Net-Zero America - rhode island 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	0.864	0.9	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.047	0.081	0.084	0.089	0.091	0.093	0.096
Sale of space heating units by type - Electric Resistance	0.039	0.057	0.056	0.055	0.055	0.053	0.051
Sale of space heating units by type - Fossil	0.373	0.451	0.232	0.078	0.068	0.067	0.067
Sale of space heating units by type - Gas	0.542	0.411	0.628	0.778	0.786	0.788	0.787
Sales of cooking units - Electric Resistance	0.545	0.545	0.545	0.545	0.545	0.545	0.545
Sales of cooking units - Gas	0.455	0.455	0.455	0.455	0.455	0.455	0.455
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	0.221	0.384	0.384	0.384	0.384	0.384	0.384
Sales of water heating units by type - Gas Furnace	0.655	0.521	0.522	0.521	0.521	0.521	0.521
Sales of water heating units by type - Other	0.124	0.094	0.095	0.095	0.095	0.095	0.095

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	0.012	0.017	0.021	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.047	0.071	0.079	0.098	0.118	0.133	0.146
End-use technology sales by technology - LDV - gasoline	0.884	0.844	0.819	0.797	0.774	0.756	0.741
End-use technology sales by technology - LDV - hybrid	0.056	0.064	0.077	0.082	0.087	0.091	0.093
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	14.226
Carbon sink enhancement potential - All (not counting overlap)	0	0	1015.739
Carbon sink enhancement potential - Avoid deforestation	0	0	261.855
Carbon sink enhancement potential - Extend rotation length	0	0	416.512
Carbon sink enhancement potential - Improve plantations	0	0	0
Carbon sink enhancement potential - Increase retention of HWP	0	0	91.472
Carbon sink enhancement potential - Increase trees outside forests	0	0	47.788
Carbon sink enhancement potential - Reforest cropland	0	0	0
Carbon sink enhancement potential - Reforest pasture	0	0	77.286
Carbon sink enhancement potential - Restore productivity	0	0	106.6
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	70.291
Land impacted for carbon sink enhancement - Extend rotation length	0	0	229.448
Land impacted for carbon sink enhancement - Improve plantations	0	0	0
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	13.481
Land impacted for carbon sink enhancement - Natural uptake	-1.01	-0.322	-0.288
Land impacted for carbon sink enhancement - Reforest cropland	0	0	0
Land impacted for carbon sink enhancement - Reforest pasture	0	0	5.843
Land impacted for carbon sink enhancement - Restore productivity	0	0	60.154
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.015	-0.027	-0.028
Land impacted for carbon sink enhancement - Total	-1.025	-0.349	-0.316
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0

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	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.038	0.037	0.037	0.037	0.037	0.038	0.04
Final energy demand by sector - industry	0.007	0.007	0.008	0.008	0.008	0.009	0.009
Final energy demand by sector - residential	0.046	0.043	0.042	0.041	0.041	0.04	0.04
Final energy demand by sector - transportation	0.058	0.054	0.051	0.048	0.048	0.05	0.052

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	1927887532	1983309619	0	0	0	0
Sales of cooking units - Electric Resistance	0.369	0.39	0.386	0.385	0.383	0.385	0.384
Sales of cooking units - Gas	0.631	0.61	0.614	0.615	0.617	0.615	0.616
Sales of space heating units - Electric Heat Pump	0.027	0.127	0.408	0.639	0.676	0.679	0.68
Sales of space heating units - Electric Resistance	0.014	0.029	0.077	0.2	0.302	0.319	0.32
Sales of space heating units - Fossil	0.274	0.334	0.236	0.093	0.013	0.001	0
Sales of space heating units - Gas Furnace	0.685	0.51	0.279	0.068	0.009	0	0
Sales of water heating units - Electric Heat Pump	0.014	0.024	0.023	0.023	0.023	0.023	0.023
Sales of water heating units - Electric Resistance	0.073	0.111	0.109	0.111	0.111	0.11	0.11
Sales of water heating units - Gas Furnace	0.884	0.824	0.827	0.825	0.825	0.827	0.826
Sales of water heating units - Other	0.029	0.042	0.041	0.041	0.042	0.04	0.04

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	0.245	0.243	0.8	0.865	0.782	0.829

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	0.886	0.975	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.049	0.124	0.572	0.909	0.959	0.962	0.962
Sale of space heating units by type - Electric Resistance	0.039	0.059	0.046	0.02	0.015	0.015	0.016
Sale of space heating units by type - Fossil	0.372	0.459	0.129	0.029	0.021	0.02	0.02
Sale of space heating units by type - Gas	0.541	0.358	0.253	0.043	0.005	0.003	0.003
Sales of cooking units - Electric Resistance	0.551	0.646	0.94	0.997	1	1	1
Sales of cooking units - Gas	0.449	0.354	0.06	0.003	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.015	0.138	0.346	0.382	0.384	0.384
Sales of water heating units by type - Electric Resistance	0.221	0.395	0.477	0.594	0.614	0.615	0.615
Sales of water heating units by type - Gas Furnace	0.655	0.51	0.369	0.059	0.003	0	0
Sales of water heating units by type - Other	0.124	0.08	0.016	0.001	0.001	0.001	0.001

Table 9: *RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.972	0.921	0.67	0.233	0.042	0.006	0
End-use technology sales by technology - HDV - EV	0.006	0.038	0.19	0.456	0.574	0.596	0.6
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.002	0.001	0	0	0
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0	0	0	0
End-use technology sales by technology - HDV - hydrogen FC	0.004	0.025	0.127	0.304	0.382	0.397	0.4
End-use technology sales by technology - HDV - other	0.015	0.012	0.011	0.006	0.002	0	0
End-use technology sales by technology - LDV - diesel	0.012	0.015	0.011	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.051	0.187	0.516	0.838	0.966	0.993	1
End-use technology sales by technology - LDV - gasoline	0.88	0.74	0.435	0.145	0.03	0.006	0
End-use technology sales by technology - LDV - hybrid	0.055	0.054	0.036	0.013	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	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	167244851	429098164	694637144	1052518992	1145222686	1092069878
Number of public EV charging plugs - DC Fast Charging	24	0	246.609	0	1078.2	0	1742.7
Number of public EV charging plugs - L2 Charging	374	0	5916.4	0	25866.6	0	41808.9

Table 10: *RE- scenario - PILLAR 2: Clean Electricity - Generating capacity*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation capital investment - biomass power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	0	0
Power generation capital investment - Offshore Wind - Base	0	0	0.829	1.036	0.454	0	0
Power generation capital investment - Offshore Wind - Constrained	0	2.079	0.546	0	0	0	0
Power generation capital investment - Solar PV - Base	0	0	0.656	0	0	0	0
Power generation capital investment - Solar PV - Constrained	0	0.137	0.725	0	0	0	0
Power generation capital investment - Wind - Base	0	0	0	0	0	0	0
Power generation capital investment - Wind - Constrained	0	0	0	0	0	0	0

Table 11: *RE- scenario - PILLAR 2: Clean Electricity - Generation*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation by technology - biomass power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu power plant	0	0	0	0	0	0	0

Table 12: *RE- scenario - PILLAR 2: Clean Electricity - Transmission*

variable_name	2020	2025	2030	2035	2040	2045	2050
HV transmission for wind and solar - base all	0	20.183	181.208	354.546	567.993	768.861	1309.8
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	3.238	22.343	22.343	22.343	22.343	22.343
HV transmission for wind and solar - constrained all	0	149.008	256.409	385.464	505.668	566.964	1232.4
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	2.284	17.268	17.268	17.268	17.268	17.268

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	0.044
Capital investment	0	0	0	0	0	0	1.088
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	1
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 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	1.48
Annual - BECCS	0	0	0	0	0	1.48
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	1.48
Cumulative - BECCS	0	0	0	0	0	1.48
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	59340.945
CO2 pipelines - Spur	0	0	0	0	0	59340.945
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	12.233	14.103	28.634	10.945	8.49	6.24	78.037
Jobs by economic sector - construction	1432.5	1127.2	1360.3	1277.5	1702.4	1558.6	2007
Jobs by economic sector - manufacturing	495.183	607.306	920.154	877.884	1035.4	1291.7	1855.8
Jobs by economic sector - mining	545.216	428.299	299.701	185.982	104.655	51.356	21.381
Jobs by economic sector - other	164.626	129.719	185.555	143.469	190.472	191.23	320.491
Jobs by economic sector - pipeline	104.189	101.481	84.991	65.424	46.539	28.247	27.075
Jobs by economic sector - professional	539.886	464.739	574.627	581.103	825.094	756.161	1075.6
Jobs by economic sector - trade	517.778	433.981	456.815	406.25	508.792	463.95	640.515
Jobs by economic sector - utilities	882.105	796.617	822.949	1168.7	2040.8	1835.3	2092.8
Jobs by resource sector - Biomass	50.708	60.528	78.95	31.171	25.557	22.758	333.248
Jobs by resource sector - CO2	0	0	0	0	0	0	84.703
Jobs by resource sector - Grid	1016.1	557.651	1107.1	1940.3	3131.6	3110.1	3648.8
Jobs by resource sector - Natural Gas	968.662	1212.1	685.252	544.76	1083.3	683.572	568.423
Jobs by resource sector - Nuclear	0	0	0	0	0	0	0
Jobs by resource sector - Oil	1195.2	1003.6	772.011	517.004	310.477	165.734	63.571
Jobs by resource sector - Solar	1384.6	1177.4	1604.6	870.496	1004	1330.9	2086.1
Jobs by resource sector - Wind	78.523	92.157	485.913	813.527	907.649	869.869	1333.9
Median wages - All	66614.1	67361.1	67135.8	69084	70830.4	71151.9	71295.9
Required Level of Education - Associates degree or some college	1455.5	1281.7	1487.1	1509.6	2113.2	2020.3	2624.4
Required Level of Education - Bachelors degree	972.307	856.147	954.676	943.398	1277.1	1213.5	1593.5
Required Level of Education - Doctoral degree	33.111	28.393	32.061	30.565	40.998	37.567	51.806
Required Level of Education - High school diploma or less	2001.7	1736	2035.3	2008.5	2720.4	2620.3	3464.8
Required Level of Education - Masters or professional degree	231.068	201.159	224.58	225.22	310.892	291.181	384.105
Wage income - All	312699755	276437028	317839703	325918032	457786457	439961753	578887939

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	14.226
Carbon sink enhancement potential - All (not counting overlap)	1015.739
Carbon sink enhancement potential - Avoid deforestation	261.855
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-15.723
Carbon sink enhancement potential - Extend rotation length	416.512
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	91.472
Carbon sink enhancement potential - Increase trees outside forests	47.788
Carbon sink enhancement potential - permanent conservation cover	-0.491
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	77.286
Carbon sink enhancement potential - Restore productivity	106.6
Carbon sink enhancement potential - total	-16.214
Land impacted for carbon sink enhancement - Accelerate regeneration	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	70.291
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	9.981
Land impacted for carbon sink enhancement - Extend rotation length	229.448
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	13.481
Land impacted for carbon sink enhancement - permanent conservation cover	0.893
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	5.843
Land impacted for carbon sink enhancement - Restore productivity	60.154
Land impacted for carbon sink enhancement - total	10.874
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428

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

variable_name	2050
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	77637.9	78790.9	66416.3	53268.6	40099.8	25229.4	17498.5
Oil consumption	24518.2	22574.7	18924.2	13727	8875.8	5071.9	2071

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.038	0.036	0.034	0.032	0.03	0.028	0.027
Final energy demand by sector - industry	0.007	0.007	0.007	0.007	0.007	0.007	0.008
Final energy demand by sector - residential	0.046	0.043	0.039	0.034	0.029	0.024	0.022
Final energy demand by sector - transportation	0.058	0.054	0.047	0.039	0.032	0.027	0.025

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	1951972648	2131291662	0	0	0	0
Sales of cooking units - Electric Resistance	0.369	0.499	0.812	0.874	0.877	0.877	0.877
Sales of cooking units - Gas	0.631	0.501	0.188	0.126	0.123	0.123	0.123
Sales of space heating units - Electric Heat Pump	0.027	0.105	0.385	0.721	0.776	0.779	0.78
Sales of space heating units - Electric Resistance	0.014	0.046	0.164	0.213	0.22	0.221	0.22
Sales of space heating units - Fossil	0.274	0.299	0.057	0.002	0	0	0
Sales of space heating units - Gas Furnace	0.685	0.55	0.393	0.063	0.004	0	0
Sales of water heating units - Electric Heat Pump	0.014	0.035	0.158	0.412	0.457	0.46	0.46
Sales of water heating units - Electric Resistance	0.073	0.122	0.238	0.48	0.522	0.525	0.525
Sales of water heating units - Gas Furnace	0.884	0.806	0.585	0.093	0.006	0	0
Sales of water heating units - Other	0.029	0.037	0.019	0.016	0.015	0.015	0.016

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	0.337	0.347	1.188	1.297	1.077	1.146

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	0.888	1.031	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.049	0.057	0.109	0.262	0.538	0.788	0.908
Sale of space heating units by type - Electric Resistance	0.039	0.059	0.057	0.053	0.041	0.027	0.019
Sale of space heating units by type - Fossil	0.372	0.521	0.485	0.375	0.203	0.083	0.037
Sale of space heating units by type - Gas	0.541	0.363	0.349	0.31	0.217	0.102	0.035
Sales of cooking units - Electric Resistance	0.549	0.561	0.602	0.711	0.862	0.956	0.988
Sales of cooking units - Gas	0.451	0.439	0.398	0.289	0.138	0.044	0.012
Sales of water heating units by type - Electric Heat Pump	0	0.005	0.019	0.065	0.166	0.285	0.352
Sales of water heating units by type - Electric Resistance	0.221	0.387	0.397	0.427	0.489	0.559	0.597
Sales of water heating units by type - Gas Furnace	0.655	0.516	0.499	0.444	0.313	0.146	0.048
Sales of water heating units by type - Other	0.124	0.092	0.085	0.064	0.032	0.011	0.003

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	0.012	0.017	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.023	0.056	0.136	0.287	0.514	0.74	0.883
End-use technology sales by technology - LDV - gasoline	0.905	0.858	0.769	0.631	0.428	0.228	0.101
End-use technology sales by technology - LDV - hybrid	0.058	0.065	0.072	0.063	0.046	0.026	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	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	27129081	56840410	192107590	604027927	880174513
Number of public EV charging plugs - DC Fast Charging	24	0	76.808	0	400.285	0	1116.2
Number of public EV charging plugs - L2 Charging	374	0	1842.7	0	9603.2	0	26778.6

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	14.226
Carbon sink enhancement potential - All (not counting overlap)	1015.739
Carbon sink enhancement potential - Avoid deforestation	261.855
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-15.723
Carbon sink enhancement potential - Extend rotation length	416.512
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	91.472
Carbon sink enhancement potential - Increase trees outside forests	47.788
Carbon sink enhancement potential - permanent conservation cover	-0.491
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	77.286
Carbon sink enhancement potential - Restore productivity	106.6
Carbon sink enhancement potential - total	-16.214
Land impacted for carbon sink enhancement - Accelerate regeneration	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	70.291
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	9.981
Land impacted for carbon sink enhancement - Extend rotation length	229.448
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	13.481
Land impacted for carbon sink enhancement - permanent conservation cover	0.893
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	5.843
Land impacted for carbon sink enhancement - Restore productivity	60.154
Land impacted for carbon sink enhancement - total	10.874
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.038	0.036	0.035	0.034	0.033	0.032	0.031
Final energy demand by sector - industry	0.007	0.007	0.007	0.007	0.007	0.008	0.008
Final energy demand by sector - residential	0.046	0.043	0.041	0.039	0.036	0.032	0.028
Final energy demand by sector - transportation	0.058	0.054	0.05	0.046	0.043	0.039	0.034

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	1951660326	2132276521	0	0	0	0
Sales of cooking units - Electric Resistance	0.369	0.407	0.447	0.565	0.727	0.829	0.864
Sales of cooking units - Gas	0.631	0.593	0.553	0.435	0.273	0.171	0.136
Sales of space heating units - Electric Heat Pump	0.027	0.074	0.106	0.205	0.404	0.614	0.728
Sales of space heating units - Electric Resistance	0.014	0.025	0.038	0.077	0.143	0.192	0.212
Sales of space heating units - Fossil	0.274	0.346	0.324	0.245	0.119	0.038	0.01
Sales of space heating units - Gas Furnace	0.685	0.555	0.532	0.473	0.334	0.156	0.051
Sales of water heating units - Electric Heat Pump	0.014	0.029	0.043	0.09	0.201	0.34	0.421
Sales of water heating units - Electric Resistance	0.073	0.116	0.128	0.174	0.28	0.411	0.488
Sales of water heating units - Gas Furnace	0.884	0.814	0.792	0.703	0.495	0.231	0.075
Sales of water heating units - Other	0.029	0.041	0.038	0.032	0.024	0.018	0.016

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	0.246	0.245	0.466	0.491	0.969	1.048

Table 31: *E+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

variable_name	2025	2030	2035	2040	2045	2050
Power generation capital investment - Offshore Wind - Base	0	0.829	1.597	0	0	0
Power generation capital investment - Solar PV - Base	0	0.656	0	0	0	0

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	14.227	160.671	428.874	554.895	808.243	1363.8
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	2.603	2.603	2.603	2.603	2.603	2.603

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	14.226
Carbon sink enhancement potential - All (not counting overlap)	1015.739
Carbon sink enhancement potential - Avoid deforestation	261.855
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-15.723
Carbon sink enhancement potential - Extend rotation length	416.512
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	91.472
Carbon sink enhancement potential - Increase trees outside forests	47.788
Carbon sink enhancement potential - permanent conservation cover	-0.491
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	77.286
Carbon sink enhancement potential - Restore productivity	106.6
Carbon sink enhancement potential - total	-16.214
Land impacted for carbon sink enhancement - Accelerate regeneration	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	70.291
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	9.981
Land impacted for carbon sink enhancement - Extend rotation length	229.448
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	13.481
Land impacted for carbon sink enhancement - permanent conservation cover	0.893
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	5.843
Land impacted for carbon sink enhancement - Restore productivity	60.154
Land impacted for carbon sink enhancement - total	10.874
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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	0.107
Capital investment	0	0	0	0	0	0	1.422
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	1
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	1.94
Annual - BECCS	0	0	0	0	0	1.94
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	0	0	0	1.94
Cumulative - BECCS	0	0	0	0	0	1.94
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	65695.645
CO2 pipelines - Spur	0	0	0	0	0	65695.645
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	14.226
Carbon sink enhancement potential - All (not counting overlap)	1015.739
Carbon sink enhancement potential - Avoid deforestation	261.855
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-15.723
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	416.512
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	91.472
Carbon sink enhancement potential - Increase trees outside forests	47.788
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-0.491
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	77.286
Carbon sink enhancement potential - Restore productivity	106.6

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

variable_name	2050
Carbon sink enhancement potential - total	-16.214
Land impacted for carbon sink enhancement - Accelerate regeneration	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	70.291
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	19.61
Land impacted for carbon sink enhancement - Cropland to woody energy crops	0
Land impacted for carbon sink enhancement - Extend rotation length	229.448
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	13.481
Land impacted for carbon sink enhancement - pasture to energy crops	0.094
Land impacted for carbon sink enhancement - permanent conservation cover	0.893
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	5.843
Land impacted for carbon sink enhancement - Restore productivity	60.154
Land impacted for carbon sink enhancement - total	20.596
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	14.226
Carbon sink enhancement potential - All (not counting overlap)	1015.739
Carbon sink enhancement potential - Avoid deforestation	261.855
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-15.723
Carbon sink enhancement potential - Extend rotation length	416.512
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	91.472
Carbon sink enhancement potential - Increase trees outside forests	47.788
Carbon sink enhancement potential - permanent conservation cover	-0.491
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	77.286
Carbon sink enhancement potential - Restore productivity	106.6
Carbon sink enhancement potential - total	-16.214
Land impacted for carbon sink enhancement - Accelerate regeneration	5.734
Land impacted for carbon sink enhancement - All (not counting overlap)	179.808
Land impacted for carbon sink enhancement - Avoid deforestation	70.291
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	9.981
Land impacted for carbon sink enhancement - Extend rotation length	229.448
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	18.294
Land impacted for carbon sink enhancement - Increase trees outside forests	13.481
Land impacted for carbon sink enhancement - permanent conservation cover	0.893

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

variable_name	2050
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	5.843
Land impacted for carbon sink enhancement - Restore productivity	60.154
Land impacted for carbon sink enhancement - total	10.874
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	223.439

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	1.33
Business-as-usual carbon sink - Avoid deforestation	22.392
Business-as-usual carbon sink - Extend rotation length	125.524
Business-as-usual carbon sink - Improve plantations	0
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	2.71
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	1.428
Business-as-usual carbon sink - Restore productivity	21.176
Business-as-usual carbon sink - Total impacted (over 30 years)	0