Net-Zero America - missouri 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	5.537	5.983	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.049	0.296	0.308	0.326	0.341	0.357	0.376
Sale of space heating units by type - Electric Resistance	0.204	0.208	0.203	0.198	0.194	0.18	0.159
Sale of space heating units by type - Fossil	0.095	0.109	0.111	0.111	0.106	0.102	0.106
Sale of space heating units by type - Gas	0.652	0.387	0.378	0.364	0.358	0.36	0.36
Sales of cooking units - Electric Resistance	0.762	0.762	0.762	0.762	0.762	0.762	0.762
Sales of cooking units - Gas	0.238	0.238	0.238	0.238	0.238	0.238	0.238
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	0.425	0.58	0.579	0.577	0.577	0.576	0.575
Sales of water heating units by type - Gas Furnace	0.574	0.42	0.421	0.423	0.423	0.424	0.424
Sales of water heating units by type - Other	0	0	0	0	0	0	0

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	0.054	0.062	0.076	0.093	0.108	0.119
End-use technology sales by technology - LDV - gasoline	0.904	0.869	0.848	0.83	0.81	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	286.571
Carbon sink enhancement potential - All (not counting overlap)	0	0	83586.9
Carbon sink enhancement potential - Avoid deforestation	0	0	3600
Carbon sink enhancement potential - Extend rotation length	0	0	13097.5
Carbon sink enhancement potential - Improve plantations	0	0	264.084
Carbon sink enhancement potential - Increase retention of HWP	0	0	5353.3
Carbon sink enhancement potential - Increase trees outside forests	0	0	3764.5
Carbon sink enhancement potential - Reforest cropland	0	0	18647.4
Carbon sink enhancement potential - Reforest pasture	0	0	32417.3
Carbon sink enhancement potential - Restore productivity	0	0	6156.2
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	966.382
Land impacted for carbon sink enhancement - Extend rotation length	0	0	7215.1
Land impacted for carbon sink enhancement - Improve plantations	0	0	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	1061.927
Land impacted for carbon sink enhancement - Natural uptake	-4.2	-13.41	-11.991
Land impacted for carbon sink enhancement - Reforest cropland	0	0	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	0	0	2451.247
Land impacted for carbon sink enhancement - Restore productivity	0	0	3474.093
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.874	-1.572	-1.634
Land impacted for carbon sink enhancement - Total	-5.074	-14.982	-13.625
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736

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	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.182	0.183	0.183	0.181	0.179	0.181	0.187
Final energy demand by sector - industry	0.241	0.258	0.268	0.276	0.288	0.303	0.318
Final energy demand by sector - residential	0.241	0.227	0.219	0.214	0.212	0.213	0.214
Final energy demand by sector - transportation	0.67	0.629	0.58	0.552	0.553	0.571	0.593

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	16080421451	16491244547	0	0	0	0
Sales of cooking units - Electric Resistance	0.448	0.478	0.479	0.478	0.479	0.479	0.48
Sales of cooking units - Gas	0.552	0.522	0.521	0.522	0.521	0.521	0.52
Sales of space heating units - Electric Heat Pump	0.045	0.205	0.483	0.711	0.748	0.752	0.752
Sales of space heating units - Electric Resistance	0.081	0.064	0.108	0.184	0.235	0.242	0.243
Sales of space heating units - Fossil	0	0.02	0.016	0.007	0.001	0	0
Sales of space heating units - Gas Furnace	0.874	0.711	0.393	0.098	0.016	0.005	0.005
Sales of water heating units - Electric Heat Pump	0.012	0.008	0.008	0.008	0.008	0.008	0.008
Sales of water heating units - Electric Resistance	0.101	0.071	0.071	0.07	0.071	0.071	0.07
Sales of water heating units - Gas Furnace	0.877	0.911	0.911	0.911	0.911	0.911	0.911
Sales of water heating units - Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01

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	3.46	3.524	3.751	3.834	4.564	4.724

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	5.849	7.793	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.075	0.225	0.723	0.861	0.875	0.878	0.874
Sale of space heating units by type - Electric Resistance	0.197	0.224	0.1	0.066	0.064	0.065	0.067
Sale of space heating units by type - Fossil	0.093	0.136	0.074	0.056	0.05	0.046	0.049
Sale of space heating units by type - Gas	0.635	0.414	0.102	0.017	0.011	0.01	0.01
Sales of cooking units - Electric Resistance	0.765	0.815	0.968	0.998	1	1	1
Sales of cooking units - Gas	0.235	0.185	0.032	0.002	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.087	0.465	0.561	0.567	0.567	0.567
Sales of water heating units by type - Electric Resistance	0.425	0.555	0.453	0.433	0.433	0.433	0.433
Sales of water heating units by type - Gas Furnace	0.574	0.357	0.082	0.006	0	0	0
Sales of water heating units by type - Other	0	0	0	0	0	0	0

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	0.785	0.494	0.168	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	1054881826	2704266902	4381361187	6637234066	7223388887	6887286314
Number of public EV charging plugs - DC Fast Charging	178	0	1975.7	0	8667.2	0	14014.4
Number of public EV charging plugs - L2 Charging	1667	0	47515.8	0	208447.1	0	337048.3

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	0.003	0.021	0	0.003	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0.009	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	1.19	0.005	0
Power generation capital investment - Solar PV - Base	0	13.161	10.576	18.568	20.997	5.544	2.173
Power generation capital investment - Solar PV - Constrained	0	9.585	11.588	13.909	23.729	1.244	0.374
Power generation capital investment - Wind - Base	0	28.545	22.775	21.992	35.194	34.684	36.581
Power generation capital investment - Wind - Constrained	0	31.58	32.496	34.536	16.18	1.978	80.415

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	5.967	46.376	46.376	52.398	52.398	52.398
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	0	9.079	9.079
Power generation by technology - biomass w/ccu power plant	0	0	0	0	1335.3	1341.3	1341.3

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	4240.1	9975.1	17834.9	30588.2	43135.4	56961
HV transmission for wind and solar - base other intra-state	0	1916.8	4515.4	7733.5	14349.5	20694.5	24904.1
HV transmission for wind and solar - base spur intra-state	0	1760.2	3664.6	6097.7	9660.7	12912.2	16237.9
HV transmission for wind and solar - constrained all	0	10162.1	23137.1	39613.2	50687.3	53983.3	56872.8
HV transmission for wind and solar - constrained other intra-state	0	3077.9	7529.6	12415.4	15114.2	15720.6	15724.5
HV transmission for wind and solar - constrained spur intra-state	0	2089.9	4662.7	8227.8	10138	10478.4	10546.2

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0.036	0.091	0.092	0.181	0.281	0.618
Capital investment	0	0	0.025	0	1.625	0	7.667
Number of facilities - allam power w ccu	0	0	0	0	0	1	1
Number of facilities - beccs hydrogen	0	0	0	0	1	4	11
Number of facilities - diesel	0	0	0	1	1	1	1
Number of facilities - diesel ccu	0	0	0	0	0	1	1
Number of facilities - power	0	1	1	1	1	1	1
Number of facilities - power ccu	0	0	0	0	1	2	2
Number of facilities - pyrolysis	0	0	0	1	1	1	1
Number of facilities - pyrolysis ccu	0	0	0	0	1	2	2
Number of facilities - sng	0	1	1	1	1	1	1
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 14: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	3.24	3.35	5.37	14.72	23.1
Annual - BECCS	0	0	0	2.05	4.46	12.5
Annual - Cement	0	3.24	3.35	3.32	10.26	10.6
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	3.24	6.59	11.96	26.68	49.78
Cumulative - BECCS	0	0	0	2.05	6.51	19.01
Cumulative - Cement	0	3.24	6.59	9.91	20.17	30.77
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	0.88	1.81	3.44	3.73
Injection wells	0	1	2	4	7	9
Resource characterization, appraisal and permitting costs cumulative	27.92	78.18	100.52	100.52	100.52	100.52
Wells and facilities construction costs cumulative	0	18.59	72.46	129.13	215.91	268.06

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1961943.533	2109868.929	2192763.324	2337711.359	2846580.4
CO2 pipelines - Spur	0	11872.663	159797.26	242692.454	387639.789	896509.1
CO2 pipelines - Trunk	0	1950071.17	1950071.17	1950071.17	1950071.17	1950071.17

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	440.655	441.265	515.343	610.029	544.87	437.92	734.281
Jobs by economic sector - construction	6440.4	24231.6	29824.5	40936.2	53854.6	53147.9	58829.6
Jobs by economic sector - manufacturing	3859.6	8268.1	10342.4	13919.6	14930.3	13555.4	17080.1

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	3110.5	2223.6	1583.9	1072.7	698.516	467.95	322.472
Jobs by economic sector - other	471.865	3011.1	3743.7	6019.9	8467.5	7691.2	8637
Jobs by economic sector - pipeline	412.139	404.295	503.752	279.164	220.654	179.473	216.63
Jobs by economic sector - professional	3980.2	12914.4	16867.3	23916.3	32989.4	36250	42699
Jobs by economic sector - trade	3601.3	7818.5	9644.3	13647.8	18885.6	20378.6	24221.4
Jobs by economic sector - utilities	7430.4	14201.3	19173.4	26240.3	37257.6	42240.7	49482.1
Jobs by resource sector - Biomass	1070.1	1041.7	1210.5	1474.3	1485.8	1617.5	3207.2
Jobs by resource sector - CO2	0	14.747	1317.8	91.331	194.166	437.998	1118.1
Jobs by resource sector - Coal	3712.7	1494.7	345.434	150.947	131.902	118.846	104.554
Jobs by resource sector - Grid	8652.1	21308.9	31637.9	47437.5	69140.8	80149.2	94228.8
Jobs by resource sector - Natural Gas	3259.6	3513.4	2388.1	2008	2339.8	1044.6	796.329
Jobs by resource sector - Nuclear	633.965	623.744	613.783	356.019	0	0	0
Jobs by resource sector - Oil	6239.2	5419	4356.2	3168.5	2194.9	1500.2	1003
Jobs by resource sector - Solar	2255.5	18264	19292.4	31168.1	39241.4	26324.8	26730.1
Jobs by resource sector - Wind	3923.9	21833.9	31036.4	40787.2	53120.1	63155.9	75034.3
Median wages - All	58615.6	58824.5	59744.1	60424.3	61583.1	63065.4	64083
Required Level of Education - Associates degree or some college	9098.7	23298.5	29432.3	40627.1	54160.7	56337.6	65292.9
Required Level of Education - Bachelors degree	6380.2	14947.9	18744.8	25637	34101.9	36077.9	42174.9
Required Level of Education - Doctoral degree	218.184	605.363	766.288	1062.1	1435.3	1541.8	1802.6
Required Level of Education - High school diploma or less	12511.6	30892.7	38475.6	52721.4	69260.1	70862.5	81787.7
Required Level of Education - Masters or professional degree	1538.5	3769.7	4779.6	6594.3	8890.9	9529.2	11164.4
Wage income - All	1743738523	4324945916	5508972673	7653283829	10338138022	10996823210	12960677155

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	286.571
Carbon sink enhancement potential - All (not counting overlap)	83586.9
Carbon sink enhancement potential - Avoid deforestation	3600
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-20563.054
Carbon sink enhancement potential - Extend rotation length	13097.5
Carbon sink enhancement potential - Improve plantations	264.084
Carbon sink enhancement potential - Increase retention of HWP	5353.3
Carbon sink enhancement potential - Increase trees outside forests	3764.5
Carbon sink enhancement potential - permanent conservation cover	-470.136
Carbon sink enhancement potential - Reforest cropland	18647.4
Carbon sink enhancement potential - Reforest pasture	32417.3
Carbon sink enhancement potential - Restore productivity	6156.2
Carbon sink enhancement potential - total	-21033.188
Land impacted for carbon sink enhancement - Accelerate regeneration	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	966.382
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	8764.1
Land impacted for carbon sink enhancement - Extend rotation length	7215.1
Land impacted for carbon sink enhancement - Improve plantations	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	1061.927
Land impacted for carbon sink enhancement - permanent conservation cover	855.091
Land impacted for carbon sink enhancement - Reforest cropland	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	2451.247
Land impacted for carbon sink enhancement - Restore productivity	3474.093
Land impacted for carbon sink enhancement - total	9619.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	245665.2	249313.6	210157.3	168554.8	126885.6	79832.1	55369.5
Oil consumption	127544.8	121411.5	106303.6	83653.8	62376.8	45611.6	32478.8

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.182	0.178	0.169	0.158	0.147	0.141	0.138
Final energy demand by sector - industry	0.241	0.249	0.271	0.274	0.29	0.326	0.33
Final energy demand by sector - residential	0.241	0.227	0.206	0.178	0.155	0.141	0.134
Final energy demand by sector - transportation	0.669	0.623	0.55	0.461	0.38	0.331	0.311

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	16268519258	17610702207	0	0	0	0
Sales of cooking units - Electric Resistance	0.448	0.571	0.84	0.893	0.896	0.896	0.896
Sales of cooking units - Gas	0.552	0.429	0.16	0.107	0.104	0.104	0.104
Sales of space heating units - Electric Heat Pump	0.045	0.244	0.706	0.877	0.897	0.897	0.897
Sales of space heating units - Electric Resistance	0.081	0.057	0.071	0.093	0.098	0.098	0.098
Sales of space heating units - Fossil	0	0.017	0.003	0	0	0	0
Sales of space heating units - Gas Furnace	0.874	0.681	0.22	0.029	0.006	0.005	0.005
Sales of water heating units - Electric Heat Pump	0.012	0.106	0.531	0.642	0.65	0.65	0.65
Sales of water heating units - Electric Resistance	0.101	0.11	0.284	0.338	0.343	0.343	0.343
Sales of water heating units - Gas Furnace	0.877	0.775	0.178	0.013	0	0	0
Sales of water heating units - Other	0.01	0.009	0.007	0.007	0.007	0.007	0.007

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	3.816	3.922	6.231	6.599	6.191	6.467

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	5.808	7.681	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.075	0.13	0.187	0.352	0.611	0.79	0.852
Sale of space heating units by type - Electric Resistance	0.197	0.248	0.233	0.192	0.128	0.085	0.07
Sale of space heating units by type - Fossil	0.093	0.149	0.144	0.122	0.085	0.058	0.052
Sale of space heating units by type - Gas	0.635	0.473	0.437	0.335	0.176	0.067	0.025
Sales of cooking units - Electric Resistance	0.764	0.77	0.792	0.849	0.928	0.977	0.994
Sales of cooking units - Gas	0.236	0.23	0.208	0.151	0.072	0.023	0.006
Sales of water heating units by type - Electric Heat Pump	0	0.015	0.058	0.182	0.375	0.504	0.55
Sales of water heating units by type - Electric Resistance	0.425	0.575	0.563	0.529	0.478	0.447	0.436
Sales of water heating units by type - Gas Furnace	0.574	0.409	0.378	0.289	0.147	0.049	0.013
Sales of water heating units by type - Other	0	0	0	0	0	0	0

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	0.255	0.48	0.718	0.875
End-use technology sales by technology - LDV - gasoline	0.919	0.877	0.799	0.671	0.466	0.251	0.111
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	170723305	358562649	1211022960	3810349975	5551438385
Number of public EV charging plugs - DC Fast Charging	178	0	611.387	0	3214.7	0	8976.2
Number of public EV charging plugs - L2 Charging	1667	0	14704	0	77313.5	0	215879.2

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	286.571
Carbon sink enhancement potential - All (not counting overlap)	83586.9
Carbon sink enhancement potential - Avoid deforestation	3600
Carbon sink enhancement potential - corn-ethanol to energy grasses	0

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-20563.054
Carbon sink enhancement potential - Extend rotation length	13097.5
Carbon sink enhancement potential - Improve plantations	264.084
Carbon sink enhancement potential - Increase retention of HWP	5353.3
Carbon sink enhancement potential - Increase trees outside forests	3764.5
Carbon sink enhancement potential - permanent conservation cover	-470.136
Carbon sink enhancement potential - Reforest cropland	18647.4
Carbon sink enhancement potential - Reforest pasture	32417.3
Carbon sink enhancement potential - Restore productivity	6156.2
Carbon sink enhancement potential - total	-21033.188
Land impacted for carbon sink enhancement - Accelerate regeneration	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	966.382
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	8764.1
Land impacted for carbon sink enhancement - Extend rotation length	7215.1
Land impacted for carbon sink enhancement - Improve plantations	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	1061.927
Land impacted for carbon sink enhancement - permanent conservation cover	855.091
Land impacted for carbon sink enhancement - Reforest cropland	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	2451.247
Land impacted for carbon sink enhancement - Restore productivity	3474.093
Land impacted for carbon sink enhancement - total	9619.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.182	0.179	0.174	0.169	0.162	0.155	0.149
Final energy demand by sector - industry	0.241	0.25	0.272	0.277	0.295	0.331	0.335
Final energy demand by sector - residential	0.241	0.228	0.218	0.206	0.189	0.17	0.154
Final energy demand by sector - transportation	0.67	0.628	0.574	0.531	0.498	0.459	0.413

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	16265767787	17675389892	0	0	0	0
Sales of cooking units - Electric Resistance	0.448	0.493	0.531	0.63	0.769	0.855	0.885
Sales of cooking units - Gas	0.552	0.507	0.469	0.37	0.231	0.145	0.115
Sales of space heating units - Electric Heat Pump	0.045	0.159	0.212	0.366	0.613	0.795	0.868
Sales of space heating units - Electric Resistance	0.081	0.056	0.057	0.062	0.074	0.087	0.095
Sales of space heating units - Fossil	0	0.02	0.019	0.014	0.007	0.002	0.001
Sales of space heating units - Gas Furnace	0.874	0.765	0.711	0.557	0.306	0.116	0.036
Sales of water heating units - Electric Heat Pump	0.012	0.025	0.074	0.213	0.431	0.577	0.63
Sales of water heating units - Electric Resistance	0.101	0.078	0.097	0.155	0.246	0.31	0.334
Sales of water heating units - Gas Furnace	0.877	0.887	0.819	0.623	0.316	0.106	0.029
Sales of water heating units - Other	0.01	0.01	0.01	0.009	0.008	0.007	0.007

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	3.198	3.23	3.901	4.009	5.794	6.102

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	11.773	14.429	21.075	17.773	44.816	27.453
Power generation capital investment - Wind - Base	28.991	22.746	41.108	51.779	57.205	30.307

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	4225.5	10283.6	22227.4	40270.4	69021.2	88038.9
HV transmission for wind and solar - base other intra-state	0	2032.3	4922.8	11682.1	22235.3	37889.6	46194
HV transmission for wind and solar - base spur intra-state	0	1804.2	3983.8	7673.2	12729.1	20491	25236.7

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	286.571
Carbon sink enhancement potential - All (not counting overlap)	83586.9
Carbon sink enhancement potential - Avoid deforestation	3600
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-20563.054
Carbon sink enhancement potential - Extend rotation length	13097.5
Carbon sink enhancement potential - Improve plantations	264.084
Carbon sink enhancement potential - Increase retention of HWP	5353.3
Carbon sink enhancement potential - Increase trees outside forests	3764.5
Carbon sink enhancement potential - permanent conservation cover	-470.136
Carbon sink enhancement potential - Reforest cropland	18647.4
Carbon sink enhancement potential - Reforest pasture	32417.3
Carbon sink enhancement potential - Restore productivity	6156.2
Carbon sink enhancement potential - total	-21033.188
Land impacted for carbon sink enhancement - Accelerate regeneration	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	966.382
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	8764.1
Land impacted for carbon sink enhancement - Extend rotation length	7215.1
Land impacted for carbon sink enhancement - Improve plantations	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	1061.927
Land impacted for carbon sink enhancement - permanent conservation cover	855.091
Land impacted for carbon sink enhancement - Reforest cropland	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	2451.247
Land impacted for carbon sink enhancement - Restore productivity	3474.093
Land impacted for carbon sink enhancement - total	9619.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506

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	0.01	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	3.669	21.922	3.217

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	9.64	9.64
Power generation by technology - biomass w/ccu power plant	0	0	0	0	4118.4	28722.6	32332.7

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0.517	1.013	3.126	3.583
Capital investment	0	0	0	0	11.522	0	31.166
Number of facilities - allam power w ccu	0	0	0	0	0	1	1
Number of facilities - beccs hydrogen	0	0	0	7	10	18	21
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	1	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	3	23	26
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	1	1	2
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	3.24	11.07	18.77	59.26	66.51
Annual - BECCS	0	0	7.72	15.46	49	55.91
Annual - Cement	0	3.24	3.35	3.32	10.26	10.6
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	3.24	14.31	33.08	92.34	158.85
Cumulative - BECCS	0	0	7.72	23.18	72.18	128.09
Cumulative - Cement	0	3.24	6.59	9.91	20.17	30.77
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	7.13	10.83	10.87
Injection wells	0	2	7	13	22	27
Resource characterization, appraisal and permitting costs cumulative	27.92	122.86	189.87	189.87	189.87	189.87
Wells and facilities construction costs cumulative	0	55.78	217.37	387.38	647.73	804.17

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1961943.533	2301337.324	2696055.155	4824520.4	5268648.4
CO2 pipelines - Spur	0	11872.663	351266.454	550472.086	2678937.2	3123065.2
CO2 pipelines - Trunk	0	1950071.17	1950071.17	2145583.17	2145583.17	2145583.17

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	286.571
Carbon sink enhancement potential - All (not counting overlap)	83586.9
Carbon sink enhancement potential - Avoid deforestation	3600
Carbon sink enhancement potential - corn-ethanol to energy grasses	-2144.344
Carbon sink enhancement potential - cropland measures	-18821.389
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	13097.5
Carbon sink enhancement potential - Improve plantations	264.084
Carbon sink enhancement potential - Increase retention of HWP	5353.3
Carbon sink enhancement potential - Increase trees outside forests	3764.5
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-426.556
Carbon sink enhancement potential - Reforest cropland	18647.4
Carbon sink enhancement potential - Reforest pasture	32417.3
Carbon sink enhancement potential - Restore productivity	6156.2
Carbon sink enhancement potential - total	-21392.289
Land impacted for carbon sink enhancement - Accelerate regeneration	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	966.382
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	994.798
Land impacted for carbon sink enhancement - cropland measures	15783

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	584.476
Land impacted for carbon sink enhancement - Extend rotation length	7215.1
Land impacted for carbon sink enhancement - Improve plantations	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	1061.927
Land impacted for carbon sink enhancement - pasture to energy crops	1958.038
Land impacted for carbon sink enhancement - permanent conservation cover	775.828
Land impacted for carbon sink enhancement - Reforest cropland	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	2451.247
Land impacted for carbon sink enhancement - Restore productivity	3474.093
Land impacted for carbon sink enhancement - total	20096.1
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	286.571
Carbon sink enhancement potential - All (not counting overlap)	83586.9
Carbon sink enhancement potential - Avoid deforestation	3600
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-20563.054
Carbon sink enhancement potential - Extend rotation length	13097.5
Carbon sink enhancement potential - Improve plantations	264.084
Carbon sink enhancement potential - Increase retention of HWP	5353.3
Carbon sink enhancement potential - Increase trees outside forests	3764.5
Carbon sink enhancement potential - permanent conservation cover	-470.136
Carbon sink enhancement potential - Reforest cropland	18647.4
Carbon sink enhancement potential - Reforest pasture	32417.3
Carbon sink enhancement potential - Restore productivity	6156.2
Carbon sink enhancement potential - total	-21033.188
Land impacted for carbon sink enhancement - Accelerate regeneration	115.499
Land impacted for carbon sink enhancement - All (not counting overlap)	13536.8
Land impacted for carbon sink enhancement - Avoid deforestation	966.382
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	8764.1
Land impacted for carbon sink enhancement - Extend rotation length	7215.1
Land impacted for carbon sink enhancement - Improve plantations	146.772
Land impacted for carbon sink enhancement - Increase retention of HWP	1070.7
Land impacted for carbon sink enhancement - Increase trees outside forests	1061.927
Land impacted for carbon sink enhancement - permanent conservation cover	855.091
Land impacted for carbon sink enhancement - Reforest cropland	6208.432
Land impacted for carbon sink enhancement - Reforest pasture	2451.247
Land impacted for carbon sink enhancement - Restore productivity	3474.093
Land impacted for carbon sink enhancement - total	9619.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	9173.3

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	26.782
Business-as-usual carbon sink - Avoid deforestation	307.844
Business-as-usual carbon sink - Extend rotation length	3947.2
Business-as-usual carbon sink - Improve plantations	55.736
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	213.509
Business-as-usual carbon sink - Reforest cropland	704.506
Business-as-usual carbon sink - Reforest pasture	598.842
Business-as-usual carbon sink - Restore productivity	1223
Business-as-usual carbon sink - Total impacted (over 30 years)	704.506