Net-Zero America - wyoming state report v2

Larson et al. 2020

February 2021

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	0.191	0.192	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.046	0.146	0.149	0.155	0.161	0.166	0.172
Sale of space heating units by type - Electric Resistance	0.091	0.153	0.151	0.151	0.151	0.146	0.14
Sale of space heating units by type - Fossil	0.153	0.162	0.165	0.153	0.14	0.142	0.142
Sale of space heating units by type - Gas	0.709	0.538	0.534	0.54	0.548	0.546	0.545
Sales of cooking units - Electric Resistance	0.372	0.372	0.372	0.372	0.372	0.372	0.372
Sales of cooking units - Gas	0.628	0.628	0.628	0.628	0.628	0.628	0.628
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	0.122	0.244	0.247	0.25	0.254	0.256	0.258
Sales of water heating units by type - Gas Furnace	0.871	0.747	0.744	0.741	0.737	0.736	0.733
Sales of water heating units by type - Other	0.007	0.008	0.009	0.009	0.009	0.009	0.009

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	0.021	0.024	0.023	0.021	0.019	0.018	0.017
End-use technology sales by technology - LDV - EV	0.017	0.033	0.037	0.044	0.055	0.066	0.077
End-use technology sales by technology - LDV - gasoline	0.933	0.901	0.891	0.88	0.864	0.846	0.828
End-use technology sales by technology - LDV - hybrid	0.026	0.036	0.044	0.05	0.057	0.065	0.073
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.004	0.003	0.003	0.004	0.004
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	3409.4
Carbon sink enhancement potential - All (not counting overlap)	0	0	22171.6
Carbon sink enhancement potential - Avoid deforestation	0	0	1094.807
Carbon sink enhancement potential - Extend rotation length	0	0	4071.2
Carbon sink enhancement potential - Improve plantations	0	0	50.325
Carbon sink enhancement potential - Increase retention of HWP	0	0	400.207
Carbon sink enhancement potential - Increase trees outside forests	0	0	644.177
Carbon sink enhancement potential - Reforest cropland	0	0	4158.3
Carbon sink enhancement potential - Reforest pasture	0	0	2935.9
Carbon sink enhancement potential - Restore productivity	0	0	5407.3
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	293.886
Land impacted for carbon sink enhancement - Extend rotation length	0	0	2242.738
Land impacted for carbon sink enhancement - Improve plantations	0	0	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	181.715
Land impacted for carbon sink enhancement - Natural uptake	29.01	1.956	0.561
Land impacted for carbon sink enhancement - Reforest cropland	0	0	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	0	0	222
Land impacted for carbon sink enhancement - Restore productivity	0	0	3051.371
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.065	-0.136	-0.143
Land impacted for carbon sink enhancement - Total	28.945	1.82	0.418
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621

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	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.024	0.024	0.025	0.025	0.025	0.025	0.026
Final energy demand by sector - industry	0.091	0.098	0.1	0.103	0.106	0.111	0.116
Final energy demand by sector - residential	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Final energy demand by sector - transportation	0.1	0.094	0.086	0.082	0.082	0.084	0.087

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	1732450819	1819429988	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.447	0.447	0.446	0.444	0.445	0.446
Sales of cooking units - Gas	0.581	0.553	0.553	0.554	0.556	0.555	0.554
Sales of space heating units - Electric Heat Pump	0.015	0.134	0.453	0.725	0.774	0.781	0.781
Sales of space heating units - Electric Resistance	0.015	0.043	0.091	0.163	0.207	0.214	0.214
Sales of space heating units - Fossil	0	0.002	0.001	0	0	0	0
Sales of space heating units - Gas Furnace	0.971	0.82	0.455	0.112	0.019	0.006	0.005
Sales of water heating units - Electric Heat Pump	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance	0.007	0.015	0.015	0.015	0.015	0.015	0.015
Sales of water heating units - Gas Furnace	0.992	0.981	0.981	0.981	0.981	0.981	0.981
Sales of water heating units - Other	0.002	0.004	0.004	0.004	0.004	0.004	0.004

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	0.451	0.465	0.504	0.521	0.589	0.612

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	0.195	0.209	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.051	0.125	0.352	0.82	0.929	0.94	0.939
Sale of space heating units by type - Electric Resistance	0.09	0.157	0.126	0.059	0.043	0.041	0.042
Sale of space heating units by type - Fossil	0.152	0.173	0.126	0.024	0.002	0	0
Sale of space heating units by type - Gas	0.706	0.546	0.396	0.098	0.026	0.019	0.019
Sales of cooking units - Electric Resistance	0.38	0.512	0.917	0.996	1	1	1
Sales of cooking units - Gas	0.62	0.488	0.083	0.004	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.008	0.114	0.355	0.41	0.414	0.414
Sales of water heating units by type - Electric Resistance	0.122	0.251	0.335	0.524	0.571	0.576	0.577
Sales of water heating units by type - Gas Furnace	0.871	0.733	0.542	0.113	0.01	0	0
Sales of water heating units by type - Other	0.007	0.008	0.009	0.009	0.009	0.009	0.009

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	0.021	0.023	0.015	0.005	0.001	0	0
End-use technology sales by technology - LDV - EV	0.021	0.097	0.375	0.782	0.959	0.993	1
End-use technology sales by technology - LDV - gasoline	0.929	0.843	0.581	0.202	0.038	0.006	0
End-use technology sales by technology - LDV - hybrid	0.026	0.033	0.026	0.01	0.002	0	0
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	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	161105949	411278076	669139741	1012554385	1103186056	1051199499
Number of public EV charging plugs - DC Fast Charging	67	0	334.73	0	1494.4	0	2421
Number of public EV charging plugs - L2 Charging	87	0	8090.7	0	36119.9	0	58518.2

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	0.302
Power generation capital investment - Wind - Base	0	1.38	9.974	7.607	10.74	7.235	3.438
Power generation capital investment - Wind - Constrained	0	6.489	5.038	2.638	3.927	3.26	2.021

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	338.903

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	812.337	2637.2	5559.1	8499.3	10410.5	11305.3
HV transmission for wind and solar - base other intra-state	0	0	0	0	0	0	0
HV transmission for wind and solar - base spur intra-state	0	304.84	1085.8	1678	2524.4	3100.3	3513.9
HV transmission for wind and solar - constrained all	0	826.911	1949.7	2840.4	3781.3	4733.9	5272.5
HV transmission for wind and solar - constrained other intra-state	0	0	0	0	0	0	0
HV transmission for wind and solar - constrained spur intra-state	0	301.91	629.403	870.284	1183.1	1501.3	1634

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	0.016
Capital investment	0	0	0	0	0	0	0.261
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	0	0
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	0	0
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	0	0	1
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

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

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	0	0	0	0.32
Annual - BECCS	0	0	0	0	0	0.32
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	0.32
Cumulative - BECCS	0	0	0	0	0	0.32
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	13748.394	14843.594	52736.494	14839.994	117047.852
CO2 pipelines - Spur	0	13748.394	14843.594	52736.494	14839.994	117047.852
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	0	0	0	0	0	0	15.229
Jobs by economic sector - construction	5579.1	6006.9	8230.2	9850.3	11769.4	12142.5	11338.3
Jobs by economic sector - manufacturing	6686.8	6303.7	7764.3	8870.4	8021.8	6909.4	6810.2
Jobs by economic sector - mining	13501	9381.2	6651.1	5046.4	3291	2068	1101.9
Jobs by economic sector - other	263.172	301.03	533.187	739.052	1018	1170.6	1209.8
Jobs by economic sector - pipeline	706.347	729.998	662.891	582.235	451.563	328.354	218.358

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - professional	4766.6	4586.9	5950.3	7183.3	8785.6	9437	9203.6
Jobs by economic sector - trade	9934.7	5530.3	4607.8	5011.3	5493.6	5658.7	5395.6
Jobs by economic sector - utilities	5052.3	4536.6	5684.9	7196	9489.1	10097	9659.6
Jobs by resource sector - Biomass	0	0	0	0	0	0	65.032
Jobs by resource sector - CO2	0	0	0	14.597	17.793	18.06	99.91
Jobs by resource sector - Coal	12945.7	3817.1	363.621	192.916	142.403	110.379	92.313
Jobs by resource sector - Grid	4435.9	4061.1	7284	10870.8	15253.8	16972.4	16761.7
Jobs by resource sector - Natural Gas	11300.2	10720.7	8700.5	6671.9	5461.9	3799.5	2338.8
Jobs by resource sector - Nuclear	0	0	0	0	0	0	0
Jobs by resource sector - Oil	12187.5	11813.5	10701.4	9640.7	7043	5295.7	3313.2
Jobs by resource sector - Solar	1612.4	1037.8	1396.1	2498.4	2528.2	2589.3	3245.4
Jobs by resource sector - Wind	4008.3	5926.3	11639	14589.7	17872.9	19026.1	19036.2
Median wages - All	61418	63265.9	63772.4	64191.2	64925.8	65780.2	66476.2
Required Level of Education - Associates degree or some college	13353.6	10995.5	12150.6	13693.3	15164.5	15141	14338
Required Level of Education - Bachelors degree	10734.2	8829.1	9224.7	9985.1	10614.1	10428.2	9743
Required Level of Education - Doctoral degree	329.282	303.429	340.18	374.968	417.86	425.771	402.276
Required Level of Education - High school diploma or less	19678.8	15166.9	16127.6	17979	19455.7	19147.4	17959.5
Required Level of Education - Masters or professional degree	2394.2	2081.6	2241.6	2446.7	2667.8	2669.1	2509.8
Wage income - All	2855403730	2364743875	2556433207	2855332845	3137446332	3145309473	2988541047

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	3409.4
Carbon sink enhancement potential - All (not counting overlap)	22171.6
Carbon sink enhancement potential - Avoid deforestation	1094.807
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-1120.09
Carbon sink enhancement potential - Extend rotation length	4071.2
Carbon sink enhancement potential - Improve plantations	50.325
Carbon sink enhancement potential - Increase retention of HWP	400.207
Carbon sink enhancement potential - Increase trees outside forests	644.177
Carbon sink enhancement potential - permanent conservation cover	-43.512
Carbon sink enhancement potential - Reforest cropland	4158.3
Carbon sink enhancement potential - Reforest pasture	2935.9
Carbon sink enhancement potential - Restore productivity	5407.3
Carbon sink enhancement potential - total	-1163.602
Land impacted for carbon sink enhancement - Accelerate regeneration	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	293.886
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1516.113
Land impacted for carbon sink enhancement - Extend rotation length	2242.738
Land impacted for carbon sink enhancement - Improve plantations	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	181.715
Land impacted for carbon sink enhancement - permanent conservation cover	66.883
Land impacted for carbon sink enhancement - Reforest cropland	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	222
Land impacted for carbon sink enhancement - Restore productivity	3051.371
Land impacted for carbon sink enhancement - total	1583.007
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	125343.4	127204.9	107226.6	86000.1	64739.6	40732	28250.6
Oil consumption	29538.8	28693.8	25812.2	21136.4	16321.9	12555.4	8981.6

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.024	0.024	0.023	0.022	0.021	0.019	0.019
Final energy demand by sector - industry	0.091	0.095	0.095	0.095	0.097	0.098	0.099
Final energy demand by sector - residential	0.012	0.012	0.011	0.01	0.008	0.007	0.007
Final energy demand by sector - transportation	0.1	0.094	0.082	0.069	0.058	0.051	0.048

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	1753723026	1950750034	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.546	0.83	0.886	0.889	0.889	0.889
Sales of cooking units - Gas	0.581	0.454	0.17	0.114	0.111	0.111	0.111
Sales of space heating units - Electric Heat Pump	0.015	0.077	0.292	0.779	0.897	0.908	0.908
Sales of space heating units - Electric Resistance	0.015	0.034	0.049	0.081	0.087	0.087	0.087
Sales of space heating units - Fossil	0	0.002	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.971	0.886	0.66	0.14	0.017	0.005	0.005
Sales of water heating units - Electric Heat Pump	0	0.01	0.134	0.417	0.486	0.492	0.492
Sales of water heating units - Electric Resistance	0.007	0.024	0.148	0.429	0.497	0.504	0.504
Sales of water heating units - Gas Furnace	0.992	0.962	0.715	0.15	0.013	0.001	0
Sales of water heating units - Other	0.002	0.004	0.004	0.004	0.004	0.004	0.004

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	0.475	0.492	0.982	1.056	0.888	0.932

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	0.194	0.206	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.051	0.108	0.122	0.17	0.279	0.414	0.497
Sale of space heating units by type - Electric Resistance	0.09	0.159	0.156	0.151	0.138	0.118	0.106
Sale of space heating units by type - Fossil	0.152	0.176	0.177	0.153	0.12	0.098	0.082
Sale of space heating units by type - Gas	0.706	0.557	0.546	0.526	0.463	0.37	0.314
Sales of cooking units - Electric Resistance	0.378	0.394	0.451	0.601	0.81	0.939	0.983
Sales of cooking units - Gas	0.622	0.606	0.549	0.399	0.19	0.061	0.017
Sales of water heating units by type - Electric Heat Pump	0	0.002	0.009	0.031	0.083	0.151	0.193
Sales of water heating units by type - Electric Resistance	0.122	0.246	0.254	0.274	0.318	0.372	0.406
Sales of water heating units by type - Gas Furnace	0.871	0.743	0.728	0.687	0.59	0.468	0.391
Sales of water heating units by type - Other	0.007	0.008	0.009	0.009	0.009	0.009	0.009

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	0.021	0.024	0.022	0.018	0.012	0.006	0.003
End-use technology sales by technology - LDV - EV	0.012	0.033	0.088	0.21	0.429	0.683	0.861
End-use technology sales by technology - LDV - gasoline	0.937	0.901	0.844	0.729	0.524	0.288	0.125
End-use technology sales by technology - LDV - hybrid	0.027	0.036	0.042	0.04	0.033	0.021	0.011
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.004	0.003	0.002	0.001	0.001
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	25770653	54797514	184426833	582318620	847696972
Number of public EV charging plugs - DC Fast Charging	67	0	100.089	0	551.537	0	1550.7
Number of public EV charging plugs - L2 Charging	87	0	2419.2	0	13331.1	0	37480.8

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	3409.4
Carbon sink enhancement potential - All (not counting overlap)	22171.6
Carbon sink enhancement potential - Avoid deforestation	1094.807
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	-1120.09
Carbon sink enhancement potential - Extend rotation length	4071.2
Carbon sink enhancement potential - Improve plantations	50.325
Carbon sink enhancement potential - Increase retention of HWP	400.207
Carbon sink enhancement potential - Increase trees outside forests	644.177
Carbon sink enhancement potential - permanent conservation cover	-43.512
Carbon sink enhancement potential - Reforest cropland	4158.3
Carbon sink enhancement potential - Reforest pasture	2935.9
Carbon sink enhancement potential - Restore productivity	5407.3
Carbon sink enhancement potential - total	-1163.602
Land impacted for carbon sink enhancement - Accelerate regeneration	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	293.886
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1516.113
Land impacted for carbon sink enhancement - Extend rotation length	2242.738
Land impacted for carbon sink enhancement - Improve plantations	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	181.715
Land impacted for carbon sink enhancement - permanent conservation cover	66.883
Land impacted for carbon sink enhancement - Reforest cropland	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	222
Land impacted for carbon sink enhancement - Restore productivity	3051.371
Land impacted for carbon sink enhancement - total	1583.007
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.024	0.024	0.024	0.024	0.023	0.023	0.023
Final energy demand by sector - industry	0.091	0.095	0.095	0.096	0.099	0.1	0.1
Final energy demand by sector - residential	0.012	0.012	0.011	0.011	0.011	0.01	0.01
Final energy demand by sector - transportation	0.1	0.094	0.086	0.079	0.075	0.069	0.063

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	1753422434	1948248862	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.462	0.502	0.608	0.754	0.846	0.878
Sales of cooking units - Gas	0.581	0.538	0.498	0.392	0.246	0.154	0.122
Sales of space heating units - Electric Heat Pump	0.015	0.065	0.078	0.12	0.224	0.358	0.442
Sales of space heating units - Electric Resistance	0.015	0.034	0.034	0.037	0.044	0.053	0.059
Sales of space heating units - Fossil	0	0.002	0.002	0.002	0.002	0.001	0.001
Sales of space heating units - Gas Furnace	0.971	0.899	0.886	0.841	0.73	0.587	0.498
Sales of water heating units - Electric Heat Pump	0	0.003	0.011	0.036	0.098	0.179	0.23
Sales of water heating units - Electric Resistance	0.007	0.017	0.025	0.05	0.112	0.193	0.243
Sales of water heating units - Gas Furnace	0.992	0.976	0.96	0.91	0.786	0.624	0.524
Sales of water heating units - Other	0.002	0.004	0.004	0.004	0.004	0.004	0.004

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	0.375	0.38	0.515	0.536	0.847	0.903

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	0	0	10.459
Power generation capital investment - Wind - Base	2.044	10.927	14.384	17.342	14.034	33.375

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	782.083	2774.4	7788.1	12581.9	16187.7	28873.9
HV transmission for wind and solar - base other intra-state	0	0	0	0	0	0	0
HV transmission for wind and solar - base spur intra-state	0	284.828	1149.8	2265.3	3831.3	5015.7	9132

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	3409.4
Carbon sink enhancement potential - All (not counting overlap)	22171.6
Carbon sink enhancement potential - Avoid deforestation	1094.807
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-1120.09
Carbon sink enhancement potential - Extend rotation length	4071.2
Carbon sink enhancement potential - Improve plantations	50.325
Carbon sink enhancement potential - Increase retention of HWP	400.207
Carbon sink enhancement potential - Increase trees outside forests	644.177
Carbon sink enhancement potential - permanent conservation cover	-43.512
Carbon sink enhancement potential - Reforest cropland	4158.3
Carbon sink enhancement potential - Reforest pasture	2935.9
Carbon sink enhancement potential - Restore productivity	5407.3
Carbon sink enhancement potential - total	-1163.602
Land impacted for carbon sink enhancement - Accelerate regeneration	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	293.886
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1516.113
Land impacted for carbon sink enhancement - Extend rotation length	2242.738
Land impacted for carbon sink enhancement - Improve plantations	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	181.715
Land impacted for carbon sink enhancement - permanent conservation cover	66.883
Land impacted for carbon sink enhancement - Reforest cropland	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	222
Land impacted for carbon sink enhancement - Restore productivity	3051.371
Land impacted for carbon sink enhancement - total	1583.007
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103

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	0.68

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	763.448

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	0	0.044
Capital investment	0	0	0	0	0	0	0.588
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	0	0	0	0
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	0	0
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	0	0	1
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 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	0	0.75
Annual - BECCS	0	0	0	0	0	0.75
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	0.75
Cumulative - BECCS	0	0	0	0	0	0.75
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	32290.994	16588.494	16587.694	178862.017	179611.082
CO2 pipelines - Spur	0	32290.994	16588.494	16587.694	178862.017	179611.082
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	3409.4
Carbon sink enhancement potential - All (not counting overlap)	22171.6
Carbon sink enhancement potential - Avoid deforestation	1094.807
Carbon sink enhancement potential - corn-ethanol to energy grasses	-11.196
Carbon sink enhancement potential - cropland measures	-1110.027
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	4071.2
Carbon sink enhancement potential - Improve plantations	50.325
Carbon sink enhancement potential - Increase retention of HWP	400.207
Carbon sink enhancement potential - Increase trees outside forests	644.177
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-42.414
Carbon sink enhancement potential - Reforest cropland	4158.3
Carbon sink enhancement potential - Reforest pasture	2935.9
Carbon sink enhancement potential - Restore productivity	5407.3
Carbon sink enhancement potential - total	-1163.637
Land impacted for carbon sink enhancement - Accelerate regeneration	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	293.886
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	16.916
Land impacted for carbon sink enhancement - cropland measures	2959.879

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	5.542
Land impacted for carbon sink enhancement - Extend rotation length	2242.738
Land impacted for carbon sink enhancement - Improve plantations	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	181.715
Land impacted for carbon sink enhancement - pasture to energy crops	0
Land impacted for carbon sink enhancement - permanent conservation cover	65.199
Land impacted for carbon sink enhancement - Reforest cropland	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	222
Land impacted for carbon sink enhancement - Restore productivity	3051.371
Land impacted for carbon sink enhancement - total	3047.541
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	3409.4
Carbon sink enhancement potential - All (not counting overlap)	22171.6
Carbon sink enhancement potential - Avoid deforestation	1094.807
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-1120.09
Carbon sink enhancement potential - Extend rotation length	4071.2
Carbon sink enhancement potential - Improve plantations	50.325
Carbon sink enhancement potential - Increase retention of HWP	400.207
Carbon sink enhancement potential - Increase trees outside forests	644.177
Carbon sink enhancement potential - permanent conservation cover	-43.512
Carbon sink enhancement potential - Reforest cropland	4158.3
Carbon sink enhancement potential - Reforest pasture	2935.9
Carbon sink enhancement potential - Restore productivity	5407.3
Carbon sink enhancement potential - total	-1163.602
Land impacted for carbon sink enhancement - Accelerate regeneration	1374.114
Land impacted for carbon sink enhancement - All (not counting overlap)	4669.7
Land impacted for carbon sink enhancement - Avoid deforestation	293.886
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1516.113
Land impacted for carbon sink enhancement - Extend rotation length	2242.738
Land impacted for carbon sink enhancement - Improve plantations	27.97
Land impacted for carbon sink enhancement - Increase retention of HWP	80.041
Land impacted for carbon sink enhancement - Increase trees outside forests	181.715
Land impacted for carbon sink enhancement - permanent conservation cover	66.883
Land impacted for carbon sink enhancement - Reforest cropland	1384.478
Land impacted for carbon sink enhancement - Reforest pasture	222
Land impacted for carbon sink enhancement - Restore productivity	3051.371
Land impacted for carbon sink enhancement - total	1583.007
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	4188.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	318.635
Business-as-usual carbon sink - Avoid deforestation	93.618
Business-as-usual carbon sink - Extend rotation length	1226.9
Business-as-usual carbon sink - Improve plantations	10.621
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	36.535
Business-as-usual carbon sink - Reforest cropland	157.103
Business-as-usual carbon sink - Reforest pasture	54.235
Business-as-usual carbon sink - Restore productivity	1074.2
Business-as-usual carbon sink - Total impacted (over 30 years)	157.103