Gas	0.299	0.299	0.299	0.299	0.299	0.299	0.299
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	0.501	0.659	0.659	0.658	0.658	0.657	0.657
Sales of water heating units by type - Gas Furnace	0.455	0.31	0.31	0.31	0.311	0.311	0.312
Sales of water heating units by type - Other	0.044	0.031	0.031	0.031	0.031	0.031	0.032

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	0.014	0.019	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.04	0.061	0.069	0.086	0.104	0.119	0.131
End-use technology sales by technology - LDV - gasoline	0.895	0.859	0.835	0.816	0.794	0.775	0.76
End-use technology sales by technology - LDV - hybrid	0.048	0.057	0.069	0.075	0.08	0.085	0.089
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	444.167
Carbon sink enhancement potential - All (not counting overlap)	0	0	56418.8
Carbon sink enhancement potential - Avoid deforestation	0	0	3402.6
Carbon sink enhancement potential - Extend rotation length	0	0	15878.7
Carbon sink enhancement potential - Improve plantations	0	0	3954.3
Carbon sink enhancement potential - Increase retention of HWP	0	0	15933.2
Carbon sink enhancement potential - Increase trees outside forests	0	0	1175.922
Carbon sink enhancement potential - Reforest cropland	0	0	524.813
Carbon sink enhancement potential - Reforest pasture	0	0	9513.6
Carbon sink enhancement potential - Restore productivity	0	0	5591.6
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	913.362
Land impacted for carbon sink enhancement - Extend rotation length	0	0	8747.4
Land impacted for carbon sink enhancement - Improve plantations	0	0	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	331.715
Land impacted for carbon sink enhancement - Natural uptake	-41.87	-12.343	-10.003
Land impacted for carbon sink enhancement - Reforest cropland	0	0	174.731
Land impacted for carbon sink enhancement - Reforest pasture	0	0	719.381
Land impacted for carbon sink enhancement - Restore productivity	0	0	3155.424
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-2.601	-4.338	-4.567
Land impacted for carbon sink enhancement - Total	-44.471	-16.682	-14.57
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575

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	66.694
Business-as-usual carbon sink - Reforest cropland	19.828
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.246	0.251	0.253	0.255	0.257	0.265	0.279
Final energy demand by sector - industry	0.381	0.412	0.434	0.451	0.473	0.49	0.511
Final energy demand by sector - residential	0.313	0.298	0.294	0.293	0.296	0.303	0.311
Final energy demand by sector - transportation	0.709	0.67	0.623	0.596	0.599	0.617	0.64

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	30680352159	31883007897	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	0.049	0.243	0.486	0.686	0.718	0.722	0.722
Sales of space heating units - Electric Resistance	0.047	0.088	0.128	0.2	0.251	0.258	0.259
Sales of space heating units - Fossil	0.079	0.046	0.034	0.014	0.002	0	0
Sales of space heating units - Gas Furnace	0.825	0.623	0.352	0.1	0.029	0.019	0.019
Sales of water heating units - Electric Heat Pump	0.002	0.003	0.003	0.003	0.003	0.003	0.003
Sales of water heating units - Electric Resistance	0.042	0.068	0.067	0.067	0.067	0.067	0.067
Sales of water heating units - Gas Furnace	0.915	0.885	0.885	0.886	0.885	0.885	0.886
Sales of water heating units - Other	0.042	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	4.387	4.433	6.571	6.866	7.027	7.306

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	6.425	6.209	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.254	0.422	0.788	0.869	0.873	0.873	0.873
Sale of space heating units by type - Electric Resistance	0.184	0.184	0.077	0.053	0.052	0.053	0.053
Sale of space heating units by type - Fossil	0.121	0.158	0.069	0.049	0.048	0.047	0.047
Sale of space heating units by type - Gas	0.441	0.236	0.066	0.028	0.027	0.027	0.027
Sales of cooking units - Electric Resistance	0.705	0.768	0.96	0.998	1	1	1
Sales of cooking units - Gas	0.295	0.232	0.04	0.002	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.088	0.465	0.549	0.553	0.553	0.553
Sales of water heating units by type - Electric Resistance	0.501	0.622	0.463	0.427	0.425	0.425	0.425
Sales of water heating units by type - Gas Furnace	0.455	0.261	0.049	0.002	0	0	0
Sales of water heating units by type - Other	0.044	0.03	0.023	0.022	0.022	0.022	0.022

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	0.014	0.017	0.012	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.043	0.165	0.484	0.826	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.892	0.766	0.468	0.158	0.032	0.006	0
End-use technology sales by technology - LDV - hybrid	0.048	0.048	0.034	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	1455617658	3742305265	6045783095	9165527442	9967460010	9507742473
Number of public EV charging plugs - DC Fast Charging	390	0	2576.5	0	11171.1	0	18039
Number of public EV charging plugs - L2 Charging	1370	0	61861.3	0	268211.9	0	433108.1

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	0.005	0.924	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
Power generation capital investment - Offshore Wind - Base	0	0.157	0.192	0.399	3.465	0	0
Power generation capital investment - Offshore Wind - Constrained	0	0.226	0.192	0.285	3.52	0	0
Power generation capital investment - Solar PV - Base	0	21.308	10.376	15.435	11.455	10.432	7.005
Power generation capital investment - Solar PV - Constrained	0	24.972	11.831	19.995	10.996	12.058	8.723
Power generation capital investment - Wind - Base	0	0	7.751	5.398	10.457	1.634	1.301
Power generation capital investment - Wind - Constrained	0	0	20.73	9.238	0.089	0	1.796

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	8.716	1823.3	1823.3	1823.3	1823.3	1823.3
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 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	3191.6	7626.7	13471.4	22501.4	26083.4	28415.8
HV transmission for wind and solar - base other intra-state	0	1366.1	3231.3	5492.5	9897.8	10790.7	11397.4
HV transmission for wind and solar - base spur intra-state	0	1402.8	2894.7	4743.9	7368.9	8970.6	9757.7
HV transmission for wind and solar - constrained all	0	2924.4	10357.3	17549.7	22032.9	24441.1	25613.1
HV transmission for wind and solar - constrained other intra-state	0	1264.2	3644.1	6478.4	9046.9	9896.9	10151.6
HV transmission for wind and solar - constrained spur intra-state	0	1224.3	3603	6473.5	7916.4	8997	9477

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0.127	0.397	0.399	0.399	0.399	0.49
Capital investment	0	0	0.976	0	0.029	0	1.947
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	2
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 14: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	3.88	3.76	3.76	6.49
Annual - BECCS	0	0	0	0	0	2.66
Annual - Cement	0	0	3.35	3.32	3.42	3.53
Annual - NGCC	0	0	0.53	0.45	0.34	0.3
Cumulative - All	0	0	3.88	7.64	11.4	17.89
Cumulative - BECCS	0	0	0	0	0	2.66
Cumulative - Cement	0	0	3.35	6.67	10.09	13.62
Cumulative - NGCC	0	0	0.53	0.98	1.32	1.62

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	2259176.763	2258213.763	2260952.763	2500739.88
CO2 pipelines - Spur	0	0	155249.583	154286.883	157025.483	396812.9
CO2 pipelines - Trunk	0	0	2103926.78	2103926.78	2103926.78	2103926.78

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	377.329	419.36	1111.8	1315.1	1087.4	840.139	808.812
Jobs by economic sector - construction	6941.2	22202.9	21077.3	28476.1	31550	29524.3	28852.4
Jobs by economic sector - manufacturing	6930.1	12647.8	22817	23376	19371.6	21198.7	17256.3
Jobs by economic sector - mining	5347.9	3932.9	2711.4	1871.2	1246.8	811.142	531.978
Jobs by economic sector - other	585.009	3445.2	3067.4	4478.2	5131.7	5355.8	5678.4
Jobs by economic sector - pipeline	648.013	637.558	539.939	691.777	329.502	223	189.539
Jobs by economic sector - professional	4060.3	9189.2	10304.1	13588.6	16508.3	16061.6	16258.5
Jobs by economic sector - trade	3599.1	6477	6358.4	8232.4	9877	9877.5	10209.8
Jobs by economic sector - utilities	8392.6	13577.8	16420.7	22067.4	26169.8	24087.8	23677.1
Jobs by resource sector - Biomass	1386.8	1600.1	3016.3	3683.8	3237.4	3068.9	3470.7
Jobs by resource sector - CO2	0	0	0	2189.3	127.952	159.217	443.866
Jobs by resource sector - Coal	3520.3	2024.9	1062.6	848.855	741.663	670.342	594.325
Jobs by resource sector - Grid	8160.5	19397.8	26617.5	37207.5	48132.8	44956.4	45446.1
Jobs by resource sector - Natural Gas	8137.6	8139.7	6617.2	5566.2	5297.8	3939.7	2360.3
Jobs by resource sector - Nuclear	1517.6	988.966	973.173	564.48	0	0	0
Jobs by resource sector - Oil	6693.1	5733.1	4544.2	3230.1	2161.4	1401.9	859.727
Jobs by resource sector - Solar	7415.6	34531	36719.1	43800.3	37807.1	37496.1	34505.4
Jobs by resource sector - Wind	49.974	114.241	4858	7006.3	13766.1	16287.6	15782.3
Median wages - All	61780.3	60632.9	61396.6	62227.3	63664.7	64450.8	65650.6
Required Level of Education - Associates degree or some college	11267	22955.4	26700.3	33264.5	35774.2	34757.9	33328.1
Required Level of Education - Bachelors degree	7802.5	14201.9	16703.8	20275.8	21823.2	21269.1	20424.6
Required Level of Education - Doctoral degree	250.091	493.213	540.442	679.982	777.191	753.275	747.332
Required Level of Education - High school diploma or less	15724	31485.7	36551.9	45029.6	47514.6	45977.3	43865.5
Required Level of Education - Masters or professional degree	1837.9	3393.5	3911.6	4846.9	5383	5222.4	5097.3
Wage income - All	2278668167	4398242518	5182882617	6478426986	7085006980	6960340359	6793401526

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	444.167
Carbon sink enhancement potential - All (not counting overlap)	56418.8
Carbon sink enhancement potential - Avoid deforestation	3402.6
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-2857.03
Carbon sink enhancement potential - Extend rotation length	15878.7
Carbon sink enhancement potential - Improve plantations	3954.3
Carbon sink enhancement potential - Increase retention of HWP	15933.2
Carbon sink enhancement potential - Increase trees outside forests	1175.922
Carbon sink enhancement potential - permanent conservation cover	-101.002
Carbon sink enhancement potential - Reforest cropland	524.813
Carbon sink enhancement potential - Reforest pasture	9513.6
Carbon sink enhancement potential - Restore productivity	5591.6
Carbon sink enhancement potential - total	-2958.032
Land impacted for carbon sink enhancement - Accelerate regeneration	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	913.362
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1720.506
Land impacted for carbon sink enhancement - Extend rotation length	8747.4
Land impacted for carbon sink enhancement - Improve plantations	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	331.715
Land impacted for carbon sink enhancement - permanent conservation cover	183.705
Land impacted for carbon sink enhancement - Reforest cropland	174.731
Land impacted for carbon sink enhancement - Reforest pasture	719.381
Land impacted for carbon sink enhancement - Restore productivity	3155.424
Land impacted for carbon sink enhancement - total	1904.141
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	66.694
Business-as-usual carbon sink - Reforest cropland	19.828

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

variable_name	2050
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	483567.6	490749.2	413673.9	331783.5	249761.7	157141.7	108989.3
Oil consumption	137274.5	128925.2	111358.1	85731.4	61763.6	42879.8	27994

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.246	0.247	0.237	0.223	0.212	0.208	0.211
Final energy demand by sector - industry	0.381	0.402	0.412	0.418	0.428	0.431	0.439
Final energy demand by sector - residential	0.313	0.296	0.274	0.246	0.223	0.21	0.204
Final energy demand by sector - transportation	0.709	0.66	0.582	0.488	0.403	0.349	0.324

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	31137953345	34699563305	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	0.049	0.284	0.707	0.838	0.851	0.851	0.851
Sales of space heating units - Electric Resistance	0.047	0.084	0.105	0.126	0.13	0.13	0.13
Sales of space heating units - Fossil	0.079	0.041	0.008	0	0	0	0
Sales of space heating units - Gas Furnace	0.825	0.592	0.181	0.036	0.019	0.019	0.019
Sales of water heating units - Electric Heat Pump	0.002	0.105	0.546	0.644	0.648	0.648	0.648
Sales of water heating units - Electric Resistance	0.042	0.108	0.284	0.323	0.325	0.325	0.325
Sales of water heating units - Gas Furnace	0.915	0.745	0.141	0.006	0	0	0
Sales of water heating units - Other	0.042	0.042	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	4.759	4.85	8.113	8.581	8.028	8.375

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	6.4	6.149	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.254	0.351	0.393	0.513	0.697	0.817	0.858
Sale of space heating units by type - Electric Resistance	0.184	0.205	0.192	0.156	0.103	0.069	0.057
Sale of space heating units by type - Fossil	0.121	0.175	0.166	0.137	0.091	0.061	0.051
Sale of space heating units by type - Gas	0.441	0.269	0.249	0.194	0.109	0.053	0.034
Sales of cooking units - Electric Resistance	0.704	0.712	0.739	0.81	0.91	0.971	0.992
Sales of cooking units - Gas	0.296	0.288	0.261	0.19	0.09	0.029	0.008
Sales of water heating units by type - Electric Heat Pump	0	0.015	0.058	0.182	0.371	0.495	0.538
Sales of water heating units by type - Electric Resistance	0.501	0.653	0.635	0.582	0.501	0.449	0.431
Sales of water heating units by type - Gas Furnace	0.455	0.301	0.277	0.208	0.102	0.033	0.009
Sales of water heating units by type - Other	0.044	0.031	0.03	0.028	0.025	0.023	0.023

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	0.014	0.019	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.02	0.05	0.125	0.269	0.495	0.728	0.879
End-use technology sales by technology - LDV - gasoline	0.913	0.869	0.786	0.653	0.449	0.241	0.107
End-use technology sales by technology - LDV - hybrid	0.05	0.058	0.065	0.058	0.043	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	237457658	494550576	1674334928	5255457540	7661237034
Number of public EV charging plugs - DC Fast Charging	390	0	815.095	0	4157.2	0	11554
Number of public EV charging plugs - L2 Charging	1370	0	19570	0	99813.3	0	277405.4

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	444.167
Carbon sink enhancement potential - All (not counting overlap)	56418.8
Carbon sink enhancement potential - Avoid deforestation	3402.6
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-2857.03
Carbon sink enhancement potential - Extend rotation length	15878.7
Carbon sink enhancement potential - Improve plantations	3954.3
Carbon sink enhancement potential - Increase retention of HWP	15933.2
Carbon sink enhancement potential - Increase trees outside forests	1175.922
Carbon sink enhancement potential - permanent conservation cover	-101.002
Carbon sink enhancement potential - Reforest cropland	524.813
Carbon sink enhancement potential - Reforest pasture	9513.6
Carbon sink enhancement potential - Restore productivity	5591.6
Carbon sink enhancement potential - total	-2958.032
Land impacted for carbon sink enhancement - Accelerate regeneration	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	913.362
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1720.506
Land impacted for carbon sink enhancement - Extend rotation length	8747.4
Land impacted for carbon sink enhancement - Improve plantations	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	331.715
Land impacted for carbon sink enhancement - permanent conservation cover	183.705
Land impacted for carbon sink enhancement - Reforest cropland	174.731
Land impacted for carbon sink enhancement - Reforest pasture	719.381
Land impacted for carbon sink enhancement - Restore productivity	3155.424
Land impacted for carbon sink enhancement - total	1904.141
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	66.694
Business-as-usual carbon sink - Reforest cropland	19.828
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.246	0.247	0.244	0.24	0.233	0.227	0.224
Final energy demand by sector - industry	0.381	0.403	0.413	0.422	0.433	0.437	0.443
Final energy demand by sector - residential	0.313	0.297	0.288	0.278	0.263	0.239	0.221
Final energy demand by sector - transportation	0.71	0.666	0.609	0.562	0.524	0.48	0.428

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	31111588373	34614455447	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	0.049	0.204	0.252	0.391	0.612	0.769	0.829
Sales of space heating units - Electric Resistance	0.047	0.08	0.083	0.091	0.105	0.119	0.127
Sales of space heating units - Fossil	0.079	0.047	0.044	0.033	0.016	0.005	0.001
Sales of space heating units - Gas Furnace	0.825	0.669	0.622	0.484	0.266	0.107	0.043
Sales of water heating units - Electric Heat Pump	0.002	0.02	0.07	0.215	0.436	0.581	0.631
Sales of water heating units - Electric Resistance	0.042	0.075	0.094	0.152	0.24	0.297	0.318
Sales of water heating units - Gas Furnace	0.915	0.861	0.792	0.595	0.291	0.093	0.024
Sales of water heating units - Other	0.042	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	4.068	4.076	5.451	5.623	6.974	7.285

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	0.157	0.251	4.428	9.836	11.754	0
Power generation capital investment - Solar PV - Base	21.286	15.089	26.214	10.296	10.132	106.221
Power generation capital investment - Wind - Base	0	10.743	7.715	14.125	1.179	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	2964.4	8172.3	19158.3	32133	48777.8	70344.1
HV transmission for wind and solar - base other intra-state	0	905.92	2556.4	7105.8	12094.4	16531.2	22899
HV transmission for wind and solar - base spur intra-state	0	1621.7	3773	7804.5	12490.4	19124.3	30339.3

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	444.167
Carbon sink enhancement potential - All (not counting overlap)	56418.8
Carbon sink enhancement potential - Avoid deforestation	3402.6
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-2857.03
Carbon sink enhancement potential - Extend rotation length	15878.7
Carbon sink enhancement potential - Improve plantations	3954.3
Carbon sink enhancement potential - Increase retention of HWP	15933.2
Carbon sink enhancement potential - Increase trees outside forests	1175.922
Carbon sink enhancement potential - permanent conservation cover	-101.002
Carbon sink enhancement potential - Reforest cropland	524.813
Carbon sink enhancement potential - Reforest pasture	9513.6
Carbon sink enhancement potential - Restore productivity	5591.6
Carbon sink enhancement potential - total	-2958.032
Land impacted for carbon sink enhancement - Accelerate regeneration	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	913.362
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1720.506
Land impacted for carbon sink enhancement - Extend rotation length	8747.4
Land impacted for carbon sink enhancement - Improve plantations	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	331.715
Land impacted for carbon sink enhancement - permanent conservation cover	183.705
Land impacted for carbon sink enhancement - Reforest cropland	174.731
Land impacted for carbon sink enhancement - Reforest pasture	719.381
Land impacted for carbon sink enhancement - Restore productivity	3155.424
Land impacted for carbon sink enhancement - total	1904.141
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	66.694
Business-as-usual carbon sink - Reforest cropland	19.828
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828

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
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	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	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	0.483	0.485	0.485	0.485	0.848
Capital investment	0	0	0.972	0	0.029	0	4.262
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	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	0	0	0	0
Number of facilities - pyrolysis	0	0	0	0	0	0	5
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 38: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	3.35	3.32	3.42	3.53
Annual - BECCS	0	0	0	0	0	0
Annual - Cement	0	0	3.35	3.32	3.42	3.53
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	3.35	6.67	10.09	13.62
Cumulative - BECCS	0	0	0	0	0	0
Cumulative - Cement	0	0	3.35	6.67	10.09	13.62
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	2258831.263	2257876.263	2260624.263	2292288.003
CO2 pipelines - Spur	0	0	154904.483	153949.183	156697.183	188361.422
CO2 pipelines - Trunk	0	0	2103926.78	2103926.78	2103926.78	2103926.78

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	444.167
Carbon sink enhancement potential - All (not counting overlap)	56418.8
Carbon sink enhancement potential - Avoid deforestation	3402.6
Carbon sink enhancement potential - corn-ethanol to energy grasses	-408.672
Carbon sink enhancement potential - cropland measures	-2638.128
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	15878.7
Carbon sink enhancement potential - Improve plantations	3954.3
Carbon sink enhancement potential - Increase retention of HWP	15933.2
Carbon sink enhancement potential - Increase trees outside forests	1175.922
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-91.074
Carbon sink enhancement potential - Reforest cropland	524.813
Carbon sink enhancement potential - Reforest pasture	9513.6
Carbon sink enhancement potential - Restore productivity	5591.6

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

variable_name	2050
Carbon sink enhancement potential - total	-3137.874
Land impacted for carbon sink enhancement - Accelerate regeneration	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	913.362
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	234.324
Land impacted for carbon sink enhancement - cropland measures	3050.925
Land impacted for carbon sink enhancement - Cropland to woody energy crops	47.232
Land impacted for carbon sink enhancement - Extend rotation length	8747.4
Land impacted for carbon sink enhancement - Improve plantations	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	331.715
Land impacted for carbon sink enhancement - pasture to energy crops	594.986
Land impacted for carbon sink enhancement - permanent conservation cover	165.648
Land impacted for carbon sink enhancement - Reforest cropland	174.731
Land impacted for carbon sink enhancement - Reforest pasture	719.381
Land impacted for carbon sink enhancement - Restore productivity	3155.424
Land impacted for carbon sink enhancement - total	4093.1
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	66.694
Business-as-usual carbon sink - Reforest cropland	19.828
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	444.167
Carbon sink enhancement potential - All (not counting overlap)	56418.8
Carbon sink enhancement potential - Avoid deforestation	3402.6
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-2857.03
Carbon sink enhancement potential - Extend rotation length	15878.7
Carbon sink enhancement potential - Improve plantations	3954.3
Carbon sink enhancement potential - Increase retention of HWP	15933.2
Carbon sink enhancement potential - Increase trees outside forests	1175.922
Carbon sink enhancement potential - permanent conservation cover	-101.002
Carbon sink enhancement potential - Reforest cropland	524.813
Carbon sink enhancement potential - Reforest pasture	9513.6
Carbon sink enhancement potential - Restore productivity	5591.6
Carbon sink enhancement potential - total	-2958.032
Land impacted for carbon sink enhancement - Accelerate regeneration	179.015
Land impacted for carbon sink enhancement - All (not counting overlap)	10422.9
Land impacted for carbon sink enhancement - Avoid deforestation	913.362
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1720.506
Land impacted for carbon sink enhancement - Extend rotation length	8747.4
Land impacted for carbon sink enhancement - Improve plantations	2197.706
Land impacted for carbon sink enhancement - Increase retention of HWP	3186.6
Land impacted for carbon sink enhancement - Increase trees outside forests	331.715
Land impacted for carbon sink enhancement - permanent conservation cover	183.705

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

variable_name	2050
Land impacted for carbon sink enhancement - Reforest cropland	174.731
Land impacted for carbon sink enhancement - Reforest pasture	719.381
Land impacted for carbon sink enhancement - Restore productivity	3155.424
Land impacted for carbon sink enhancement - total	1904.141
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9182.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	41.511
Business-as-usual carbon sink - Avoid deforestation	290.955
Business-as-usual carbon sink - Extend rotation length	4785.4
Business-as-usual carbon sink - Improve plantations	834.575
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	66.694
Business-as-usual carbon sink - Reforest cropland	19.828
Business-as-usual carbon sink - Reforest pasture	175.745
Business-as-usual carbon sink - Restore productivity	1110.8
Business-as-usual carbon sink - Total impacted (over 30 years)	19.828