Net-Zero America - oklahoma state report v2

Larson et al. 2020

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Reading guide

IN DRAFT

List of Tables

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	3.091	3.21	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.058	0.351	0.366	0.389	0.405	0.421	0.444
Sale of space heating units by type - Electric Resistance	0.258	0.231	0.227	0.221	0.212	0.198	0.175
Sale of space heating units by type - Fossil	0.06	0.06	0.061	0.06	0.06	0.06	0.06
Sale of space heating units by type - Gas	0.623	0.357	0.346	0.33	0.324	0.321	0.322
Sales of cooking units - Electric Resistance	0.397	0.397	0.397	0.397	0.397	0.397	0.397
Sales of cooking units - Gas	0.603	0.603	0.603	0.603	0.603	0.603	0.603
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	0.305	0.426	0.425	0.426	0.425	0.425	0.424
Sales of water heating units by type - Gas Furnace	0.682	0.561	0.562	0.562	0.563	0.563	0.564
Sales of water heating units by type - Other	0.014	0.012	0.012	0.012	0.012	0.012	0.012

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	0.017	0.021	0.022	0.021	0.019	0.017	0.016
End-use technology sales by technology - LDV - EV	0.032	0.051	0.058	0.071	0.087	0.102	0.113
End-use technology sales by technology - LDV - gasoline	0.909	0.875	0.855	0.838	0.818	0.799	0.783
End-use technology sales by technology - LDV - hybrid	0.04	0.049	0.06	0.066	0.072	0.078	0.084
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.004	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	1666.679
Carbon sink enhancement potential - All (not counting overlap)	0	0	70613.1
Carbon sink enhancement potential - Avoid deforestation	0	0	2671.103
Carbon sink enhancement potential - Extend rotation length	0	0	7856.1
Carbon sink enhancement potential - Improve plantations	0	0	1128.524
Carbon sink enhancement potential - Increase retention of HWP	0	0	2955.4
Carbon sink enhancement potential - Increase trees outside forests	0	0	2307.636
Carbon sink enhancement potential - Reforest cropland	0	0	17030.4
Carbon sink enhancement potential - Reforest pasture	0	0	29455.3
Carbon sink enhancement potential - Restore productivity	0	0	5542
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	717.029
Land impacted for carbon sink enhancement - Extend rotation length	0	0	4327.764
Land impacted for carbon sink enhancement - Improve plantations	0	0	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	650.955
Land impacted for carbon sink enhancement - Natural uptake	-3.92	-9.164	-7.427
Land impacted for carbon sink enhancement - Reforest cropland	0	0	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	0	0	2227.285
Land impacted for carbon sink enhancement - Restore productivity	0	0	3127.36
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.482	-0.805	-0.847
Land impacted for carbon sink enhancement - Total	-4.402	-9.969	-8.274
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181

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	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.121	0.123	0.124	0.125	0.127	0.132	0.141
Final energy demand by sector - industry	0.31	0.325	0.335	0.34	0.35	0.358	0.369
Final energy demand by sector - residential	0.177	0.167	0.164	0.162	0.163	0.166	0.169
Final energy demand by sector - transportation	0.431	0.408	0.377	0.358	0.359	0.37	0.385

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	13857234415	14542937023	0	0	0	0
Sales of cooking units - Electric Resistance	0.301	0.323	0.323	0.323	0.323	0.323	0.323
Sales of cooking units - Gas	0.699	0.677	0.677	0.677	0.677	0.677	0.677
Sales of space heating units - Electric Heat Pump	0.019	0.296	0.708	0.791	0.795	0.795	0.795
Sales of space heating units - Electric Resistance	0.02	0.063	0.121	0.159	0.187	0.191	0.192
Sales of space heating units - Fossil	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.961	0.641	0.171	0.051	0.018	0.014	0.013
Sales of water heating units - Electric Heat Pump	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Sales of water heating units - Electric Resistance	0.017	0.037	0.036	0.036	0.037	0.037	0.037
Sales of water heating units - Gas Furnace	0.974	0.944	0.945	0.945	0.944	0.944	0.944
Sales of water heating units - Other	0.008	0.018	0.018	0.018	0.018	0.018	0.018

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	2.836	2.893	4.382	4.609	4.423	4.601

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	3.197	3.892	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.085	0.252	0.769	0.885	0.89	0.889	0.888
Sale of space heating units by type - Electric Resistance	0.248	0.261	0.109	0.075	0.074	0.075	0.076
Sale of space heating units by type - Fossil	0.059	0.09	0.035	0.022	0.022	0.022	0.022
Sale of space heating units by type - Gas	0.607	0.398	0.087	0.018	0.015	0.014	0.014
Sales of cooking units - Electric Resistance	0.404	0.531	0.92	0.996	1	1	1
Sales of cooking units - Gas	0.596	0.469	0.08	0.004	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.116	0.617	0.729	0.734	0.734	0.734
Sales of water heating units by type - Electric Resistance	0.305	0.399	0.282	0.255	0.254	0.254	0.254
Sales of water heating units by type - Gas Furnace	0.682	0.472	0.089	0.004	0	0	0
Sales of water heating units by type - Other	0.014	0.012	0.012	0.012	0.012	0.012	0.012

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	0.017	0.019	0.013	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.035	0.139	0.445	0.81	0.962	0.993	1
End-use technology sales by technology - LDV - gasoline	0.906	0.794	0.508	0.173	0.034	0.006	0
End-use technology sales by technology - LDV - hybrid	0.04	0.043	0.031	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	709725375	1819124915	2947783472	4465338507	4859902086	4633655155
Number of public EV charging plugs - DC Fast Charging	326	0	1404.1	0	6163.8	0	9967.3
Number of public EV charging plugs - L2 Charging	301	0	33808.4	0	148417.4	0	240002.3

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	0.019	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	0	1.089	4.458	0.979
Power generation capital investment - Solar PV - Constrained	0	1.7	4.958	6.166	5.533	5.506	2.59
Power generation capital investment - Wind - Base	0	0	8.177	17.231	16.695	11.978	1.18
Power generation capital investment - Wind - Constrained	0	6.508	7.428	13.61	12.277	8.592	0.321

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	19.014	19.014	19.014	19.014
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	1373.4	2638.8	6112.3	10825.8	15375.4	18104.3
HV transmission for wind and solar - base other intra-state	0	330.177	669.234	2248.6	3901	5476.7	6071.9
HV transmission for wind and solar - base spur intra-state	0	340.212	712.242	1795.9	3083.1	4262.5	4362.1
HV transmission for wind and solar - constrained all	0	3009.7	6686	12358	19168.3	25516	29149.6
HV transmission for wind and solar - constrained other intra-state	0	881.384	2341	4974.7	7509.2	9902.7	11094
HV transmission for wind and solar - constrained spur intra-state	0	354.202	826.528	2068.8	3767.6	4944.7	5174.5

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0.181	0.25	0.388	0.501
Capital investment	0	0	0	0	4.352	0	4.441
Number of facilities - allam power w ccu	0	0	0	1	1	1	1
Number of facilities - beccs hydrogen	0	0	0	4	7	9	12
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	1	1	1	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	1	1	1	1
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	10.97	12.53	16	18.84
Annual - BECCS	0	0	4.26	5.9	9.16	11.77
Annual - Cement	0	0	6.71	6.64	6.84	7.07
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	10.97	23.5	39.5	58.34
Cumulative - BECCS	0	0	4.26	10.16	19.32	31.09
Cumulative - Cement	0	0	6.71	13.35	20.19	27.26
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	1.1	1.76	3.61	6.02	7.46
Injection wells	0	1	4	8	13	16
Resource characterization, appraisal and permitting costs cumulative	102.93	251.02	294.78	294.78	294.78	294.78
Wells and facilities construction costs cumulative	0	35.59	138.71	247.19	413.32	513.15

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	4032839.441	6503445.5	6686560.5	7206442.9	7409730.8
CO2 pipelines - Spur	0	0	558019.378	741134.681	1261017	1464304.9
CO2 pipelines - Trunk	0	4032839.441	5945425.9	5945425.9	5945425.9	5945425.9

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	23.764	27.396	55.624	378.829	446.661	559.796	593.05
Jobs by economic sector - construction	14473.8	14780.9	16934.5	21026.8	22801	25207.7	21719
Jobs by economic sector - manufacturing	20485.3	28890.7	31436.3	36802.2	33310.1	27008.1	28975.2

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	40144.3	35057.5	27734.6	21463.7	14037.9	9029.3	4915
Jobs by economic sector - other	761.852	777.742	931.024	1480.1	2080.4	2978.2	2722.9
Jobs by economic sector - pipeline	1754.3	1798.2	2039.7	1680.8	1137.4	880.938	642.8
Jobs by economic sector - professional	13126	13331.2	13581.2	16852.1	18326.2	19829.1	17485.4
Jobs by economic sector - trade	12746.5	12358.4	11761.9	12563.9	12277.2	12543	10597
Jobs by economic sector - utilities	12098.7	11521	12675.5	16002	17480.7	18830.7	17098.2
Jobs by resource sector - Biomass	98.506	117.581	153.37	1079	1344.6	2041.6	2532.6
Jobs by resource sector - CO2	0	53.615	3571.4	2475.7	755.958	1294.9	1714.4
Jobs by resource sector - Coal	1917.6	679.099	47.686	0.976	0.751	0.607	0.518
Jobs by resource sector - Grid	11224.4	10694.3	12550.4	21365.3	26557.3	30550.3	28842
Jobs by resource sector - Natural Gas	36708.5	34454.8	26923	20615.9	15609.7	10051.2	5608.6
Jobs by resource sector - Nuclear	0	0	0.003	0.006	0	0	0
Jobs by resource sector - Oil	54160.2	52246.8	47100.3	42253.6	30569.7	22743.8	13938.1
Jobs by resource sector - Solar	3460.3	6431.7	7478.8	10834	12680.2	15428.4	17569.3
Jobs by resource sector - Wind	8045	13865.1	19325.2	29625.9	34379.3	34755.9	34543
Median wages - All	59844.4	59948.4	59892.4	59534.1	59523.2	59782.4	59634.4
Required Level of Education - Associates degree or some college	33252.2	34438.8	34580.1	38497.9	37227.2	36154.3	32760.2
Required Level of Education - Bachelors degree	29412.5	29546.1	28272.2	29905.7	27655.3	25932.7	22759.6
Required Level of Education - Doctoral degree	1032.1	1008.4	952.803	1026.1	990.793	982.291	838.895
Required Level of Education - High school diploma or less	44778.9	46510.7	46673.5	51742.5	49377.2	47417.5	42852.5
Required Level of Education - Masters or professional degree	7138.7	7039.1	6671.7	7078.1	6647.1	6380.1	5537.2
Wage income - All	6919092448	7106683129	7016644756	7635609138	7256165473	6987160027	6247127364

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	1666.679
Carbon sink enhancement potential - All (not counting overlap)	70613.1
Carbon sink enhancement potential - Avoid deforestation	2671.103
Carbon sink enhancement potential - corn-ethanol to energy grasses	-36.482
Carbon sink enhancement potential - cropland measures	-6906.212
Carbon sink enhancement potential - Extend rotation length	7856.1
Carbon sink enhancement potential - Improve plantations	1128.524
Carbon sink enhancement potential - Increase retention of HWP	2955.4
Carbon sink enhancement potential - Increase trees outside forests	2307.636
Carbon sink enhancement potential - permanent conservation cover	-393.363
Carbon sink enhancement potential - Reforest cropland	17030.4
Carbon sink enhancement potential - Reforest pasture	29455.3
Carbon sink enhancement potential - Restore productivity	5542
Carbon sink enhancement potential - total	-7336.056
Land impacted for carbon sink enhancement - Accelerate regeneration	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	717.029
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	23.31
Land impacted for carbon sink enhancement - cropland measures	6536.8
Land impacted for carbon sink enhancement - Extend rotation length	4327.764
Land impacted for carbon sink enhancement - Improve plantations	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	650.955
Land impacted for carbon sink enhancement - permanent conservation cover	675.603
Land impacted for carbon sink enhancement - Reforest cropland	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	2227.285
Land impacted for carbon sink enhancement - Restore productivity	3127.36
Land impacted for carbon sink enhancement - total	7235.8
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	616789.7	625949.8	527640.4	423189.4	318570.6	200433.9	139015.7
Oil consumption	108674.7	101740.5	87652.4	66714.3	45863.2	29578.5	14726.6

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.121	0.122	0.117	0.109	0.103	0.101	0.103
Final energy demand by sector - industry	0.31	0.318	0.324	0.323	0.325	0.323	0.33
Final energy demand by sector - residential	0.177	0.168	0.153	0.133	0.115	0.105	0.1
Final energy demand by sector - transportation	0.431	0.405	0.359	0.302	0.25	0.219	0.207

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	14173231633	16553819121	0	0	0	0
Sales of cooking units - Electric Resistance	0.301	0.444	0.792	0.861	0.865	0.865	0.865
Sales of cooking units - Gas	0.699	0.556	0.208	0.139	0.135	0.136	0.135
Sales of space heating units - Electric Heat Pump	0.019	0.269	0.77	0.911	0.923	0.923	0.923
Sales of space heating units - Electric Resistance	0.02	0.044	0.047	0.06	0.063	0.064	0.064
Sales of space heating units - Fossil	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.961	0.687	0.182	0.028	0.014	0.013	0.013
Sales of water heating units - Electric Heat Pump	0.001	0.107	0.564	0.665	0.67	0.67	0.669
Sales of water heating units - Electric Resistance	0.017	0.081	0.269	0.311	0.313	0.313	0.313
Sales of water heating units - Gas Furnace	0.974	0.794	0.15	0.006	0	0	0
Sales of water heating units - Other	0.008	0.018	0.018	0.018	0.018	0.018	0.018

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	2.974	3.047	4.832	5.108	4.99	5.219

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	3.16	3.727	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.085	0.153	0.211	0.381	0.641	0.81	0.868
Sale of space heating units by type - Electric Resistance	0.248	0.29	0.271	0.221	0.145	0.098	0.081
Sale of space heating units by type - Fossil	0.059	0.1	0.095	0.076	0.048	0.03	0.024
Sale of space heating units by type - Gas	0.607	0.458	0.423	0.322	0.166	0.063	0.027
Sales of cooking units - Electric Resistance	0.402	0.418	0.472	0.617	0.817	0.941	0.984
Sales of cooking units - Gas	0.598	0.582	0.528	0.383	0.183	0.059	0.016
Sales of water heating units by type - Electric Heat Pump	0	0.02	0.077	0.241	0.492	0.656	0.714
Sales of water heating units by type - Electric Resistance	0.305	0.422	0.408	0.37	0.311	0.273	0.259
Sales of water heating units by type - Gas Furnace	0.682	0.546	0.503	0.377	0.184	0.059	0.015
Sales of water heating units by type - Other	0.014	0.012	0.012	0.012	0.012	0.012	0.012

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	0.017	0.021	0.021	0.017	0.011	0.006	0.002
End-use technology sales by technology - LDV - EV	0.017	0.044	0.112	0.248	0.472	0.713	0.873
End-use technology sales by technology - LDV - gasoline	0.922	0.881	0.806	0.68	0.475	0.257	0.113
End-use technology sales by technology - LDV - hybrid	0.042	0.05	0.056	0.052	0.04	0.024	0.012
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.003	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	114808795	241247725	814683579	2563675461	3734987111
Number of public EV charging plugs - DC Fast Charging	326	0	433.91	0	2285.7	0	6384
Number of public EV charging plugs - L2 Charging	301	0	10448.2	0	55037.5	0	153721.3

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	1666.679
Carbon sink enhancement potential - All (not counting overlap)	70613.1
Carbon sink enhancement potential - Avoid deforestation	2671.103
Carbon sink enhancement potential - corn-ethanol to energy grasses	-36.482

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-6906.212
Carbon sink enhancement potential - Extend rotation length	7856.1
Carbon sink enhancement potential - Improve plantations	1128.524
Carbon sink enhancement potential - Increase retention of HWP	2955.4
Carbon sink enhancement potential - Increase trees outside forests	2307.636
Carbon sink enhancement potential - permanent conservation cover	-393.363
Carbon sink enhancement potential - Reforest cropland	17030.4
Carbon sink enhancement potential - Reforest pasture	29455.3
Carbon sink enhancement potential - Restore productivity	5542
Carbon sink enhancement potential - total	-7336.056
Land impacted for carbon sink enhancement - Accelerate regeneration	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	717.029
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	23.31
Land impacted for carbon sink enhancement - cropland measures	6536.8
Land impacted for carbon sink enhancement - Extend rotation length	4327.764
Land impacted for carbon sink enhancement - Improve plantations	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	650.955
Land impacted for carbon sink enhancement - permanent conservation cover	675.603
Land impacted for carbon sink enhancement - Reforest cropland	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	2227.285
Land impacted for carbon sink enhancement - Restore productivity	3127.36
Land impacted for carbon sink enhancement - total	7235.8
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.121	0.122	0.121	0.12	0.117	0.113	0.111
Final energy demand by sector - industry	0.31	0.319	0.325	0.326	0.33	0.327	0.334
Final energy demand by sector - residential	0.177	0.169	0.164	0.158	0.146	0.131	0.118
Final energy demand by sector - transportation	0.431	0.408	0.374	0.347	0.327	0.302	0.274

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	14156977297	16435140339	0	0	0	0
Sales of cooking units - Electric Resistance	0.301	0.342	0.39	0.52	0.701	0.812	0.85
Sales of cooking units - Gas	0.699	0.658	0.61	0.48	0.299	0.188	0.15
Sales of space heating units - Electric Heat Pump	0.019	0.174	0.231	0.397	0.655	0.832	0.898
Sales of space heating units - Electric Resistance	0.02	0.044	0.045	0.046	0.051	0.057	0.062
Sales of space heating units - Fossil	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.961	0.782	0.724	0.557	0.294	0.11	0.04
Sales of water heating units - Electric Heat Pump	0.001	0.02	0.071	0.221	0.45	0.599	0.651
Sales of water heating units - Electric Resistance	0.017	0.044	0.065	0.127	0.222	0.284	0.305
Sales of water heating units - Gas Furnace	0.974	0.919	0.845	0.634	0.31	0.099	0.026
Sales of water heating units - Other	0.008	0.018	0.018	0.018	0.018	0.018	0.018

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	2.538	2.559	3.087	3.168	4.704	4.958

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	0	0	0.381	4.534	11.078	7.931
Power generation capital investment - Wind - Base	3.943	9.8	31.151	29.881	33.32	33.701

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	1630.4	3188	9943.2	18918.5	35780.3	57713.7
HV transmission for wind and solar - base other intra-state	0	440.717	904.348	3524.4	6603.6	11498.1	16436.9
HV transmission for wind and solar - base spur intra-state	0	448.742	951.221	3145	5773.7	9400.4	13684.7

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	1666.679
Carbon sink enhancement potential - All (not counting overlap)	70613.1
Carbon sink enhancement potential - Avoid deforestation	2671.103
Carbon sink enhancement potential - corn-ethanol to energy grasses	-36.482
Carbon sink enhancement potential - cropland measures	-6906.212
Carbon sink enhancement potential - Extend rotation length	7856.1
Carbon sink enhancement potential - Improve plantations	1128.524
Carbon sink enhancement potential - Increase retention of HWP	2955.4
Carbon sink enhancement potential - Increase trees outside forests	2307.636
Carbon sink enhancement potential - permanent conservation cover	-393.363
Carbon sink enhancement potential - Reforest cropland	17030.4
Carbon sink enhancement potential - Reforest pasture	29455.3
Carbon sink enhancement potential - Restore productivity	5542
Carbon sink enhancement potential - total	-7336.056
Land impacted for carbon sink enhancement - Accelerate regeneration	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	717.029
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	23.31
Land impacted for carbon sink enhancement - cropland measures	6536.8
Land impacted for carbon sink enhancement - Extend rotation length	4327.764
Land impacted for carbon sink enhancement - Improve plantations	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	650.955
Land impacted for carbon sink enhancement - permanent conservation cover	675.603
Land impacted for carbon sink enhancement - Reforest cropland	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	2227.285
Land impacted for carbon sink enhancement - Restore productivity	3127.36
Land impacted for carbon sink enhancement - total	7235.8
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415

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	0.034	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	2.595	1.6	12.546	21.226	5.445

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	34.181	34.181	34.181	34.181
Power generation by technology - biomass w/ccu power plant	0	0	2912.7	4708.9	18789.4	42612.4	48723.3

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.177	2.385	4.098	6.444	6.815
Capital investment	0	0	2.243	0	44.723	0	32.921
Number of facilities - allam power w ccu	0	0	0	1	1	1	1
Number of facilities - beccs hydrogen	0	0	0	27	39	51	51
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	1	1	1	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	2	3	14	34	39
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	1	2	2	2
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	1	1	1	1	1

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

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	2.89	42.78	69.48	106.72	112.81
Annual - BECCS	0	2.89	36.07	62.84	99.88	105.74
Annual - Cement	0	0	6.71	6.64	6.84	7.07
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	2.89	45.67	115.15	221.87	334.68
Cumulative - BECCS	0	2.89	38.96	101.8	201.68	307.42
Cumulative - Cement	0	0	6.71	13.35	20.19	27.26
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	0.92	4.28	9.51	12.8	13.38
Injection wells	0	2	9	16	26	33
Resource characterization, appraisal and permitting costs cumulative	102.93	293.8	379.75	379.75	379.75	379.75
Wells and facilities construction costs cumulative	0	70.36	274.23	488.69	817.14	1014.5

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	4390749.134	8119086.2	11944503.1	14172106.1	14569063
CO2 pipelines - Spur	0	69151.292	1513327.3	2639358.9	4866963	5263918.9
CO2 pipelines - Trunk	0	4321597.441	6605759.9	9305143.1	9305143.1	9305143.1

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	1666.679
Carbon sink enhancement potential - All (not counting overlap)	70613.1
Carbon sink enhancement potential - Avoid deforestation	2671.103
Carbon sink enhancement potential - corn-ethanol to energy grasses	-1119.276
Carbon sink enhancement potential - cropland measures	-6416.824
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	7856.1
Carbon sink enhancement potential - Improve plantations	1128.524
Carbon sink enhancement potential - Increase retention of HWP	2955.4
Carbon sink enhancement potential - Increase trees outside forests	2307.636
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-347.235
Carbon sink enhancement potential - Reforest cropland	17030.4
Carbon sink enhancement potential - Reforest pasture	29455.3
Carbon sink enhancement potential - Restore productivity	5542
Carbon sink enhancement potential - total	-7883.335
Land impacted for carbon sink enhancement - Accelerate regeneration	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	717.029
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	991.778
Land impacted for carbon sink enhancement - cropland measures	11430.8

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	365.816
Land impacted for carbon sink enhancement - Extend rotation length	4327.764
Land impacted for carbon sink enhancement - Improve plantations	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	650.955
Land impacted for carbon sink enhancement - pasture to energy crops	4600
Land impacted for carbon sink enhancement - permanent conservation cover	597.858
Land impacted for carbon sink enhancement - Reforest cropland	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	2227.285
Land impacted for carbon sink enhancement - Restore productivity	3127.36
Land impacted for carbon sink enhancement - total	17986.3
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	1666.679
Carbon sink enhancement potential - All (not counting overlap)	70613.1
Carbon sink enhancement potential - Avoid deforestation	2671.103
Carbon sink enhancement potential - corn-ethanol to energy grasses	-36.482
Carbon sink enhancement potential - cropland measures	-6906.212
Carbon sink enhancement potential - Extend rotation length	7856.1
Carbon sink enhancement potential - Improve plantations	1128.524
Carbon sink enhancement potential - Increase retention of HWP	2955.4
Carbon sink enhancement potential - Increase trees outside forests	2307.636
Carbon sink enhancement potential - permanent conservation cover	-393.363
Carbon sink enhancement potential - Reforest cropland	17030.4
Carbon sink enhancement potential - Reforest pasture	29455.3
Carbon sink enhancement potential - Restore productivity	5542
Carbon sink enhancement potential - total	-7336.056
Land impacted for carbon sink enhancement - Accelerate regeneration	671.733
Land impacted for carbon sink enhancement - All (not counting overlap)	11380.2
Land impacted for carbon sink enhancement - Avoid deforestation	717.029
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	23.31
Land impacted for carbon sink enhancement - cropland measures	6536.8
Land impacted for carbon sink enhancement - Extend rotation length	4327.764
Land impacted for carbon sink enhancement - Improve plantations	627.21
Land impacted for carbon sink enhancement - Increase retention of HWP	591.076
Land impacted for carbon sink enhancement - Increase trees outside forests	650.955
Land impacted for carbon sink enhancement - permanent conservation cover	675.603
Land impacted for carbon sink enhancement - Reforest cropland	5670.07
Land impacted for carbon sink enhancement - Reforest pasture	2227.285
Land impacted for carbon sink enhancement - Restore productivity	3127.36
Land impacted for carbon sink enhancement - total	7235.8
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7230.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	155.764
Business-as-usual carbon sink - Avoid deforestation	228.412
Business-as-usual carbon sink - Extend rotation length	2367.6
Business-as-usual carbon sink - Improve plantations	238.181
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	130.88
Business-as-usual carbon sink - Reforest cropland	643.415
Business-as-usual carbon sink - Reforest pasture	544.125
Business-as-usual carbon sink - Restore productivity	1100.9
Business-as-usual carbon sink - Total impacted (over 30 years)	643.415