Net-Zero America - pennsylvania 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	10.373	10.89	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.069	0.206	0.212	0.22	0.225	0.23	0.237
Sale of space heating units by type - Electric Resistance	0.097	0.113	0.111	0.109	0.107	0.101	0.094
Sale of space heating units by type - Fossil	0.246	0.297	0.177	0.102	0.098	0.098	0.098
Sale of space heating units by type - Gas	0.588	0.385	0.5	0.569	0.57	0.57	0.571
Sales of cooking units - Electric Resistance	0.548	0.548	0.548	0.548	0.548	0.548	0.548
Sales of cooking units - Gas	0.452	0.452	0.452	0.452	0.452	0.452	0.452
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	0.355	0.527	0.526	0.525	0.524	0.524	0.523
Sales of water heating units by type - Gas Furnace	0.588	0.435	0.436	0.437	0.437	0.438	0.439
Sales of water heating units by type - Other	0.057	0.038	0.038	0.039	0.039	0.039	0.039

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	0.014	0.019	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.04	0.061	0.069	0.085	0.103	0.119	0.131
End-use technology sales by technology - LDV - gasoline	0.896	0.859	0.836	0.816	0.795	0.775	0.76
End-use technology sales by technology - LDV - hybrid	0.048	0.056	0.069	0.074	0.08	0.085	0.089
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	508.988
Carbon sink enhancement potential - All (not counting overlap)	0	0	45943.9
Carbon sink enhancement potential - Avoid deforestation	0	0	4915.2
Carbon sink enhancement potential - Extend rotation length	0	0	14850.7
Carbon sink enhancement potential - Improve plantations	0	0	767.952
Carbon sink enhancement potential - Increase retention of HWP	0	0	9892
Carbon sink enhancement potential - Increase trees outside forests	0	0	1877.992
Carbon sink enhancement potential - Reforest cropland	0	0	326.235
Carbon sink enhancement potential - Reforest pasture	0	0	6338.5
Carbon sink enhancement potential - Restore productivity	0	0	6466.4
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	1319.413
Land impacted for carbon sink enhancement - Extend rotation length	0	0	8181
Land impacted for carbon sink enhancement - Improve plantations	0	0	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	529.755
Land impacted for carbon sink enhancement - Natural uptake	-32.93	-14.706	-13.15
Land impacted for carbon sink enhancement - Reforest cropland	0	0	108.617
Land impacted for carbon sink enhancement - Reforest pasture	0	0	479.292
Land impacted for carbon sink enhancement - Restore productivity	0	0	3648.972
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-1.615	-2.905	-3.02
Land impacted for carbon sink enhancement - Total	-34.545	-17.611	-16.17
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08

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	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.388	0.385	0.387	0.386	0.389	0.402	0.426
Final energy demand by sector - industry	0.792	0.798	0.821	0.83	0.852	0.875	0.887
Final energy demand by sector - residential	0.467	0.43	0.411	0.398	0.391	0.386	0.383
Final energy demand by sector - transportation	0.816	0.774	0.716	0.682	0.684	0.705	0.733

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	58458680356	60226318810	0	0	0	0
Sales of cooking units - Electric Resistance	0.185	0.194	0.194	0.196	0.197	0.198	0.199
Sales of cooking units - Gas	0.815	0.806	0.806	0.804	0.803	0.802	0.801
Sales of space heating units - Electric Heat Pump	0.026	0.128	0.398	0.617	0.65	0.656	0.655
Sales of space heating units - Electric Resistance	0.056	0.04	0.089	0.213	0.319	0.334	0.336
Sales of space heating units - Fossil	0.194	0.167	0.13	0.058	0.009	0.001	0
Sales of space heating units - Gas Furnace	0.724	0.664	0.384	0.111	0.022	0.01	0.009
Sales of water heating units - Electric Heat Pump	0.006	0.003	0.003	0.003	0.003	0.003	0.003
Sales of water heating units - Electric Resistance	0.035	0.02	0.019	0.019	0.019	0.019	0.019
Sales of water heating units - Gas Furnace	0.942	0.963	0.963	0.963	0.963	0.962	0.962
Sales of water heating units - Other	0.017	0.014	0.015	0.014	0.015	0.015	0.015

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	5.283	5.322	8.007	8.362	9.845	10.333

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	10.84	12.535	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.084	0.197	0.588	0.856	0.895	0.897	0.897
Sale of space heating units by type - Electric Resistance	0.095	0.118	0.079	0.038	0.031	0.032	0.033
Sale of space heating units by type - Fossil	0.242	0.313	0.125	0.069	0.064	0.063	0.062
Sale of space heating units by type - Gas	0.579	0.373	0.207	0.037	0.009	0.007	0.007
Sales of cooking units - Electric Resistance	0.554	0.649	0.94	0.997	1	1	1
Sales of cooking units - Gas	0.446	0.351	0.06	0.003	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.038	0.242	0.402	0.426	0.428	0.428
Sales of water heating units by type - Electric Resistance	0.355	0.524	0.524	0.563	0.571	0.571	0.571
Sales of water heating units by type - Gas Furnace	0.588	0.405	0.227	0.034	0.002	0	0
Sales of water heating units by type - Other	0.057	0.032	0.007	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	0.014	0.017	0.012	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.043	0.164	0.483	0.825	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.892	0.766	0.469	0.158	0.032	0.006	0
End-use technology sales by technology - LDV - hybrid	0.048	0.048	0.033	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	2057382273	5276387730	8545160810	12946262981	14088092033	13433386958
Number of public EV charging plugs - DC Fast Charging	267	0	3519	0	15411.7	0	24915.3
Number of public EV charging plugs - L2 Charging	1319	0	84552.2	0	370303.2	0	598648.8

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	0.031
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	0	0
Power generation capital investment - Solar PV - Base	0	1.235	2.289	11.728	18.788	27.734	33.487
Power generation capital investment - Solar PV - Constrained	0	0.076	2.554	12.173	15.15	34.637	27.826
Power generation capital investment - Wind - Base	0	0	0	0	0	0	0
Power generation capital investment - Wind - Constrained	0	0	0	15.81	85.678	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	30.7
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	168.948	611.669	2268.6	5743.6	11706.7	20449
HV transmission for wind and solar - base other intra-state	0	31.141	87.251	242.705	1155.6	3207.8	6324.4
HV transmission for wind and solar - base spur intra-state	0	76.807	227.794	948.935	2149.2	4229.2	7510.5
HV transmission for wind and solar - constrained all	0	378.134	1323.9	5347.4	17653.2	26409.2	33536.9
HV transmission for wind and solar - constrained other intra-state	0	58.395	83.502	446.631	4566.4	7276.5	9855.7
HV transmission for wind and solar - constrained spur intra-state	0	168.752	503.815	1880.2	7364.5	10395.8	12995.5

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	0.42
Capital investment	0	0	0	0	0	0	8.492
Number of facilities - allam power w ccu	0	0	0	0	0	0	1
Number of facilities - beccs hydrogen	0	0	0	0	0	0	9
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	1
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	3.35	3.32	6.84	18.56
Annual - BECCS	0	0	0	0	0	11.49
Annual - Cement	0	0	3.35	3.32	6.84	7.07
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	3.35	6.67	13.51	32.07
Cumulative - BECCS	0	0	0	0	0	11.49
Cumulative - Cement	0	0	3.35	6.67	13.51	20.58
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	1669009.184	2719766.5	2627422.538	2709546.494	3541259.7
CO2 pipelines - Spur	0	54586.295	190166.995	97823.395	179947.451	1011661.1
CO2 pipelines - Trunk	0	1614423.189	2529599.643	2529599.643	2529599.643	2529599.643

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	350.049	374.87	567.794	326.427	210.702	97.699	632.06
Jobs by economic sector - construction	16494.6	16337.8	16396.2	22401.3	28171.2	34354.9	45294.6
Jobs by economic sector - manufacturing	11278.1	19601.7	22640.3	28983.7	28118.8	23356.6	29915.4

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - mining	18558.3	13344.5	9255.9	6635.8	4454.2	2849.8	1740.3
Jobs by economic sector - other	856.215	840.028	1025.4	2668.1	4596.9	6936.4	10798.7
Jobs by economic sector - pipeline	2582.4	2599.7	2425.6	1919.9	1377.7	930.871	740.818
Jobs by economic sector - professional	8958.2	7980.5	7155.9	9193.5	11822.5	14796.3	20937.8
Jobs by economic sector - trade	8030.4	6467.6	5544.7	6816.9	8519.5	10749.2	15134.1
Jobs by economic sector - utilities	24164.5	22849.2	21083.1	22795.1	24713.4	26600.2	31660.6
Jobs by resource sector - Biomass	1125.9	1242.7	1475.1	816.617	567.921	365.084	2729.9
Jobs by resource sector - CO2	0	0	1595.9	1019.6	136.392	246.427	1445.9
Jobs by resource sector - Coal	11978.5	5456.7	2203	1747.6	1518.8	1367.3	1211.2
Jobs by resource sector - Grid	17267.9	17017.7	17048.8	25485.5	33636.1	43359.1	57864.8
Jobs by resource sector - Natural Gas	35586.4	34051.5	28380.2	22686	19156.7	13136.6	7603
Jobs by resource sector - Nuclear	4890	4428.4	3817.1	3179.3	1813.6	635.667	0
Jobs by resource sector - Oil	12341.9	11168.8	9435.7	7556.4	5500	4056.4	2774
Jobs by resource sector - Solar	5812.6	9471.7	12100.7	26280.4	37790.1	48918.3	72735.9
Jobs by resource sector - Wind	2269.7	7558.5	10038.6	12969.2	11865.3	8587.2	10489.8
Median wages - All	61908.8	62196.4	62443.1	62390	63104.3	64136	64668
Required Level of Education - Associates degree or some college	28200.3	28277.3	27132.9	32433.2	36053.9	39102.7	50749.3
Required Level of Education - Bachelors degree	19339.4	19135.5	17875.7	20440.1	22007	23331.3	30187.2
Required Level of Education - Doctoral degree	619.116	573.326	512.465	589.536	672.258	768.025	1034.4
Required Level of Education - High school diploma or less	38472.9	37948.5	36482.8	43619.8	48134.8	51879.3	67564.2
Required Level of Education - Masters or professional degree	4641.1	4461.4	4091.2	4658.1	5117	5590.6	7319.3
Wage income - All	5650795047	5622493704	5376248587	6348072491	7067495267	7740575743	10145260284

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	508.988
Carbon sink enhancement potential - All (not counting overlap)	45943.9
Carbon sink enhancement potential - Avoid deforestation	4915.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-607.058
Carbon sink enhancement potential - cropland measures	-3145.733
Carbon sink enhancement potential - Extend rotation length	14850.7
Carbon sink enhancement potential - Improve plantations	767.952
Carbon sink enhancement potential - Increase retention of HWP	9892
Carbon sink enhancement potential - Increase trees outside forests	1877.992
Carbon sink enhancement potential - permanent conservation cover	-142.83
Carbon sink enhancement potential - Reforest cropland	326.235
Carbon sink enhancement potential - Reforest pasture	6338.5
Carbon sink enhancement potential - Restore productivity	6466.4
Carbon sink enhancement potential - total	-3895.619
Land impacted for carbon sink enhancement - Accelerate regeneration	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	1319.413
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	278.198
Land impacted for carbon sink enhancement - cropland measures	2400.523
Land impacted for carbon sink enhancement - Extend rotation length	8181
Land impacted for carbon sink enhancement - Improve plantations	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	529.755
Land impacted for carbon sink enhancement - permanent conservation cover	259.782
Land impacted for carbon sink enhancement - Reforest cropland	108.617
Land impacted for carbon sink enhancement - Reforest pasture	479.292
Land impacted for carbon sink enhancement - Restore productivity	3648.972
Land impacted for carbon sink enhancement - total	2938.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	1111867	1128380	951160.6	762870	574277.2	361315.9	250599.3
Oil consumption	187707.6	181243.3	161878.7	132118.1	103578	81042	62021.6

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.388	0.381	0.368	0.346	0.323	0.31	0.307
Final energy demand by sector - industry	0.791	0.783	0.767	0.757	0.724	0.706	0.669
Final energy demand by sector - residential	0.467	0.427	0.389	0.337	0.289	0.255	0.236
Final energy demand by sector - transportation	0.816	0.765	0.673	0.56	0.457	0.393	0.364

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	59163412739	64630342584	0	0	0	0
Sales of cooking units - Electric Resistance	0.185	0.337	0.753	0.835	0.839	0.84	0.84
Sales of cooking units - Gas	0.815	0.663	0.247	0.165	0.161	0.16	0.16
Sales of space heating units - Electric Heat Pump	0.026	0.117	0.42	0.737	0.786	0.792	0.791
Sales of space heating units - Electric Resistance	0.056	0.048	0.133	0.19	0.202	0.199	0.2
Sales of space heating units - Fossil	0.194	0.148	0.029	0.001	0	0	0
Sales of space heating units - Gas Furnace	0.724	0.687	0.418	0.071	0.012	0.009	0.009
Sales of water heating units - Electric Heat Pump	0.006	0.048	0.296	0.522	0.558	0.56	0.56
Sales of water heating units - Electric Resistance	0.035	0.043	0.198	0.402	0.436	0.438	0.438
Sales of water heating units - Gas Furnace	0.942	0.898	0.502	0.074	0.004	0	0
Sales of water heating units - Other	0.017	0.012	0.004	0.002	0.002	0.002	0.002

Table 23: *RE- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	6.128	6.268	11.632	12.393	12.403	13.075

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	10.84	12.951	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.084	0.136	0.18	0.312	0.545	0.749	0.845
Sale of space heating units by type - Electric Resistance	0.095	0.122	0.118	0.104	0.078	0.052	0.039
Sale of space heating units by type - Fossil	0.242	0.348	0.327	0.266	0.17	0.103	0.077
Sale of space heating units by type - Gas	0.579	0.394	0.375	0.318	0.207	0.096	0.039
Sales of cooking units - Electric Resistance	0.552	0.564	0.605	0.713	0.863	0.956	0.988
Sales of cooking units - Gas	0.448	0.436	0.395	0.287	0.137	0.044	0.012
Sales of water heating units by type - Electric Heat Pump	0	0.008	0.031	0.101	0.227	0.342	0.398
Sales of water heating units by type - Electric Resistance	0.355	0.527	0.526	0.526	0.535	0.552	0.564
Sales of water heating units by type - Gas Furnace	0.588	0.428	0.408	0.346	0.224	0.1	0.036
Sales of water heating units by type - Other	0.057	0.037	0.035	0.026	0.014	0.005	0.002

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	0.014	0.019	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.02	0.05	0.125	0.268	0.494	0.727	0.878
End-use technology sales by technology - LDV - gasoline	0.913	0.869	0.786	0.654	0.45	0.241	0.107
End-use technology sales by technology - LDV - hybrid	0.05	0.058	0.064	0.058	0.043	0.025	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	333343662	699275535	2362561044	7431015267	10827389022
Number of public EV charging plugs - DC Fast Charging	267	0	1092.4	0	5719	0	15958.2
Number of public EV charging plugs - L2 Charging	1319	0	26248.4	0	137411.3	0	383434.1

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	508.988
Carbon sink enhancement potential - All (not counting overlap)	45943.9
Carbon sink enhancement potential - Avoid deforestation	4915.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-607.058

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-3145.733
Carbon sink enhancement potential - Extend rotation length	14850.7
Carbon sink enhancement potential - Improve plantations	767.952
Carbon sink enhancement potential - Increase retention of HWP	9892
Carbon sink enhancement potential - Increase trees outside forests	1877.992
Carbon sink enhancement potential - permanent conservation cover	-142.83
Carbon sink enhancement potential - Reforest cropland	326.235
Carbon sink enhancement potential - Reforest pasture	6338.5
Carbon sink enhancement potential - Restore productivity	6466.4
Carbon sink enhancement potential - total	-3895.619
Land impacted for carbon sink enhancement - Accelerate regeneration	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	1319.413
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	278.198
Land impacted for carbon sink enhancement - cropland measures	2400.523
Land impacted for carbon sink enhancement - Extend rotation length	8181
Land impacted for carbon sink enhancement - Improve plantations	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	529.755
Land impacted for carbon sink enhancement - permanent conservation cover	259.782
Land impacted for carbon sink enhancement - Reforest cropland	108.617
Land impacted for carbon sink enhancement - Reforest pasture	479.292
Land impacted for carbon sink enhancement - Restore productivity	3648.972
Land impacted for carbon sink enhancement - total	2938.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.388	0.381	0.378	0.375	0.368	0.359	0.349
Final energy demand by sector - industry	0.791	0.783	0.769	0.764	0.735	0.716	0.676
Final energy demand by sector - residential	0.467	0.428	0.403	0.379	0.349	0.315	0.281
Final energy demand by sector - transportation	0.817	0.772	0.705	0.65	0.607	0.555	0.495

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	59149716737	64632431878	0	0	0	0
Sales of cooking units - Electric Resistance	0.185	0.216	0.275	0.43	0.645	0.777	0.823
Sales of cooking units - Gas	0.815	0.784	0.725	0.57	0.355	0.223	0.177
Sales of space heating units - Electric Heat Pump	0.026	0.078	0.112	0.218	0.421	0.626	0.732
Sales of space heating units - Electric Resistance	0.056	0.035	0.044	0.074	0.127	0.168	0.19
Sales of space heating units - Fossil	0.194	0.172	0.164	0.128	0.066	0.022	0.008
Sales of space heating units - Gas Furnace	0.724	0.716	0.679	0.581	0.386	0.183	0.07
Sales of water heating units - Electric Heat Pump	0.006	0.013	0.042	0.127	0.288	0.441	0.519
Sales of water heating units - Electric Resistance	0.035	0.026	0.043	0.099	0.212	0.335	0.401
Sales of water heating units - Gas Furnace	0.942	0.947	0.902	0.764	0.494	0.221	0.078
Sales of water heating units - Other	0.017	0.013	0.013	0.01	0.006	0.003	0.002

Table 30: *REF scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	5.075	5.089	7.059	7.306	10.054	10.598

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	3.216	5.384	30.081	47.778	37.411	20.446
Power generation capital investment - Wind - Base	0	0	0	0	53.011	92.774

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	326.592	986.895	6368.6	17258	33178.5	46260
HV transmission for wind and solar - base other intra-state	0	46.933	90.699	1768.9	5318.5	9354	13485.4
HV transmission for wind and solar - base spur intra-state	0	165.358	500.84	2901.8	7463.1	15707.5	22406.5

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	508.988
Carbon sink enhancement potential - All (not counting overlap)	45943.9
Carbon sink enhancement potential - Avoid deforestation	4915.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-607.058
Carbon sink enhancement potential - cropland measures	-3145.733
Carbon sink enhancement potential - Extend rotation length	14850.7
Carbon sink enhancement potential - Improve plantations	767.952
Carbon sink enhancement potential - Increase retention of HWP	9892
Carbon sink enhancement potential - Increase trees outside forests	1877.992
Carbon sink enhancement potential - permanent conservation cover	-142.83
Carbon sink enhancement potential - Reforest cropland	326.235
Carbon sink enhancement potential - Reforest pasture	6338.5
Carbon sink enhancement potential - Restore productivity	6466.4
Carbon sink enhancement potential - total	-3895.619
Land impacted for carbon sink enhancement - Accelerate regeneration	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	1319.413
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	278.198
Land impacted for carbon sink enhancement - cropland measures	2400.523
Land impacted for carbon sink enhancement - Extend rotation length	8181
Land impacted for carbon sink enhancement - Improve plantations	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	529.755
Land impacted for carbon sink enhancement - permanent conservation cover	259.782
Land impacted for carbon sink enhancement - Reforest cropland	108.617
Land impacted for carbon sink enhancement - Reforest pasture	479.292
Land impacted for carbon sink enhancement - Restore productivity	3648.972
Land impacted for carbon sink enhancement - total	2938.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325

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	1.24
Capital investment	0	0	0	0	0	0	14.052
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	15
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	3.35	3.32	6.84	7.07
Annual - BECCS	0	0	0	0	0	0
Annual - Cement	0	0	3.35	3.32	6.84	7.07
Annual - NGCC	0	0	0	0	0	0
Cumulative - All	0	0	3.35	6.67	13.51	20.58
Cumulative - BECCS	0	0	0	0	0	0
Cumulative - Cement	0	0	3.35	6.67	13.51	20.58
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	1669012.184	2627614.538	2627450.538	3210969.5	3122361.494
CO2 pipelines - Spur	0	54589.395	98014.895	97851.195	272201.851	183594.351
CO2 pipelines - Trunk	0	1614423.189	2529599.643	2529599.643	2938767.643	2938767.643

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	508.988
Carbon sink enhancement potential - All (not counting overlap)	45943.9
Carbon sink enhancement potential - Avoid deforestation	4915.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-1253.728
Carbon sink enhancement potential - cropland measures	-2920.896
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	14850.7
Carbon sink enhancement potential - Improve plantations	767.952
Carbon sink enhancement potential - Increase retention of HWP	9892
Carbon sink enhancement potential - Increase trees outside forests	1877.992
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-132.217
Carbon sink enhancement potential - Reforest cropland	326.235
Carbon sink enhancement potential - Reforest pasture	6338.5
Carbon sink enhancement potential - Restore productivity	6466.4
Carbon sink enhancement potential - total	-4306.841
Land impacted for carbon sink enhancement - Accelerate regeneration	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	1319.413
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	506.042
Land impacted for carbon sink enhancement - cropland measures	4362.097

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	29.534
Land impacted for carbon sink enhancement - Extend rotation length	8181
Land impacted for carbon sink enhancement - Improve plantations	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	529.755
Land impacted for carbon sink enhancement - pasture to energy crops	116.236
Land impacted for carbon sink enhancement - permanent conservation cover	240.479
Land impacted for carbon sink enhancement - Reforest cropland	108.617
Land impacted for carbon sink enhancement - Reforest pasture	479.292
Land impacted for carbon sink enhancement - Restore productivity	3648.972
Land impacted for carbon sink enhancement - total	5254.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	508.988
Carbon sink enhancement potential - All (not counting overlap)	45943.9
Carbon sink enhancement potential - Avoid deforestation	4915.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-607.058
Carbon sink enhancement potential - cropland measures	-3145.733
Carbon sink enhancement potential - Extend rotation length	14850.7
Carbon sink enhancement potential - Improve plantations	767.952
Carbon sink enhancement potential - Increase retention of HWP	9892
Carbon sink enhancement potential - Increase trees outside forests	1877.992
Carbon sink enhancement potential - permanent conservation cover	-142.83
Carbon sink enhancement potential - Reforest cropland	326.235
Carbon sink enhancement potential - Reforest pasture	6338.5
Carbon sink enhancement potential - Restore productivity	6466.4
Carbon sink enhancement potential - total	-3895.619
Land impacted for carbon sink enhancement - Accelerate regeneration	205.141
Land impacted for carbon sink enhancement - All (not counting overlap)	8340.7
Land impacted for carbon sink enhancement - Avoid deforestation	1319.413
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	278.198
Land impacted for carbon sink enhancement - cropland measures	2400.523
Land impacted for carbon sink enhancement - Extend rotation length	8181
Land impacted for carbon sink enhancement - Improve plantations	426.811
Land impacted for carbon sink enhancement - Increase retention of HWP	1978.4
Land impacted for carbon sink enhancement - Increase trees outside forests	529.755
Land impacted for carbon sink enhancement - permanent conservation cover	259.782
Land impacted for carbon sink enhancement - Reforest cropland	108.617
Land impacted for carbon sink enhancement - Reforest pasture	479.292
Land impacted for carbon sink enhancement - Restore productivity	3648.972
Land impacted for carbon sink enhancement - total	2938.4
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	8536.8

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	47.569
Business-as-usual carbon sink - Avoid deforestation	420.304
Business-as-usual carbon sink - Extend rotation length	4475.6
Business-as-usual carbon sink - Improve plantations	162.08
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	106.512
Business-as-usual carbon sink - Reforest cropland	12.325
Business-as-usual carbon sink - Reforest pasture	117.091
Business-as-usual carbon sink - Restore productivity	1284.6
Business-as-usual carbon sink - Total impacted (over 30 years)	12.325