Net-Zero America - utah 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	2.682	2.799	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.024	0.113	0.117	0.123	0.127	0.13	0.133
Sale of space heating units by type - Electric Resistance	0.039	0.072	0.071	0.07	0.07	0.068	0.065
Sale of space heating units by type - Fossil	0.036	0.091	0.092	0.092	0.088	0.084	0.086
Sale of space heating units by type - Gas	0.901	0.724	0.72	0.715	0.715	0.717	0.715
Sales of cooking units - Electric Resistance	0.363	0.363	0.363	0.363	0.363	0.363	0.363
Sales of cooking units - Gas	0.637	0.637	0.637	0.637	0.637	0.637	0.637
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	0.07	0.148	0.148	0.148	0.149	0.149	0.149
Sales of water heating units by type - Gas Furnace	0.923	0.844	0.844	0.844	0.844	0.844	0.843
Sales of water heating units by type - Other	0.006	0.008	0.008	0.008	0.008	0.008	0.008

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	0.036	0.056	0.064	0.078	0.095	0.11	0.122
End-use technology sales by technology - LDV - gasoline	0.902	0.867	0.845	0.827	0.806	0.787	0.771
End-use technology sales by technology - LDV - hybrid	0.044	0.053	0.065	0.07	0.076	0.082	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	2471.9
Carbon sink enhancement potential - All (not counting overlap)	0	0	31247.1
Carbon sink enhancement potential - Avoid deforestation	0	0	1326.167
Carbon sink enhancement potential - Extend rotation length	0	0	12859.6
Carbon sink enhancement potential - Improve plantations	0	0	18.47
Carbon sink enhancement potential - Increase retention of HWP	0	0	49.598
Carbon sink enhancement potential - Increase trees outside forests	0	0	556.113
Carbon sink enhancement potential - Reforest cropland	0	0	4160.6
Carbon sink enhancement potential - Reforest pasture	0	0	2044.285
Carbon sink enhancement potential - Restore productivity	0	0	7760.4
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	6755
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	355.991
Land impacted for carbon sink enhancement - Extend rotation length	0	0	7084.1
Land impacted for carbon sink enhancement - Improve plantations	0	0	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	156.874
Land impacted for carbon sink enhancement - Natural uptake	-0.72	2.424	0.695
Land impacted for carbon sink enhancement - Reforest cropland	0	0	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	0	0	154.578
Land impacted for carbon sink enhancement - Restore productivity	0	0	4379.208
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.008	-0.017	-0.018
Land impacted for carbon sink enhancement - Total	-0.728	2.407	0.677
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898

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	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.103	0.105	0.107	0.106	0.106	0.108	0.113
Final energy demand by sector - industry	0.086	0.092	0.095	0.099	0.105	0.112	0.121
Final energy demand by sector - residential	0.126	0.123	0.123	0.125	0.127	0.13	0.132
Final energy demand by sector - transportation	0.304	0.294	0.276	0.267	0.271	0.282	0.297

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	7439584952	7805739556	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	0.007	0.146	0.481	0.741	0.784	0.788	0.788
Sales of space heating units - Electric Resistance	0.009	0.043	0.088	0.156	0.199	0.206	0.207
Sales of space heating units - Fossil	0	0.002	0.001	0	0	0	0
Sales of space heating units - Gas Furnace	0.984	0.809	0.43	0.102	0.017	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	0.004	0.015	0.015	0.015	0.015	0.015	0.015
Sales of water heating units - Gas Furnace	0.995	0.981	0.981	0.981	0.981	0.981	0.981
Sales of water heating units - Other	0.001	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	1.538	1.601	1.881	1.97	2.432	2.565

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	2.76	3.211	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.03	0.099	0.348	0.795	0.876	0.884	0.882
Sale of space heating units by type - Electric Resistance	0.038	0.074	0.057	0.025	0.02	0.02	0.02
Sale of space heating units by type - Fossil	0.036	0.092	0.089	0.081	0.076	0.073	0.074
Sale of space heating units by type - Gas	0.896	0.735	0.506	0.1	0.029	0.024	0.024
Sales of cooking units - Electric Resistance	0.371	0.505	0.915	0.996	1	1	1
Sales of cooking units - Gas	0.629	0.495	0.085	0.004	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.015	0.157	0.416	0.462	0.465	0.465
Sales of water heating units by type - Electric Resistance	0.07	0.157	0.263	0.485	0.525	0.527	0.527
Sales of water heating units by type - Gas Furnace	0.923	0.82	0.573	0.091	0.005	0	0
Sales of water heating units by type - Other	0.006	0.008	0.008	0.008	0.008	0.008	0.008

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	0.039	0.152	0.464	0.818	0.963	0.993	1
End-use technology sales by technology - LDV - gasoline	0.899	0.78	0.488	0.165	0.033	0.006	0
End-use technology sales by technology - LDV - hybrid	0.044	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	449229210	1171168159	1865834995	2839077093	3076133464	2940409765
Number of public EV charging plugs - DC Fast Charging	174	0	748.345	0	3072.4	0	4929.6
Number of public EV charging plugs - L2 Charging	1069	0	18000.9	0	73904.3	0	118577.1

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	0.029	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	0.377
Power generation capital investment - Solar PV - Base	0	0	0	0	0	0	0.525
Power generation capital investment - Solar PV - Constrained	0	1.093	0	0	2.177	2.602	1.202
Power generation capital investment - Wind - Base	0	0.251	7.553	5.672	2.216	1.037	3.243
Power generation capital investment - Wind - Constrained	0	0.199	7.897	6.705	0.918	0.419	2.698

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	4.897	61.814	61.814	61.814	61.814	61.814
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	423.108

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	582.17	7130	12558.1	16034.3	18485.9	20354
HV transmission for wind and solar - base other intra-state	0	120.53	904.024	1468.7	1645.9	1705.3	1998.2
HV transmission for wind and solar - base spur intra-state	0	97.957	684.774	1192.1	1389.7	1429.5	1988.3
HV transmission for wind and solar - constrained all	0	1032.5	8243.6	11756.6	17498	20125.2	22044.2
HV transmission for wind and solar - constrained other intra-state	0	379.482	1280.9	1735.5	3159.7	3364.1	3892.5
HV transmission for wind and solar - constrained spur intra-state	0	170.735	754.895	1198.6	1679.8	1784	2241.1

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.004	0.005	0.005	0.005	0.025
Capital investment	0	0	0.033	0	0.02	0	0.326
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	1	1	1	1
Number of facilities - diesel ccu	0	0	0	0	0	0	0
Number of facilities - power	0	1	1	1	1	1	1
Number of facilities - power ccu	0	0	0	0	0	0	1
Number of facilities - pyrolysis	0	0	0	1	1	1	1
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
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	0	0	0	0	0.4
Annual - BECCS	0	0	0	0	0	0.4
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	0.4
Cumulative - BECCS	0	0	0	0	0	0.4
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	0	13481.931
CO2 pipelines - Spur	0	0	0	0	0	13481.931
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	3.646	4.203	10.684	10.765	9.298	7.454	25.024
Jobs by economic sector - construction	5728.4	4630	7652.4	8842.2	8198.3	7715.8	9218
Jobs by economic sector - manufacturing	4315.7	4246.5	5978.8	6950.9	6077.4	5185.7	5480.3

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	6520.2	4906.8	3452.7	2593.8	1720.2	1120.7	654.802
Jobs by economic sector - other	655.5	445.201	717.359	909.293	967.708	1033.8	1668
Jobs by economic sector - pipeline	397.306	401.026	356.107	302.132	228.989	161.316	108.107
Jobs by economic sector - professional	3120.1	2671.9	4371.2	5247.4	5087.6	4956	6001.9
Jobs by economic sector - trade	3364.3	2730.2	3174.4	3504.7	3275.6	3138	3829.3
Jobs by economic sector - utilities	3791.9	3946.6	7062.1	7741.5	6905.4	6561.6	6857.8
Jobs by resource sector - Biomass	15.112	18.038	29.458	30.661	27.991	27.186	106.864
Jobs by resource sector - CO2	0	0	0	0	0	0	29.432
Jobs by resource sector - Coal	4431.2	2670.1	1040.1	528.563	459.608	413.977	366.828
Jobs by resource sector - Grid	4054.1	4798.7	11712	13605.4	12053.5	11417.1	12440.2
Jobs by resource sector - Natural Gas	5205.2	4854.8	4122.9	3304.6	2616.6	2125	1300
Jobs by resource sector - Nuclear	0	0	0	0	0	0	0
Jobs by resource sector - Oil	7306.7	6801.6	5928.4	5041.1	3590.7	2602.6	1588.2
Jobs by resource sector - Solar	6179.6	3443.9	3626.8	4869.2	5149.8	5442	9229.6
Jobs by resource sector - Wind	705.234	1395.4	6316	8723.4	8572.3	7852.6	8782.1
Median wages - All	56613.4	58059.9	58319	58637.2	59219	59957.9	60200.2
Required Level of Education - Associates degree or some college	8366.7	7240.1	10231.4	11370.7	10292.1	9532.5	10866.4
Required Level of Education - Bachelors degree	5989.1	5270.5	6970.1	7583.7	6784.4	6212.8	6963
Required Level of Education - Doctoral degree	201.683	173.57	238.687	267.065	247.145	232.214	271.512
Required Level of Education - High school diploma or less	11925.7	10055	13651.4	15035.1	13477.1	12355.6	13983.8
Required Level of Education - Masters or professional degree	1413.9	1243.3	1684.1	1846.3	1669.6	1547.4	1758.6
Wage income - All	1579459121	1392503182	1911576381	2117134303	1923039167	1791754881	2037655998

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2471.9
Carbon sink enhancement potential - All (not counting overlap)	31247.1
Carbon sink enhancement potential - Avoid deforestation	1326.167
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-544.5
Carbon sink enhancement potential - Extend rotation length	12859.6
Carbon sink enhancement potential - Improve plantations	18.47
Carbon sink enhancement potential - Increase retention of HWP	49.598
Carbon sink enhancement potential - Increase trees outside forests	556.113
Carbon sink enhancement potential - permanent conservation cover	-23.514
Carbon sink enhancement potential - Reforest cropland	4160.6
Carbon sink enhancement potential - Reforest pasture	2044.285
Carbon sink enhancement potential - Restore productivity	7760.4
Carbon sink enhancement potential - total	-568.014
Land impacted for carbon sink enhancement - Accelerate regeneration	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	6755
Land impacted for carbon sink enhancement - Avoid deforestation	355.991
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	974.859
Land impacted for carbon sink enhancement - Extend rotation length	7084.1
Land impacted for carbon sink enhancement - Improve plantations	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	156.874
Land impacted for carbon sink enhancement - permanent conservation cover	36.206
Land impacted for carbon sink enhancement - Reforest cropland	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	154.578
Land impacted for carbon sink enhancement - Restore productivity	4379.208
Land impacted for carbon sink enhancement - total	1011.064
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	185925.7	188686.9	159052.4	127566.6	96030.2	60419	41905
Oil consumption	56985.2	53110	45659.1	34890.9	24684.2	16648.3	10043.1

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.103	0.103	0.101	0.095	0.088	0.082	0.08
Final energy demand by sector - industry	0.086	0.089	0.09	0.097	0.111	0.116	0.122
Final energy demand by sector - residential	0.126	0.122	0.118	0.106	0.09	0.079	0.072
Final energy demand by sector - transportation	0.304	0.29	0.26	0.223	0.188	0.168	0.161

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	7533326468	8380797924	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	0.007	0.09	0.335	0.819	0.904	0.91	0.91
Sales of space heating units - Electric Resistance	0.009	0.034	0.048	0.079	0.085	0.085	0.086
Sales of space heating units - Fossil	0	0.002	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.984	0.874	0.616	0.102	0.011	0.005	0.005
Sales of water heating units - Electric Heat Pump	0	0.016	0.167	0.45	0.5	0.503	0.503
Sales of water heating units - Electric Resistance	0.004	0.027	0.163	0.441	0.49	0.493	0.493
Sales of water heating units - Gas Furnace	0.995	0.953	0.666	0.106	0.006	0	0
Sales of water heating units - Other	0.001	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	1.721	1.806	3.199	3.44	3.672	3.911

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	2.75	3.157	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.03	0.081	0.108	0.196	0.397	0.636	0.771
Sale of space heating units by type - Electric Resistance	0.038	0.074	0.072	0.067	0.054	0.037	0.028
Sale of space heating units by type - Fossil	0.036	0.093	0.093	0.091	0.084	0.077	0.076
Sale of space heating units by type - Gas	0.896	0.751	0.726	0.646	0.465	0.25	0.126
Sales of cooking units - Electric Resistance	0.369	0.385	0.443	0.595	0.807	0.938	0.983
Sales of cooking units - Gas	0.631	0.615	0.557	0.405	0.193	0.062	0.017
Sales of water heating units by type - Electric Heat Pump	0	0.006	0.021	0.071	0.186	0.323	0.402
Sales of water heating units by type - Electric Resistance	0.07	0.152	0.164	0.202	0.293	0.406	0.473
Sales of water heating units by type - Gas Furnace	0.923	0.834	0.807	0.719	0.513	0.263	0.118
Sales of water heating units by type - Other	0.006	0.008	0.008	0.008	0.008	0.008	0.008

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	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.019	0.047	0.118	0.259	0.484	0.72	0.876
End-use technology sales by technology - LDV - gasoline	0.918	0.875	0.796	0.667	0.462	0.249	0.11
End-use technology sales by technology - LDV - hybrid	0.046	0.054	0.061	0.055	0.041	0.024	0.012
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.002	0.002	0.001	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0.001	0.001	0	0
End-use technology sales by technology - MDV - diesel	0.648	0.622	0.577	0.494	0.356	0.196	0.084
End-use technology sales by technology - MDV - EV	0.007	0.019	0.055	0.143	0.314	0.526	0.68
End-use technology sales by technology - MDV - gasoline	0.338	0.347	0.347	0.319	0.244	0.142	0.063
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.005	0.005	0.004	0.003	0.001
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.005	0.014	0.036	0.079	0.132	0.17
End-use technology sales by technology - MDV - other	0.003	0.003	0.003	0.003	0.003	0.002	0.001
Light-duty vehicle capital costs - Cumulative 5-yr	0	0	76126849	152285991	521662897	1618302753	2365723756
Number of public EV charging plugs - DC Fast Charging	174	0	259.943	0	1161.7	0	3157.4
Number of public EV charging plugs - L2 Charging	1069	0	6252.7	0	27943.4	0	75948.5

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2471.9
Carbon sink enhancement potential - All (not counting overlap)	31247.1
Carbon sink enhancement potential - Avoid deforestation	1326.167
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	-544.5
Carbon sink enhancement potential - Extend rotation length	12859.6
Carbon sink enhancement potential - Improve plantations	18.47
Carbon sink enhancement potential - Increase retention of HWP	49.598
Carbon sink enhancement potential - Increase trees outside forests	556.113
Carbon sink enhancement potential - permanent conservation cover	-23.514
Carbon sink enhancement potential - Reforest cropland	4160.6
Carbon sink enhancement potential - Reforest pasture	2044.285
Carbon sink enhancement potential - Restore productivity	7760.4
Carbon sink enhancement potential - total	-568.014
Land impacted for carbon sink enhancement - Accelerate regeneration	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	6755
Land impacted for carbon sink enhancement - Avoid deforestation	355.991
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	974.859
Land impacted for carbon sink enhancement - Extend rotation length	7084.1
Land impacted for carbon sink enhancement - Improve plantations	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	156.874
Land impacted for carbon sink enhancement - permanent conservation cover	36.206
Land impacted for carbon sink enhancement - Reforest cropland	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	154.578
Land impacted for carbon sink enhancement - Restore productivity	4379.208
Land impacted for carbon sink enhancement - total	1011.064
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.103	0.103	0.103	0.102	0.1	0.096	0.093
Final energy demand by sector - industry	0.086	0.089	0.09	0.098	0.112	0.117	0.124
Final energy demand by sector - residential	0.126	0.122	0.121	0.118	0.114	0.105	0.095
Final energy demand by sector - transportation	0.304	0.292	0.27	0.253	0.241	0.225	0.207

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	7531997962	8365161321	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	0.007	0.076	0.103	0.19	0.395	0.645	0.79
Sales of space heating units - Electric Resistance	0.009	0.033	0.035	0.04	0.053	0.069	0.078
Sales of space heating units - Fossil	0	0.002	0.002	0.002	0.001	0	0
Sales of space heating units - Gas Furnace	0.984	0.888	0.86	0.768	0.552	0.286	0.132
Sales of water heating units - Electric Heat Pump	0	0.006	0.023	0.077	0.2	0.348	0.434
Sales of water heating units - Electric Resistance	0.004	0.02	0.035	0.084	0.199	0.342	0.425
Sales of water heating units - Gas Furnace	0.995	0.97	0.938	0.836	0.597	0.306	0.137
Sales of water heating units - Other	0.001	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	1.434	1.484	1.966	2.068	2.75	2.922

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	7.148
Power generation capital investment - Wind - Base	0.668	8.699	6.389	4.891	2.472	3.241

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	730.824	7355.6	14355	21167.8	26196.1	41395.6
HV transmission for wind and solar - base other intra-state	0	169.43	1072.5	1638	1931.6	2167.1	3343.8
HV transmission for wind and solar - base spur intra-state	0	115.933	801.132	1383.5	1711.5	1959.3	4117.1

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2471.9
Carbon sink enhancement potential - All (not counting overlap)	31247.1
Carbon sink enhancement potential - Avoid deforestation	1326.167
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-544.5
Carbon sink enhancement potential - Extend rotation length	12859.6
Carbon sink enhancement potential - Improve plantations	18.47
Carbon sink enhancement potential - Increase retention of HWP	49.598
Carbon sink enhancement potential - Increase trees outside forests	556.113
Carbon sink enhancement potential - permanent conservation cover	-23.514
Carbon sink enhancement potential - Reforest cropland	4160.6
Carbon sink enhancement potential - Reforest pasture	2044.285
Carbon sink enhancement potential - Restore productivity	7760.4
Carbon sink enhancement potential - total	-568.014
Land impacted for carbon sink enhancement - Accelerate regeneration	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	6755
Land impacted for carbon sink enhancement - Avoid deforestation	355.991
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	974.859
Land impacted for carbon sink enhancement - Extend rotation length	7084.1
Land impacted for carbon sink enhancement - Improve plantations	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	156.874
Land impacted for carbon sink enhancement - permanent conservation cover	36.206
Land impacted for carbon sink enhancement - Reforest cropland	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	154.578
Land impacted for carbon sink enhancement - Restore productivity	4379.208
Land impacted for carbon sink enhancement - total	1011.064
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192

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	0	0
Capital investment	0	0	0	0	0	0	0
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	0
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 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
Annual - BECCS	0	0	0	0	0	0
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	0
Cumulative - BECCS	0	0	0	0	0	0
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	0	0
CO2 pipelines - Spur	0	0	0	0	0	0
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	2471.9
Carbon sink enhancement potential - All (not counting overlap)	31247.1
Carbon sink enhancement potential - Avoid deforestation	1326.167
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-544.498
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	12859.6
Carbon sink enhancement potential - Improve plantations	18.47
Carbon sink enhancement potential - Increase retention of HWP	49.598
Carbon sink enhancement potential - Increase trees outside forests	556.113
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-23.513
Carbon sink enhancement potential - Reforest cropland	4160.6
Carbon sink enhancement potential - Reforest pasture	2044.285
Carbon sink enhancement potential - Restore productivity	7760.4
Carbon sink enhancement potential - total	-568.011
Land impacted for carbon sink enhancement - Accelerate regeneration	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	6755
Land impacted for carbon sink enhancement - Avoid deforestation	355.991
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	1923.775

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	0.004
Land impacted for carbon sink enhancement - Extend rotation length	7084.1
Land impacted for carbon sink enhancement - Improve plantations	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	156.874
Land impacted for carbon sink enhancement - pasture to energy crops	2.108
Land impacted for carbon sink enhancement - permanent conservation cover	36.206
Land impacted for carbon sink enhancement - Reforest cropland	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	154.578
Land impacted for carbon sink enhancement - Restore productivity	4379.208
Land impacted for carbon sink enhancement - total	1962.1
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2471.9
Carbon sink enhancement potential - All (not counting overlap)	31247.1
Carbon sink enhancement potential - Avoid deforestation	1326.167
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-544.5
Carbon sink enhancement potential - Extend rotation length	12859.6
Carbon sink enhancement potential - Improve plantations	18.47
Carbon sink enhancement potential - Increase retention of HWP	49.598
Carbon sink enhancement potential - Increase trees outside forests	556.113
Carbon sink enhancement potential - permanent conservation cover	-23.514
Carbon sink enhancement potential - Reforest cropland	4160.6
Carbon sink enhancement potential - Reforest pasture	2044.285
Carbon sink enhancement potential - Restore productivity	7760.4
Carbon sink enhancement potential - total	-568.014
Land impacted for carbon sink enhancement - Accelerate regeneration	996.247
Land impacted for carbon sink enhancement - All (not counting overlap)	6755
Land impacted for carbon sink enhancement - Avoid deforestation	355.991
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	974.859
Land impacted for carbon sink enhancement - Extend rotation length	7084.1
Land impacted for carbon sink enhancement - Improve plantations	10.265
Land impacted for carbon sink enhancement - Increase retention of HWP	9.92
Land impacted for carbon sink enhancement - Increase trees outside forests	156.874
Land impacted for carbon sink enhancement - permanent conservation cover	36.206
Land impacted for carbon sink enhancement - Reforest cropland	1385.29
Land impacted for carbon sink enhancement - Reforest pasture	154.578
Land impacted for carbon sink enhancement - Restore productivity	4379.208
Land impacted for carbon sink enhancement - total	1011.064
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	7777.4

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	231.014
Business-as-usual carbon sink - Avoid deforestation	113.402
Business-as-usual carbon sink - Extend rotation length	3875.5
Business-as-usual carbon sink - Improve plantations	3.898
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	31.541
Business-as-usual carbon sink - Reforest cropland	157.192
Business-as-usual carbon sink - Reforest pasture	37.763
Business-as-usual carbon sink - Restore productivity	1541.6
Business-as-usual carbon sink - Total impacted (over 30 years)	157.192