Net-Zero America - ohio 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	9.279	9.985	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.043	0.158	0.163	0.171	0.178	0.186	0.197
Sale of space heating units by type - Electric Resistance	0.157	0.207	0.205	0.202	0.195	0.186	0.177
Sale of space heating units by type - Fossil	0.052	0.079	0.074	0.07	0.07	0.07	0.07
Sale of space heating units by type - Gas	0.747	0.556	0.559	0.558	0.557	0.558	0.557
Sales of cooking units - Electric Resistance	0.613	0.613	0.613	0.613	0.613	0.613	0.613
Sales of cooking units - Gas	0.387	0.387	0.387	0.387	0.387	0.387	0.387
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	0.322	0.487	0.485	0.484	0.484	0.483	0.482
Sales of water heating units by type - Gas Furnace	0.677	0.512	0.514	0.514	0.515	0.516	0.516
Sales of water heating units by type - Other	0.001	0.002	0.002	0.002	0.002	0.002	0.002

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	0.018	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.041	0.062	0.071	0.087	0.106	0.121	0.133
End-use technology sales by technology - LDV - gasoline	0.894	0.857	0.833	0.813	0.792	0.772	0.757
End-use technology sales by technology - LDV - hybrid	0.049	0.058	0.07	0.076	0.081	0.086	0.09
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	315.395
Carbon sink enhancement potential - All (not counting overlap)	0	0	35172.5
Carbon sink enhancement potential - Avoid deforestation	0	0	4956.4
Carbon sink enhancement potential - Extend rotation length	0	0	5810.9
Carbon sink enhancement potential - Improve plantations	0	0	382.581
Carbon sink enhancement potential - Increase retention of HWP	0	0	7914.4
Carbon sink enhancement potential - Increase trees outside forests	0	0	3216
Carbon sink enhancement potential - Reforest cropland	0	0	2040.15
Carbon sink enhancement potential - Reforest pasture	0	0	7082.6
Carbon sink enhancement potential - Restore productivity	0	0	3454.1
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	1330.476
Land impacted for carbon sink enhancement - Extend rotation length	0	0	3201.125
Land impacted for carbon sink enhancement - Improve plantations	0	0	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	907.187
Land impacted for carbon sink enhancement - Natural uptake	0.94	-7.029	-6.285
Land impacted for carbon sink enhancement - Reforest cropland	0	0	679.247
Land impacted for carbon sink enhancement - Reforest pasture	0	0	535.557
Land impacted for carbon sink enhancement - Restore productivity	0	0	1949.183
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-1.292	-2.324	-2.416
Land impacted for carbon sink enhancement - Total	-0.352	-9.354	-8.701
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746

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	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.372	0.372	0.369	0.36	0.351	0.351	0.36
Final energy demand by sector - industry	0.602	0.634	0.654	0.668	0.689	0.709	0.731
Final energy demand by sector - residential	0.555	0.517	0.496	0.481	0.472	0.466	0.461
Final energy demand by sector - transportation	0.953	0.894	0.818	0.774	0.775	0.799	0.83

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	36280172213	37607476286	0	0	0	0
Sales of cooking units - Electric Resistance	0.41	0.442	0.443	0.443	0.443	0.444	0.445
Sales of cooking units - Gas	0.59	0.558	0.557	0.557	0.557	0.556	0.555
Sales of space heating units - Electric Heat Pump	0.014	0.126	0.447	0.711	0.754	0.759	0.759
Sales of space heating units - Electric Resistance	0.044	0.043	0.089	0.171	0.228	0.236	0.237
Sales of space heating units - Fossil	0.054	0.028	0.014	0.002	0	0	0
Sales of space heating units - Gas Furnace	0.888	0.804	0.45	0.115	0.018	0.004	0.004
Sales of water heating units - Electric Heat Pump	0.005	0.003	0.003	0.003	0.003	0.003	0.003
Sales of water heating units - Electric Resistance	0.043	0.032	0.032	0.032	0.032	0.032	0.032
Sales of water heating units - Gas Furnace	0.95	0.962	0.963	0.963	0.963	0.963	0.963
Sales of water heating units - Other	0.003	0.002	0.002	0.002	0.002	0.002	0.002

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	5.42	5.514	10.569	11.254	10.6	11.125

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	9.703	12.799	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.055	0.137	0.414	0.842	0.917	0.921	0.919
Sale of space heating units by type - Electric Resistance	0.154	0.214	0.161	0.072	0.055	0.055	0.057
Sale of space heating units by type - Fossil	0.05	0.085	0.058	0.028	0.023	0.023	0.022
Sale of space heating units by type - Gas	0.74	0.565	0.367	0.058	0.005	0.002	0.002
Sales of cooking units - Electric Resistance	0.618	0.699	0.949	0.997	1	1	1
Sales of cooking units - Gas	0.382	0.301	0.051	0.003	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.018	0.151	0.347	0.38	0.383	0.383
Sales of water heating units by type - Electric Resistance	0.322	0.488	0.517	0.6	0.615	0.616	0.615
Sales of water heating units by type - Gas Furnace	0.677	0.493	0.33	0.052	0.003	0	0
Sales of water heating units by type - Other	0.001	0.002	0.002	0.002	0.002	0.002	0.002

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	0.044	0.167	0.488	0.827	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.891	0.763	0.464	0.156	0.032	0.006	0
End-use technology sales by technology - LDV - hybrid	0.049	0.049	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	2094681419	5366759155	8700079612	13177571975	14343500958	13674921862
Number of public EV charging plugs - DC Fast Charging	326	0	3647.7	0	16040.3	0	25943.4
Number of public EV charging plugs - L2 Charging	1062	0	87741.1	0	385833.5	0	624041.2

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
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	0	0
Power generation capital investment - Solar PV - Base	0	0	0.621	12.47	9.707	12.567	4.833
Power generation capital investment - Solar PV - Constrained	0	1.545	0.276	10.404	9.717	11.474	5.902
Power generation capital investment - Wind - Base	0	0	5.071	13.583	21.353	2.522	3.078
Power generation capital investment - Wind - Constrained	0	0	12.91	11.295	0	0	0.2

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	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	87.984	677.005	4155.1	8938.7	12035.2	13715.5
HV transmission for wind and solar - base other intra-state	0	0.307	52.136	1058.9	2108.4	2931.2	3156.5
HV transmission for wind and solar - base spur intra-state	0	76.897	443.807	2454.8	5275.2	6728.5	7430
HV transmission for wind and solar - constrained all	0	84.767	1903.5	6100.7	9226.2	12453.9	14532.2
HV transmission for wind and solar - constrained other intra-state	0	0.307	357.215	1440.5	2131.9	2690.1	3012
HV transmission for wind and solar - constrained spur intra-state	0	73.252	1074.9	2441.1	3697.3	5081.4	5963.1

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0	0	0.378	1.75
Capital investment	0	0	0	0	0	0	26.883
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	7	30
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	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	0	7.93	36.67
Annual - BECCS	0	0	0	0	7.93	36.67
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	7.93	44.6
Cumulative - BECCS	0	0	0	0	7.93	44.6
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0	0	0	0

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	1555509.183	1555509.183	1555509.183	1905974.296	3019498.9
CO2 pipelines - Spur	0	0	0	0	350465.613	1463989.7
CO2 pipelines - Trunk	0	1555509.183	1555509.183	1555509.183	1555509.183	1555509.183

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	983.457	990.899	1049	945.849	521.967	572.479	1838.1
Jobs by economic sector - construction	10659.5	9969.1	11486.5	23730.5	28313	28694.7	27059.7
Jobs by economic sector - manufacturing	10579.1	18228.3	21174.9	27549.6	26340.9	21459.2	26713.5

Table 17: *RE- scenario - IMPACTS - Jobs (continued)*

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	13847.3	11133.1	8437.7	6292.3	4037	2521.7	1363
Jobs by economic sector - other	542.946	430.582	631.233	2988.5	3778	4619.5	4315.5
Jobs by economic sector - pipeline	1605.4	1603.3	1561.3	1101.5	822.795	555.243	476.12
Jobs by economic sector - professional	6243.4	5422.3	5880.9	12177.8	16070.5	16982.5	18364.3
Jobs by economic sector - trade	6535.3	5336.2	5039.7	8350.6	9995.8	10431.8	10367.7
Jobs by economic sector - utilities	13441	12259.4	12458.3	19949.7	24333.1	23209.1	23299.8
Jobs by resource sector - Biomass	2457.3	2428.6	2441.7	2130.6	1240.8	2131.6	8002.7
Jobs by resource sector - CO2	0	0	1538.7	0	0	131.39	1132.5
Jobs by resource sector - Coal	4891.1	1710.2	216.162	17.96	13.315	10.386	8.76
Jobs by resource sector - Grid	11342.2	10491.2	12032.1	29798.8	39081.5	39898.3	42049.5
Jobs by resource sector - Natural Gas	18235.7	18142.8	15107.6	12582.6	10497.6	6864.7	3993.6
Jobs by resource sector - Nuclear	952.579	662.003	651.431	641.125	631.076	366.158	0
Jobs by resource sector - Oil	20940.8	19280.1	16571.1	13779.5	9722.3	6953.5	4254.2
Jobs by resource sector - Solar	3978.2	6458.3	8175.3	23989.9	24898	28190.9	28184.2
Jobs by resource sector - Wind	1639.6	6199.9	10985.3	20145.8	28128.5	24499.2	26172.3
Median wages - All	60130.5	59967.1	60097.4	60243.5	61373.6	62276.5	62668.7
Required Level of Education - Associates degree or some college	19256.2	19759.8	20726.7	32379.5	36392.8	34853.4	36015.6
Required Level of Education - Bachelors degree	14540.2	14492.3	14595.6	21253	23462.4	22280.3	23250
Required Level of Education - Doctoral degree	459.369	420.012	419.437	680.988	807.486	810.285	847.041
Required Level of Education - High school diploma or less	26736.2	27389.8	28670.3	43785.8	47885.9	45610.3	47970
Required Level of Education - Masters or professional degree	3445.4	3311.3	3307.3	4986.8	5664.5	5491.9	5715.1
Wage income - All	3874782920	3920341171	4069898470	6210793991	7010340929	6791824616	7132342810

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	315.395
Carbon sink enhancement potential - All (not counting overlap)	35172.5
Carbon sink enhancement potential - Avoid deforestation	4956.4
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2509.474
Carbon sink enhancement potential - cropland measures	-8345.941
Carbon sink enhancement potential - Extend rotation length	5810.9
Carbon sink enhancement potential - Improve plantations	382.581
Carbon sink enhancement potential - Increase retention of HWP	7914.4
Carbon sink enhancement potential - Increase trees outside forests	3216
Carbon sink enhancement potential - permanent conservation cover	-321.57
Carbon sink enhancement potential - Reforest cropland	2040.15
Carbon sink enhancement potential - Reforest pasture	7082.6
Carbon sink enhancement potential - Restore productivity	3454.1
Carbon sink enhancement potential - total	-11176.983
Land impacted for carbon sink enhancement - Accelerate regeneration	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	1330.476
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1045.74
Land impacted for carbon sink enhancement - cropland measures	5386.9
Land impacted for carbon sink enhancement - Extend rotation length	3201.125
Land impacted for carbon sink enhancement - Improve plantations	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	907.187
Land impacted for carbon sink enhancement - permanent conservation cover	584.877
Land impacted for carbon sink enhancement - Reforest cropland	679.247
Land impacted for carbon sink enhancement - Reforest pasture	535.557
Land impacted for carbon sink enhancement - Restore productivity	1949.183
Land impacted for carbon sink enhancement - total	7017.6
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	868992.1	881897.7	743390	596229.4	448832.6	282390.4	195858.6
Oil consumption	194840.1	182780.7	157343.5	120241.8	85583.7	58306	36959

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.372	0.366	0.351	0.325	0.295	0.272	0.261
Final energy demand by sector - industry	0.602	0.619	0.627	0.629	0.639	0.647	0.652
Final energy demand by sector - residential	0.555	0.515	0.478	0.416	0.348	0.297	0.264
Final energy demand by sector - transportation	0.952	0.886	0.773	0.638	0.516	0.442	0.411

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	36680213244	40065240561	0	0	0	0
Sales of cooking units - Electric Resistance	0.41	0.542	0.829	0.886	0.889	0.889	0.889
Sales of cooking units - Gas	0.59	0.458	0.171	0.114	0.111	0.111	0.111
Sales of space heating units - Electric Heat Pump	0.014	0.084	0.357	0.811	0.89	0.895	0.895
Sales of space heating units - Electric Resistance	0.044	0.035	0.053	0.094	0.101	0.102	0.102
Sales of space heating units - Fossil	0.054	0.026	0.005	0	0	0	0
Sales of space heating units - Gas Furnace	0.888	0.855	0.585	0.095	0.009	0.004	0.004
Sales of water heating units - Electric Heat Pump	0.005	0.025	0.196	0.462	0.508	0.511	0.511
Sales of water heating units - Electric Resistance	0.043	0.047	0.183	0.439	0.484	0.487	0.487
Sales of water heating units - Gas Furnace	0.95	0.926	0.619	0.097	0.006	0	0
Sales of water heating units - Other	0.003	0.002	0.002	0.002	0.002	0.002	0.002

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	6.236	6.426	13.259	14.241	13.056	13.779

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	9.67	12.626	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.055	0.112	0.144	0.246	0.466	0.716	0.855
Sale of space heating units by type - Electric Resistance	0.154	0.218	0.211	0.191	0.146	0.095	0.068
Sale of space heating units by type - Fossil	0.05	0.088	0.085	0.076	0.057	0.038	0.027
Sale of space heating units by type - Gas	0.74	0.582	0.56	0.487	0.331	0.151	0.05
Sales of cooking units - Electric Resistance	0.617	0.627	0.662	0.754	0.883	0.962	0.99
Sales of cooking units - Gas	0.383	0.373	0.338	0.246	0.117	0.038	0.01
Sales of water heating units by type - Electric Heat Pump	0	0.005	0.021	0.069	0.172	0.288	0.353
Sales of water heating units by type - Electric Resistance	0.322	0.488	0.49	0.501	0.534	0.577	0.603
Sales of water heating units by type - Gas Furnace	0.677	0.505	0.488	0.428	0.292	0.133	0.043
Sales of water heating units by type - Other	0.001	0.002	0.002	0.002	0.002	0.002	0.002

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	0.018	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.021	0.051	0.126	0.271	0.497	0.729	0.879
End-use technology sales by technology - LDV - gasoline	0.912	0.867	0.784	0.651	0.447	0.239	0.106
End-use technology sales by technology - LDV - hybrid	0.051	0.059	0.065	0.059	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	338460717	712064090	2403785603	7566915846	11023249596
Number of public EV charging plugs - DC Fast Charging	326	0	1123.6	0	5945.4	0	16616.7
Number of public EV charging plugs - L2 Charging	1062	0	27027.6	0	143009.6	0	399698

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	315.395
Carbon sink enhancement potential - All (not counting overlap)	35172.5
Carbon sink enhancement potential - Avoid deforestation	4956.4
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2509.474

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-8345.941
Carbon sink enhancement potential - Extend rotation length	5810.9
Carbon sink enhancement potential - Improve plantations	382.581
Carbon sink enhancement potential - Increase retention of HWP	7914.4
Carbon sink enhancement potential - Increase trees outside forests	3216
Carbon sink enhancement potential - permanent conservation cover	-321.57
Carbon sink enhancement potential - Reforest cropland	2040.15
Carbon sink enhancement potential - Reforest pasture	7082.6
Carbon sink enhancement potential - Restore productivity	3454.1
Carbon sink enhancement potential - total	-11176.983
Land impacted for carbon sink enhancement - Accelerate regeneration	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	1330.476
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1045.74
Land impacted for carbon sink enhancement - cropland measures	5386.9
Land impacted for carbon sink enhancement - Extend rotation length	3201.125
Land impacted for carbon sink enhancement - Improve plantations	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	907.187
Land impacted for carbon sink enhancement - permanent conservation cover	584.877
Land impacted for carbon sink enhancement - Reforest cropland	679.247
Land impacted for carbon sink enhancement - Reforest pasture	535.557
Land impacted for carbon sink enhancement - Restore productivity	1949.183
Land impacted for carbon sink enhancement - total	7017.6
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.372	0.367	0.358	0.35	0.337	0.32	0.302
Final energy demand by sector - industry	0.602	0.62	0.63	0.637	0.652	0.659	0.663
Final energy demand by sector - residential	0.555	0.516	0.488	0.461	0.427	0.383	0.335
Final energy demand by sector - transportation	0.954	0.894	0.812	0.747	0.696	0.637	0.566

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	36676028903	40057073609	0	0	0	0
Sales of cooking units - Electric Resistance	0.41	0.458	0.498	0.605	0.754	0.845	0.877
Sales of cooking units - Gas	0.59	0.542	0.502	0.395	0.246	0.155	0.123
Sales of space heating units - Electric Heat Pump	0.014	0.063	0.094	0.195	0.418	0.678	0.825
Sales of space heating units - Electric Resistance	0.044	0.034	0.036	0.043	0.061	0.082	0.095
Sales of space heating units - Fossil	0.054	0.03	0.027	0.021	0.01	0.003	0.001
Sales of space heating units - Gas Furnace	0.888	0.873	0.842	0.741	0.511	0.236	0.079
Sales of water heating units - Electric Heat Pump	0.005	0.011	0.03	0.093	0.228	0.383	0.47
Sales of water heating units - Electric Resistance	0.043	0.038	0.054	0.105	0.223	0.366	0.448
Sales of water heating units - Gas Furnace	0.95	0.95	0.914	0.8	0.547	0.25	0.081
Sales of water heating units - Other	0.003	0.002	0.002	0.002	0.002	0.002	0.002

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	5.035	5.083	6.883	7.139	11.15	11.853

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

variable_name	2025	2030	2035	2040	2045	2050
Power generation capital investment - Solar PV - Base	1.492	2.393	24.389	14.871	8.532	10.29
Power generation capital investment - Wind - Base	0	11.431	21.962	18.425	0.135	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	143.262	1601.1	8056.4	14147.3	18075.1	19718.8
HV transmission for wind and solar - base other intra-state	0	0.153	202.416	1778.8	3051	3441	3934.5
HV transmission for wind and solar - base spur intra-state	0	134.707	1091.3	5208.8	8454.6	9895.2	10520.3

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	315.395
Carbon sink enhancement potential - All (not counting overlap)	35172.5
Carbon sink enhancement potential - Avoid deforestation	4956.4
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2509.474
Carbon sink enhancement potential - cropland measures	-8345.941
Carbon sink enhancement potential - Extend rotation length	5810.9
Carbon sink enhancement potential - Improve plantations	382.581
Carbon sink enhancement potential - Increase retention of HWP	7914.4
Carbon sink enhancement potential - Increase trees outside forests	3216
Carbon sink enhancement potential - permanent conservation cover	-321.57
Carbon sink enhancement potential - Reforest cropland	2040.15
Carbon sink enhancement potential - Reforest pasture	7082.6
Carbon sink enhancement potential - Restore productivity	3454.1
Carbon sink enhancement potential - total	-11176.983
Land impacted for carbon sink enhancement - Accelerate regeneration	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	1330.476
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1045.74
Land impacted for carbon sink enhancement - cropland measures	5386.9
Land impacted for carbon sink enhancement - Extend rotation length	3201.125
Land impacted for carbon sink enhancement - Improve plantations	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	907.187
Land impacted for carbon sink enhancement - permanent conservation cover	584.877
Land impacted for carbon sink enhancement - Reforest cropland	679.247
Land impacted for carbon sink enhancement - Reforest pasture	535.557
Land impacted for carbon sink enhancement - Restore productivity	1949.183
Land impacted for carbon sink enhancement - total	7017.6
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078

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	0.179	0.179

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	0	1.787	5.287
Capital investment	0	0	0	0	0	0	53.896
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	23	65
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	1	2
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	0	1	1
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	1	2
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	1

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	24.71	72.91
Annual - BECCS	0	0	0	0	24.71	72.91
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	24.71	97.62
Cumulative - BECCS	0	0	0	0	24.71	97.62
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	1555509.183	1555509.183	1555509.183	3015567.3	4990832.9
CO2 pipelines - Spur	0	0	0	0	1081373.113	3056639.8
CO2 pipelines - Trunk	0	1555509.183	1555509.183	1555509.183	1934193.183	1934193.183

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	315.395
Carbon sink enhancement potential - All (not counting overlap)	35172.5
Carbon sink enhancement potential - Avoid deforestation	4956.4
Carbon sink enhancement potential - corn-ethanol to energy grasses	-3544.538
Carbon sink enhancement potential - cropland measures	-7496.613
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	5810.9
Carbon sink enhancement potential - Improve plantations	382.581
Carbon sink enhancement potential - Increase retention of HWP	7914.4
Carbon sink enhancement potential - Increase trees outside forests	3216
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-289.102
Carbon sink enhancement potential - Reforest cropland	2040.15
Carbon sink enhancement potential - Reforest pasture	7082.6
Carbon sink enhancement potential - Restore productivity	3454.1
Carbon sink enhancement potential - total	-11330.254
Land impacted for carbon sink enhancement - Accelerate regeneration	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	1330.476
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1806.748
Land impacted for carbon sink enhancement - cropland measures	9505.7

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

variable_name	2050
Land impacted for carbon sink enhancement - Cropland to woody energy crops	331.504
Land impacted for carbon sink enhancement - Extend rotation length	3201.125
Land impacted for carbon sink enhancement - Improve plantations	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	907.187
Land impacted for carbon sink enhancement - pasture to energy crops	258.206
Land impacted for carbon sink enhancement - permanent conservation cover	525.825
Land impacted for carbon sink enhancement - Reforest cropland	679.247
Land impacted for carbon sink enhancement - Reforest pasture	535.557
Land impacted for carbon sink enhancement - Restore productivity	1949.183
Land impacted for carbon sink enhancement - total	12427.9
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	315.395
Carbon sink enhancement potential - All (not counting overlap)	35172.5
Carbon sink enhancement potential - Avoid deforestation	4956.4
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2509.474
Carbon sink enhancement potential - cropland measures	-8345.941
Carbon sink enhancement potential - Extend rotation length	5810.9
Carbon sink enhancement potential - Improve plantations	382.581
Carbon sink enhancement potential - Increase retention of HWP	7914.4
Carbon sink enhancement potential - Increase trees outside forests	3216
Carbon sink enhancement potential - permanent conservation cover	-321.57
Carbon sink enhancement potential - Reforest cropland	2040.15
Carbon sink enhancement potential - Reforest pasture	7082.6
Carbon sink enhancement potential - Restore productivity	3454.1
Carbon sink enhancement potential - total	-11176.983
Land impacted for carbon sink enhancement - Accelerate regeneration	127.116
Land impacted for carbon sink enhancement - All (not counting overlap)	5927.1
Land impacted for carbon sink enhancement - Avoid deforestation	1330.476
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1045.74
Land impacted for carbon sink enhancement - cropland measures	5386.9
Land impacted for carbon sink enhancement - Extend rotation length	3201.125
Land impacted for carbon sink enhancement - Improve plantations	212.631
Land impacted for carbon sink enhancement - Increase retention of HWP	1582.9
Land impacted for carbon sink enhancement - Increase trees outside forests	907.187
Land impacted for carbon sink enhancement - permanent conservation cover	584.877
Land impacted for carbon sink enhancement - Reforest cropland	679.247
Land impacted for carbon sink enhancement - Reforest pasture	535.557
Land impacted for carbon sink enhancement - Restore productivity	1949.183
Land impacted for carbon sink enhancement - total	7017.6
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4598.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	29.476
Business-as-usual carbon sink - Avoid deforestation	423.828
Business-as-usual carbon sink - Extend rotation length	1751.2
Business-as-usual carbon sink - Improve plantations	80.746
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	182.397
Business-as-usual carbon sink - Reforest cropland	77.078
Business-as-usual carbon sink - Reforest pasture	130.837
Business-as-usual carbon sink - Restore productivity	686.168
Business-as-usual carbon sink - Total impacted (over 30 years)	77.078