Net-Zero America - wisconsin 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	3.19	3.372	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.028	0.106	0.109	0.115	0.12	0.126	0.134
Sale of space heating units by type - Electric Resistance	0.135	0.183	0.181	0.179	0.174	0.168	0.161
Sale of space heating units by type - Fossil	0.097	0.154	0.149	0.145	0.145	0.146	0.145
Sale of space heating units by type - Gas	0.74	0.557	0.56	0.561	0.56	0.561	0.56
Sales of cooking units - Electric Resistance	0.505	0.505	0.505	0.505	0.505	0.505	0.505
Sales of cooking units - Gas	0.495	0.495	0.495	0.495	0.495	0.495	0.495
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	0.246	0.401	0.399	0.398	0.399	0.397	0.397
Sales of water heating units by type - Gas Furnace	0.754	0.598	0.6	0.6	0.6	0.601	0.602
Sales of water heating units by type - Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001

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	0.016	0.02	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.034	0.055	0.062	0.076	0.093	0.108	0.12
End-use technology sales by technology - LDV - gasoline	0.904	0.869	0.848	0.83	0.809	0.79	0.774
End-use technology sales by technology - LDV - hybrid	0.043	0.052	0.063	0.069	0.075	0.081	0.086
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	686.778
Carbon sink enhancement potential - All (not counting overlap)	0	0	53664.4
Carbon sink enhancement potential - Avoid deforestation	0	0	3331.2
Carbon sink enhancement potential - Extend rotation length	0	0	13750.3
Carbon sink enhancement potential - Improve plantations	0	0	1591.738
Carbon sink enhancement potential - Increase retention of HWP	0	0	10607.3
Carbon sink enhancement potential - Increase trees outside forests	0	0	2764.6
Carbon sink enhancement potential - Reforest cropland	0	0	3903
Carbon sink enhancement potential - Reforest pasture	0	0	9990.1
Carbon sink enhancement potential - Restore productivity	0	0	7039.4
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	894.22
Land impacted for carbon sink enhancement - Extend rotation length	0	0	7574.8
Land impacted for carbon sink enhancement - Improve plantations	0	0	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	779.88
Land impacted for carbon sink enhancement - Natural uptake	-24.83	-14.859	-13.287
Land impacted for carbon sink enhancement - Reforest cropland	0	0	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	0	0	755.407
Land impacted for carbon sink enhancement - Restore productivity	0	0	3972.348
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-1.732	-3.115	-3.238
Land impacted for carbon sink enhancement - Total	-26.562	-17.974	-16.525
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945

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	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.193	0.194	0.192	0.189	0.185	0.185	0.19
Final energy demand by sector - industry	0.516	0.542	0.554	0.566	0.585	0.606	0.631
Final energy demand by sector - residential	0.247	0.231	0.221	0.214	0.209	0.206	0.203
Final energy demand by sector - transportation	0.508	0.478	0.436	0.411	0.41	0.422	0.438

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	19094943133	19795285762	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	0.009	0.113	0.433	0.702	0.749	0.755	0.755
Sales of space heating units - Electric Resistance	0.03	0.043	0.092	0.175	0.232	0.241	0.241
Sales of space heating units - Fossil	0.056	0.028	0.015	0.003	0	0	0
Sales of space heating units - Gas Furnace	0.904	0.816	0.461	0.12	0.019	0.005	0.004
Sales of water heating units - Electric Heat Pump	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Sales of water heating units - Electric Resistance	0.03	0.032	0.032	0.032	0.032	0.032	0.032
Sales of water heating units - Gas Furnace	0.966	0.963	0.963	0.963	0.963	0.963	0.963
Sales of water heating units - Other	0.002	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	3.265	3.344	4.1	4.26	3.927	4.028

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	3.306	4.144	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.037	0.088	0.325	0.795	0.895	0.904	0.903
Sale of space heating units by type - Electric Resistance	0.134	0.188	0.15	0.067	0.049	0.048	0.05
Sale of space heating units by type - Fossil	0.095	0.16	0.123	0.06	0.048	0.047	0.045
Sale of space heating units by type - Gas	0.735	0.563	0.402	0.077	0.008	0.002	0.002
Sales of cooking units - Electric Resistance	0.511	0.615	0.934	0.997	1	1	1
Sales of cooking units - Gas	0.489	0.385	0.066	0.003	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.008	0.106	0.326	0.372	0.376	0.376
Sales of water heating units by type - Electric Resistance	0.246	0.406	0.461	0.59	0.621	0.623	0.623
Sales of water heating units by type - Gas Furnace	0.754	0.586	0.432	0.082	0.007	0	0
Sales of water heating units by type - Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001

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	0.016	0.018	0.013	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.038	0.148	0.459	0.816	0.963	0.993	1
End-use technology sales by technology - LDV - gasoline	0.901	0.784	0.494	0.167	0.033	0.006	0
End-use technology sales by technology - LDV - hybrid	0.043	0.045	0.032	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	1089013610	2795824688	4523124627	6854598225	7457109051	7111670490
Number of public EV charging plugs - DC Fast Charging	143	0	2064	0	9000.6	0	14543.8
Number of public EV charging plugs - L2 Charging	459	0	49644.4	0	216489.3	0	349816.2

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	0.104	1.364	0.29	0	0.356
Power generation capital investment - Solar PV - Constrained	0	0.719	0.334	1.271	1.129	0.49	0.187
Power generation capital investment - Wind - Base	0	1.174	2.171	2.365	4.103	6.869	14.069
Power generation capital investment - Wind - Constrained	0	1.439	3.178	14.051	13.047	9.68	4.966

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	385.691	756.89	1513.8	2529.3	4389	8517.4
HV transmission for wind and solar - base other intra-state	0	63.54	100.106	232.719	356.476	581.273	1594.4
HV transmission for wind and solar - base spur intra-state	0	46.108	185.702	427.101	629.696	1074.7	2375.9
HV transmission for wind and solar - constrained all	0	226.61	749.05	3676.9	7621.5	10863.9	13714.5
HV transmission for wind and solar - constrained other intra-state	0	22.199	121.483	1115.4	2479.4	3499.6	4083.2
HV transmission for wind and solar - constrained spur intra-state	0	24.889	127.224	1184	2963.1	4116	4795.1

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	0.615	1.718
Capital investment	0	0	0	0	0	0	32.648
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	11	14
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	4
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	11
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	12.81	25.11
Annual - BECCS	0	0	0	0	12.81	25.11
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	12.81	37.92
Cumulative - BECCS	0	0	0	0	12.81	37.92
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	0	0	0	252798.778	1250651.5
CO2 pipelines - Spur	0	0	0	0	252798.778	1250651.5
CO2 pipelines - Trunk	0	0	0	0	0	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	1061.1	1079.1	1219.8	1015.9	574.444	900.189	1821.2
Jobs by economic sector - construction	4974.3	4986.8	5072.6	6937.3	7463.7	9195.4	14788.9
Jobs by economic sector - manufacturing	3785.6	6804.5	7976.2	10231.2	9739.9	8396.2	11664.5

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	2968.8	2322.1	1586.5	1066.7	686.54	423.258	268.829
Jobs by economic sector - other	329.623	312.161	343.743	665.842	703.872	906.263	1559.9
Jobs by economic sector - pipeline	532.39	528.043	451.664	361.692	274.655	212.622	359.939
Jobs by economic sector - professional	2918.1	2918.4	2956.5	3557.7	4075.3	6429.2	11532.3
Jobs by economic sector - trade	2926.5	2602	2258.4	2526.5	2568.1	3366.3	5660.7
Jobs by economic sector - utilities	6446.4	6264.3	5852.8	7175.6	8100.9	10069	15287.4
Jobs by resource sector - Biomass	2765	2791.5	2908.8	2325.2	1395.9	3327.1	7931.7
Jobs by resource sector - CO2	0	0	0	0	0	206.387	1869
Jobs by resource sector - Coal	2134.2	1355.4	369.498	0	0	0	0
Jobs by resource sector - Grid	6756.7	6659.8	6987.1	11145.8	13349	16355.6	26106.2
Jobs by resource sector - Natural Gas	5007.8	5020.1	4378.6	3610.6	3307.6	3574.6	2390.5
Jobs by resource sector - Nuclear	659.718	649.082	507.576	185.241	0	0	0
Jobs by resource sector - Oil	5682.4	4997.3	4076.3	3041.2	2199	1592.1	1166.2
Jobs by resource sector - Solar	2046.8	2968.4	3291	5999.6	5459.2	4771.6	7090.4
Jobs by resource sector - Wind	890.156	3375.9	5199.4	7230.9	8476.8	10071	16389.9
Median wages - All	60914	60691.2	60842.9	61316.6	62867.2	64759.8	65800.2
Required Level of Education - Associates degree or some college	7727.8	8381.1	8391.1	10423.9	10849.3	12626.5	19752.3
Required Level of Education - Bachelors degree	5473.3	5788.5	5658.2	6650.9	6821.8	8147.6	12964.1
Required Level of Education - Doctoral degree	176.915	177.082	172.116	196.876	209.23	293.36	503.469
Required Level of Education - High school diploma or less	11259.4	12126.2	12188.2	14736.1	14709.9	16816.2	26438.7
Required Level of Education - Masters or professional degree	1305.3	1344.6	1308.8	1530.7	1597.3	2014.8	3285.1
Wage income - All	1580347730	1688346562	1686537790	2056592338	2149404218	2584003648	4142052015

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	686.778
Carbon sink enhancement potential - All (not counting overlap)	53664.4
Carbon sink enhancement potential - Avoid deforestation	3331.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2456.68
Carbon sink enhancement potential - cropland measures	-6954.081
Carbon sink enhancement potential - Extend rotation length	13750.3
Carbon sink enhancement potential - Improve plantations	1591.738
Carbon sink enhancement potential - Increase retention of HWP	10607.3
Carbon sink enhancement potential - Increase trees outside forests	2764.6
Carbon sink enhancement potential - permanent conservation cover	-283.708
Carbon sink enhancement potential - Reforest cropland	3903
Carbon sink enhancement potential - Reforest pasture	9990.1
Carbon sink enhancement potential - Restore productivity	7039.4
Carbon sink enhancement potential - total	-9694.469
Land impacted for carbon sink enhancement - Accelerate regeneration	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	894.22
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	958.674
Land impacted for carbon sink enhancement - cropland measures	4974.7
Land impacted for carbon sink enhancement - Extend rotation length	7574.8
Land impacted for carbon sink enhancement - Improve plantations	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	779.88
Land impacted for carbon sink enhancement - permanent conservation cover	516.014
Land impacted for carbon sink enhancement - Reforest cropland	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	755.407
Land impacted for carbon sink enhancement - Restore productivity	3972.348
Land impacted for carbon sink enhancement - total	6449.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	414159.3	420310.1	354297.7	284161.4	213912.4	134586.5	93345.7
Oil consumption	116572	112407.3	99922.2	80747.6	62862.9	48721.8	37991.5

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.194	0.191	0.184	0.171	0.157	0.146	0.14
Final energy demand by sector - industry	0.516	0.524	0.516	0.503	0.496	0.492	0.49
Final energy demand by sector - residential	0.247	0.23	0.215	0.188	0.157	0.132	0.115
Final energy demand by sector - transportation	0.508	0.474	0.413	0.338	0.271	0.23	0.212

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	19303499680	21086012428	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	0.009	0.06	0.294	0.778	0.882	0.89	0.891
Sales of space heating units - Electric Resistance	0.03	0.035	0.054	0.097	0.105	0.106	0.106
Sales of space heating units - Fossil	0.056	0.027	0.005	0	0	0	0
Sales of space heating units - Gas Furnace	0.904	0.879	0.646	0.124	0.013	0.004	0.004
Sales of water heating units - Electric Heat Pump	0.003	0.013	0.139	0.421	0.483	0.488	0.488
Sales of water heating units - Electric Resistance	0.03	0.042	0.166	0.444	0.505	0.51	0.51
Sales of water heating units - Gas Furnace	0.966	0.943	0.694	0.132	0.011	0	0
Sales of water heating units - Other	0.002	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	3.383	3.476	6.548	6.996	5.907	6.172

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	3.291	4.06	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.037	0.07	0.084	0.13	0.235	0.367	0.445
Sale of space heating units by type - Electric Resistance	0.134	0.19	0.187	0.179	0.16	0.137	0.125
Sale of space heating units by type - Fossil	0.095	0.164	0.163	0.155	0.14	0.123	0.111
Sale of space heating units by type - Gas	0.735	0.575	0.566	0.536	0.464	0.374	0.319
Sales of cooking units - Electric Resistance	0.509	0.522	0.567	0.685	0.85	0.952	0.987
Sales of cooking units - Gas	0.491	0.478	0.433	0.315	0.15	0.048	0.013
Sales of water heating units by type - Electric Heat Pump	0	0.002	0.008	0.027	0.073	0.133	0.17
Sales of water heating units by type - Electric Resistance	0.246	0.402	0.404	0.414	0.442	0.477	0.499
Sales of water heating units by type - Gas Furnace	0.754	0.594	0.587	0.558	0.483	0.389	0.33
Sales of water heating units by type - Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001

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	0.016	0.02	0.021	0.016	0.011	0.005	0.002
End-use technology sales by technology - LDV - EV	0.018	0.046	0.117	0.256	0.481	0.718	0.875
End-use technology sales by technology - LDV - gasoline	0.919	0.876	0.799	0.67	0.466	0.251	0.11
End-use technology sales by technology - LDV - hybrid	0.045	0.053	0.059	0.054	0.041	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	176958344	370079022	1251440797	3932731407	5731393830
Number of public EV charging plugs - DC Fast Charging	143	0	645.969	0	3344	0	9315.3
Number of public EV charging plugs - L2 Charging	459	0	15537.3	0	80432.6	0	224057.1

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	686.778
Carbon sink enhancement potential - All (not counting overlap)	53664.4
Carbon sink enhancement potential - Avoid deforestation	3331.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2456.68

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-6954.081
Carbon sink enhancement potential - Extend rotation length	13750.3
Carbon sink enhancement potential - Improve plantations	1591.738
Carbon sink enhancement potential - Increase retention of HWP	10607.3
Carbon sink enhancement potential - Increase trees outside forests	2764.6
Carbon sink enhancement potential - permanent conservation cover	-283.708
Carbon sink enhancement potential - Reforest cropland	3903
Carbon sink enhancement potential - Reforest pasture	9990.1
Carbon sink enhancement potential - Restore productivity	7039.4
Carbon sink enhancement potential - total	-9694.469
Land impacted for carbon sink enhancement - Accelerate regeneration	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	894.22
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	958.674
Land impacted for carbon sink enhancement - cropland measures	4974.7
Land impacted for carbon sink enhancement - Extend rotation length	7574.8
Land impacted for carbon sink enhancement - Improve plantations	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	779.88
Land impacted for carbon sink enhancement - permanent conservation cover	516.014
Land impacted for carbon sink enhancement - Reforest cropland	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	755.407
Land impacted for carbon sink enhancement - Restore productivity	3972.348
Land impacted for carbon sink enhancement - total	6449.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.194	0.191	0.186	0.183	0.179	0.175	0.171
Final energy demand by sector - industry	0.516	0.524	0.517	0.508	0.504	0.5	0.498
Final energy demand by sector - residential	0.247	0.23	0.218	0.208	0.197	0.184	0.171
Final energy demand by sector - transportation	0.509	0.478	0.433	0.396	0.369	0.336	0.297

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	19300705317	21084913983	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	0.009	0.043	0.057	0.1	0.202	0.331	0.409
Sales of space heating units - Electric Resistance	0.03	0.034	0.035	0.038	0.047	0.059	0.066
Sales of space heating units - Fossil	0.056	0.031	0.03	0.027	0.022	0.019	0.018
Sales of space heating units - Gas Furnace	0.904	0.892	0.879	0.835	0.728	0.591	0.507
Sales of water heating units - Electric Heat Pump	0.003	0.006	0.014	0.038	0.098	0.175	0.222
Sales of water heating units - Electric Resistance	0.03	0.035	0.042	0.066	0.125	0.201	0.247
Sales of water heating units - Gas Furnace	0.966	0.957	0.943	0.894	0.776	0.623	0.529
Sales of water heating units - Other	0.002	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	2.656	2.662	3.621	3.741	5.53	5.849

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	0.207	0.28	0.969	0.509	7.326
Power generation capital investment - Wind - Base	1.234	2.48	3.091	9.852	22.72	26.934

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	160.096	394.827	726.483	2236.1	7023.9	14604
HV transmission for wind and solar - base other intra-state	0	63.54	113.971	200.34	504.622	2172.7	4538
HV transmission for wind and solar - base spur intra-state	0	47.729	206.391	401.106	1044.9	3198.4	7155.4

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	686.778
Carbon sink enhancement potential - All (not counting overlap)	53664.4
Carbon sink enhancement potential - Avoid deforestation	3331.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2456.68
Carbon sink enhancement potential - cropland measures	-6954.081
Carbon sink enhancement potential - Extend rotation length	13750.3
Carbon sink enhancement potential - Improve plantations	1591.738
Carbon sink enhancement potential - Increase retention of HWP	10607.3
Carbon sink enhancement potential - Increase trees outside forests	2764.6
Carbon sink enhancement potential - permanent conservation cover	-283.708
Carbon sink enhancement potential - Reforest cropland	3903
Carbon sink enhancement potential - Reforest pasture	9990.1
Carbon sink enhancement potential - Restore productivity	7039.4
Carbon sink enhancement potential - total	-9694.469
Land impacted for carbon sink enhancement - Accelerate regeneration	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	894.22
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	958.674
Land impacted for carbon sink enhancement - cropland measures	4974.7
Land impacted for carbon sink enhancement - Extend rotation length	7574.8
Land impacted for carbon sink enhancement - Improve plantations	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	779.88
Land impacted for carbon sink enhancement - permanent conservation cover	516.014
Land impacted for carbon sink enhancement - Reforest cropland	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	755.407
Land impacted for carbon sink enhancement - Restore productivity	3972.348
Land impacted for carbon sink enhancement - total	6449.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457

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	0	0	1.917	3.475
Capital investment	0	0	0	0	0	0	37.763
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	25	28
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	16
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	0	0	27.77	31.15
Annual - BECCS	0	0	0	0	27.77	31.15
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	27.77	58.92
Cumulative - BECCS	0	0	0	0	27.77	58.92
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0	0	0	0

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

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

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	0	0	0	928519.486	788306.658
CO2 pipelines - Spur	0	0	0	0	928519.486	788306.658
CO2 pipelines - Trunk	0	0	0	0	0	0

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	686.778
Carbon sink enhancement potential - All (not counting overlap)	53664.4
Carbon sink enhancement potential - Avoid deforestation	3331.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-3142.328
Carbon sink enhancement potential - cropland measures	-6301.966
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	13750.3
Carbon sink enhancement potential - Improve plantations	1591.738
Carbon sink enhancement potential - Increase retention of HWP	10607.3
Carbon sink enhancement potential - Increase trees outside forests	2764.6
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-255.459
Carbon sink enhancement potential - Reforest cropland	3903
Carbon sink enhancement potential - Reforest pasture	9990.1
Carbon sink enhancement potential - Restore productivity	7039.4
Carbon sink enhancement potential - total	-9699.751
Land impacted for carbon sink enhancement - Accelerate regeneration	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	894.22
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	1596.882
Land impacted for carbon sink enhancement - cropland measures	8838.8

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	67.228
Land impacted for carbon sink enhancement - Extend rotation length	7574.8
Land impacted for carbon sink enhancement - Improve plantations	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	779.88
Land impacted for carbon sink enhancement - pasture to energy crops	274.738
Land impacted for carbon sink enhancement - permanent conservation cover	464.632
Land impacted for carbon sink enhancement - Reforest cropland	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	755.407
Land impacted for carbon sink enhancement - Restore productivity	3972.348
Land impacted for carbon sink enhancement - total	11242.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	686.778
Carbon sink enhancement potential - All (not counting overlap)	53664.4
Carbon sink enhancement potential - Avoid deforestation	3331.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2456.68
Carbon sink enhancement potential - cropland measures	-6954.081
Carbon sink enhancement potential - Extend rotation length	13750.3
Carbon sink enhancement potential - Improve plantations	1591.738
Carbon sink enhancement potential - Increase retention of HWP	10607.3
Carbon sink enhancement potential - Increase trees outside forests	2764.6
Carbon sink enhancement potential - permanent conservation cover	-283.708
Carbon sink enhancement potential - Reforest cropland	3903
Carbon sink enhancement potential - Reforest pasture	9990.1
Carbon sink enhancement potential - Restore productivity	7039.4
Carbon sink enhancement potential - total	-9694.469
Land impacted for carbon sink enhancement - Accelerate regeneration	276.797
Land impacted for carbon sink enhancement - All (not counting overlap)	9861.1
Land impacted for carbon sink enhancement - Avoid deforestation	894.22
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	958.674
Land impacted for carbon sink enhancement - cropland measures	4974.7
Land impacted for carbon sink enhancement - Extend rotation length	7574.8
Land impacted for carbon sink enhancement - Improve plantations	884.653
Land impacted for carbon sink enhancement - Increase retention of HWP	2121.5
Land impacted for carbon sink enhancement - Increase trees outside forests	779.88
Land impacted for carbon sink enhancement - permanent conservation cover	516.014
Land impacted for carbon sink enhancement - Reforest cropland	1299.421
Land impacted for carbon sink enhancement - Reforest pasture	755.407
Land impacted for carbon sink enhancement - Restore productivity	3972.348
Land impacted for carbon sink enhancement - total	6449.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8698

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	64.185
Business-as-usual carbon sink - Avoid deforestation	284.857
Business-as-usual carbon sink - Extend rotation length	4143.9
Business-as-usual carbon sink - Improve plantations	335.945
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	156.801
Business-as-usual carbon sink - Reforest cropland	147.457
Business-as-usual carbon sink - Reforest pasture	184.546
Business-as-usual carbon sink - Restore productivity	1398.4
Business-as-usual carbon sink - Total impacted (over 30 years)	147.457