Net-Zero America - massachusetts state report v2

Larson et al. 2020

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Reading guide

IN DRAFT

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Table 1: *E- scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	5.62	6.189	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.069	0.131	0.535	0.878	0.931	0.934	0.934
Sale of space heating units by type - Electric Resistance	0.062	0.092	0.071	0.031	0.023	0.023	0.025
Sale of space heating units by type - Fossil	0.324	0.416	0.138	0.049	0.041	0.041	0.039
Sale of space heating units by type - Gas	0.545	0.362	0.256	0.043	0.005	0.003	0.002
Sales of cooking units - Electric Resistance	0.641	0.717	0.952	0.998	1	1	1
Sales of cooking units - Gas	0.359	0.283	0.048	0.002	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.012	0.122	0.318	0.352	0.354	0.354
Sales of water heating units by type - Electric Resistance	0.305	0.489	0.547	0.629	0.644	0.645	0.644
Sales of water heating units by type - Gas Furnace	0.6	0.442	0.319	0.051	0.003	0	0
Sales of water heating units by type - Other	0.095	0.057	0.012	0.001	0.001	0.001	0.001

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	0.972	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	0.044	0.167	0.487	0.827	0.964	0.993	1
End-use technology sales by technology - LDV - gasoline	0.891	0.763	0.464	0.156	0.032	0.006	0
End-use technology sales by technology - LDV - hybrid	0.049	0.049	0.034	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	962459082	2495298373	3997491246	6073698550	6590516647	6294465338
Number of public EV charging plugs - DC Fast Charging	317	0	1487.7	0	6238.8	0	10035.4
Number of public EV charging plugs - L2 Charging	2255	0	35708.2	0	149746	0	240874.4

Table 3: *E- 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	1.13	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0.005	0.001	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0.006	0	0.001	0	0.015
Power generation capital investment - Offshore Wind - Base	0	1.947	8.252	14.144	18.773	9.706	0.655
Power generation capital investment - Offshore Wind - Constrained	0	0	8.663	15.563	14.963	0	4.549
Power generation capital investment - Solar PV - Base	0	0	1.334	1.907	4.384	5.826	0
Power generation capital investment - Solar PV - Constrained	0	0.202	0.495	3.918	2.716	7.221	0
Power generation capital investment - Wind - Base	0	0.105	1.708	0.488	0.32	0	0.218
Power generation capital investment - Wind - Constrained	0	0.105	1.916	0.167	0.279	0.17	0.21

Table 4: *E- scenario - PILLAR 2: Clean Electricity - Generation*

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation by technology - biomass power plant	0	0	2220.1	2220.1	2220.1	2220.1	2220.1
Power generation by technology - biomass w/ccu allam power plant	0	0	0	5.424	6.256	6.256	6.256
Power generation by technology - biomass w/ccu power plant	0	0	6.989	6.989	7.717	7.717	24.071

Table 5: *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	1162.1	7045.7	20784.6	41623.9	59199	65270.8
HV transmission for wind and solar - base other intra-state	0	883.323	5226.6	13845.3	26791.1	35516	38845.5
HV transmission for wind and solar - base spur intra-state	0	228.114	1367.9	5955.7	12928	20578.7	21611.9
HV transmission for wind and solar - constrained all	0	605.081	6075.5	18848.3	37642.5	39337.4	50512.7
HV transmission for wind and solar - constrained other intra-state	0	455.108	3923.4	13373.7	23579.1	23785.3	30022
HV transmission for wind and solar - constrained spur intra-state	0	0.625	1785.1	4723.1	12745.7	13406.5	17670.6

Table 6: *E- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion*

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.069	0.07	0.071	0.071	0.143
Capital investment	0	0	1.194	0	0.053	0	1.934

Table 6: *E- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion (continued)*

variable_name	2020	2025	2030	2035	2040	2045	2050
Number of facilities - allam power w ccu	0	0	0	1	1	1	1
Number of facilities - beccs hydrogen	0	0	0	1	1	1	2
Number of facilities - diesel	0	0	0	1	1	1	1
Number of facilities - diesel ccu	0	0	0	1	1	1	1
Number of facilities - power	0	0	2	2	2	2	2
Number of facilities - power ccu	0	0	1	1	1	1	2
Number of facilities - pyrolysis	0	0	0	1	1	1	2
Number of facilities - pyrolysis ccu	0	0	0	1	1	1	2
Number of facilities - sng	0	0	1	1	1	1	1
Number of facilities - sng ccu	0	0	1	1	1	1	1

Table 7: *E- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0.01	0.02	0.03	0.03	1.32
Annual - BECCS	0	0.01	0.02	0.02	0.02	1.31
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0.01	0.01	0	0.01
Cumulative - All	0	0.01	0.03	0.06	0.09	1.41
Cumulative - BECCS	0	0.01	0.03	0.05	0.07	1.38
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0.01	0.02	0.02	0.03

Table 8: *E- 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 9: *E- scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	263849.758	339080.68	339091.18	339090.38	494462.092
CO2 pipelines - Spur	0	19141.107	94372.028	94382.528	94381.728	249753.441
CO2 pipelines - Trunk	0	244708.651	244708.651	244708.651	244708.651	244708.651

Table 10: *E- scenario - IMPACTS - Jobs*

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	97.377	112.262	304.33	292.755	247.276	198.031	283.287
Jobs by economic sector - construction	16496.8	13426.2	11962.6	16967.4	24459.5	25943	26719.6
Jobs by economic sector - manufacturing	3216.1	4933.2	8933.6	9220	11051.8	14310.6	19224
Jobs by economic sector - mining	2156.4	1719.3	1227.8	795.486	483.63	272.545	151.214
Jobs by economic sector - other	2658.5	2212.2	1663.8	2323.9	3509.2	4213.6	5722.8
Jobs by economic sector - pipeline	430.64	422.837	387.301	281.332	208.057	135.22	112.992
Jobs by economic sector - professional	5486.9	5017.2	5504	8234.5	12721.2	14433.3	16236.4
Jobs by economic sector - trade	4158.4	3698.4	3519	4915.9	7458.7	8664.8	10294.1
Jobs by economic sector - utilities	4423	5495.5	8636.4	14906.6	22673.1	22599.5	18210.1
Jobs by resource sector - Biomass	403.652	481.815	839.116	833.804	744.383	722.243	1209.7
Jobs by resource sector - CO2	0	0	243.214	2.22	5.644	5.629	184.511
Jobs by resource sector - Grid	5076.2	7278	14160.2	28053.3	42602.8	43034.5	34300.8
Jobs by resource sector - Natural Gas	4219.6	4338.2	3537.6	2623.9	3481.4	2501.4	1473
Jobs by resource sector - Nuclear	0	0	0.012	0.027	0.03	0.058	0.074
Jobs by resource sector - Oil	4598.9	3929.7	3107.3	2204.4	1475.5	956.825	589.422
Jobs by resource sector - Solar	24464.9	20139.5	14280.4	13698.1	18680	24790.3	34338.3
Jobs by resource sector - Wind	360.869	869.93	5971	10522.2	15822.7	18759.6	24858.7
Median wages - All	66742.9	67705	68862.5	70929.8	72486.8	73095.1	72989.4
Required Level of Education - Associates degree or some college	12354.5	11756.6	13447.3	18694.8	26900.7	29455.6	31306.7
Required Level of Education - Bachelors degree	7454.4	7187.6	8334.5	11371.9	16321.9	18044.2	19500.2
Required Level of Education - Doctoral degree	293.694	265.906	281.478	395.312	588.001	659.655	737.77
Required Level of Education - High school diploma or less	17209.2	16095.1	18088.7	24678.8	34909.5	38093.3	40552.8
Required Level of Education - Masters or professional degree	1812.3	1732	1986.9	2797.3	4092.4	4517.8	4857
Wage income - All	2611716232	2507992654	2902104502	4109994688	6003527901	6635742574	7077776844

Table 11: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	63.803
Carbon sink enhancement potential - All (not counting overlap)	7799.9
Carbon sink enhancement potential - Avoid deforestation	1814.635
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-160.37
Carbon sink enhancement potential - Extend rotation length	3308.1
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	862.843
Carbon sink enhancement potential - Increase trees outside forests	352.549

Table 11: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture (continued)*

variable_name	2050
Carbon sink enhancement potential - permanent conservation cover	-4.929
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	472.42
Carbon sink enhancement potential - Restore productivity	925.723
Carbon sink enhancement potential - total	-165.299
Land impacted for carbon sink enhancement - Accelerate regeneration	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	487.102
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	96.713
Land impacted for carbon sink enhancement - Extend rotation length	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	99.451
Land impacted for carbon sink enhancement - permanent conservation cover	8.964
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	35.723
Land impacted for carbon sink enhancement - Restore productivity	522.395
Land impacted for carbon sink enhancement - total	105.678
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	1748.513

Table 12: *E- scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
Business-as-usual carbon sink - Total impacted (over 30 years)	0

Table 13: *E- scenario - IMPACTS - Fossil fuel industries*

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	334901.5	339875.2	286495.6	229781.3	172975.9	108830.6	75482.1
Oil consumption	94344.8	88392.9	76169.1	58530.5	42180.4	29281.1	19201.7

Table 14: *E- scenario - PILLAR 1: Efficiency/Electrification - Overview*

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.253	0.241	0.23	0.215	0.199	0.188	0.181
Final energy demand by sector - industry	0.081	0.079	0.079	0.079	0.081	0.082	0.083
Final energy demand by sector - residential	0.286	0.269	0.25	0.218	0.185	0.159	0.144
Final energy demand by sector - transportation	0.5	0.466	0.414	0.349	0.289	0.25	0.231

Table 15: *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	13316743613	14546210599	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	0.043	0.107	0.386	0.722	0.778	0.781	0.781
Sales of space heating units - Electric Resistance	0.021	0.046	0.164	0.213	0.219	0.219	0.219
Sales of space heating units - Fossil	0.237	0.299	0.057	0.002	0	0	0
Sales of space heating units - Gas Furnace	0.699	0.549	0.392	0.063	0.004	0	0
Sales of water heating units - Electric Heat Pump	0.02	0.035	0.158	0.411	0.456	0.46	0.459
Sales of water heating units - Electric Resistance	0.102	0.124	0.239	0.48	0.523	0.525	0.525
Sales of water heating units - Gas Furnace	0.848	0.804	0.584	0.093	0.006	0	0
Sales of water heating units - Other	0.03	0.038	0.019	0.016	0.016	0.016	0.016

Table 16: *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	2.59	2.67	6.632	7.175	6.625	7.038

Table 17: *RE- scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	5.48	5.696	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.067	0.098	0.102	0.106	0.109	0.112	0.116
Sale of space heating units by type - Electric Resistance	0.062	0.089	0.087	0.086	0.085	0.081	0.078
Sale of space heating units by type - Fossil	0.325	0.409	0.226	0.097	0.088	0.088	0.088
Sale of space heating units by type - Gas	0.546	0.404	0.585	0.711	0.717	0.719	0.718
Sales of cooking units - Electric Resistance	0.636	0.636	0.636	0.636	0.636	0.636	0.636
Sales of cooking units - Gas	0.364	0.364	0.364	0.364	0.364	0.364	0.364
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	0.305	0.481	0.481	0.482	0.482	0.482	0.482
Sales of water heating units by type - Gas Furnace	0.6	0.451	0.451	0.45	0.45	0.45	0.45
Sales of water heating units by type - Other	0.095	0.068	0.068	0.068	0.068	0.068	0.069

Table 18: *RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.981	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	0.018	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.041	0.062	0.071	0.087	0.106	0.121	0.133
End-use technology sales by technology - LDV - gasoline	0.894	0.857	0.834	0.813	0.792	0.773	0.758
End-use technology sales by technology - LDV - hybrid	0.049	0.057	0.07	0.076	0.081	0.086	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 19: *RE- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2020	2030	2050
Carbon sink enhancement potential - Accelerate regeneration	0	0	63.803
Carbon sink enhancement potential - All (not counting overlap)	0	0	7799.9
Carbon sink enhancement potential - Avoid deforestation	0	0	1814.635
Carbon sink enhancement potential - Extend rotation length	0	0	3308.1
Carbon sink enhancement potential - Improve plantations	0	0	0
Carbon sink enhancement potential - Increase retention of HWP	0	0	862.843
Carbon sink enhancement potential - Increase trees outside forests	0	0	352.549
Carbon sink enhancement potential - Reforest cropland	0	0	0
Carbon sink enhancement potential - Reforest pasture	0	0	472.42
Carbon sink enhancement potential - Restore productivity	0	0	925.723
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	487.102
Land impacted for carbon sink enhancement - Extend rotation length	0	0	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0	0	0
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	99.451
Land impacted for carbon sink enhancement - Natural uptake	-4.85	-2.632	-2.354
Land impacted for carbon sink enhancement - Reforest cropland	0	0	0
Land impacted for carbon sink enhancement - Reforest pasture	0	0	35.723
Land impacted for carbon sink enhancement - Restore productivity	0	0	522.395
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.141	-0.253	-0.263
Land impacted for carbon sink enhancement - Total	-4.991	-2.886	-2.617
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	1748.513

Table 20: *RE- scenario - PILLAR 6: Land carbon sinks - Forests*

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
Business-as-usual carbon sink - Improve plantations	0

Table 20: *RE- 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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
Business-as-usual carbon sink - Total impacted (over 30 years)	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.253	0.246	0.249	0.25	0.251	0.258	0.269
Final energy demand by sector - industry	0.081	0.082	0.085	0.089	0.094	0.099	0.104
Final energy demand by sector - residential	0.286	0.272	0.264	0.261	0.258	0.256	0.255
Final energy demand by sector - transportation	0.501	0.474	0.444	0.426	0.429	0.442	0.458

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	13152582783	13533901232	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	0.043	0.129	0.41	0.64	0.677	0.681	0.682
Sales of space heating units - Electric Resistance	0.021	0.029	0.077	0.2	0.301	0.317	0.318
Sales of space heating units - Fossil	0.237	0.333	0.236	0.093	0.013	0.001	0
Sales of space heating units - Gas Furnace	0.699	0.509	0.278	0.067	0.009	0	0
Sales of water heating units - Electric Heat Pump	0.02	0.024	0.023	0.024	0.023	0.024	0.024
Sales of water heating units - Electric Resistance	0.102	0.113	0.111	0.113	0.112	0.111	0.111
Sales of water heating units - Gas Furnace	0.848	0.821	0.825	0.823	0.823	0.826	0.825
Sales of water heating units - Other	0.03	0.042	0.04	0.041	0.041	0.04	0.04

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	1.897	1.895	4.443	4.744	4.914	5.199

Table 24: *REF scenario - PILLAR 1: Efficiency/Electrification - Residential*

variable_name	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr	0	5.626	6.474	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.069	0.074	0.12	0.26	0.518	0.76	0.88
Sale of space heating units by type - Electric Resistance	0.062	0.092	0.089	0.081	0.064	0.041	0.029
Sale of space heating units by type - Fossil	0.324	0.467	0.438	0.346	0.199	0.096	0.056
Sale of space heating units by type - Gas	0.545	0.367	0.353	0.313	0.219	0.103	0.035
Sales of cooking units - Electric Resistance	0.64	0.649	0.682	0.769	0.89	0.964	0.99
Sales of cooking units - Gas	0.36	0.351	0.318	0.231	0.11	0.036	0.01
Sales of water heating units by type - Electric Heat Pump	0	0.005	0.017	0.058	0.151	0.261	0.324
Sales of water heating units by type - Electric Resistance	0.305	0.483	0.49	0.512	0.556	0.605	0.632
Sales of water heating units by type - Gas Furnace	0.6	0.446	0.432	0.384	0.27	0.126	0.041
Sales of water heating units by type - Other	0.095	0.066	0.061	0.046	0.023	0.008	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	0.014	0.019	0.02	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.021	0.051	0.126	0.271	0.497	0.729	0.879
End-use technology sales by technology - LDV - gasoline	0.912	0.867	0.784	0.651	0.447	0.239	0.106
End-use technology sales by technology - LDV - hybrid	0.051	0.059	0.065	0.059	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	160665268	326559757	1113422269	3470263746	5067347108
Number of public EV charging plugs - DC Fast Charging	317	0	499.121	0	2344.2	0	6427.7
Number of public EV charging plugs - L2 Charging	2255	0	11980.1	0	56266.5	0	154279.9

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	63.803
Carbon sink enhancement potential - All (not counting overlap)	7799.9
Carbon sink enhancement potential - Avoid deforestation	1814.635
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-160.37
Carbon sink enhancement potential - Extend rotation length	3308.1
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	862.843
Carbon sink enhancement potential - Increase trees outside forests	352.549
Carbon sink enhancement potential - permanent conservation cover	-4.929
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	472.42
Carbon sink enhancement potential - Restore productivity	925.723
Carbon sink enhancement potential - total	-165.299
Land impacted for carbon sink enhancement - Accelerate regeneration	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	487.102
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	96.713
Land impacted for carbon sink enhancement - Extend rotation length	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	99.451
Land impacted for carbon sink enhancement - permanent conservation cover	8.964
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	35.723
Land impacted for carbon sink enhancement - Restore productivity	522.395
Land impacted for carbon sink enhancement - total	105.678
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	1748.513

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
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	0.253	0.241	0.235	0.23	0.223	0.216	0.207
Final energy demand by sector - industry	0.081	0.079	0.08	0.081	0.083	0.084	0.085
Final energy demand by sector - residential	0.286	0.27	0.259	0.248	0.231	0.207	0.181
Final energy demand by sector - transportation	0.501	0.471	0.433	0.4	0.373	0.341	0.304

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	13314668556	14553390066	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	0.043	0.076	0.108	0.207	0.406	0.616	0.729
Sales of space heating units - Electric Resistance	0.021	0.025	0.038	0.077	0.142	0.191	0.21
Sales of space heating units - Fossil	0.237	0.345	0.324	0.244	0.119	0.038	0.01
Sales of space heating units - Gas Furnace	0.699	0.554	0.531	0.472	0.333	0.155	0.051
Sales of water heating units - Electric Heat Pump	0.02	0.029	0.043	0.09	0.201	0.34	0.42
Sales of water heating units - Electric Resistance	0.102	0.118	0.129	0.176	0.281	0.411	0.488
Sales of water heating units - Gas Furnace	0.848	0.812	0.79	0.702	0.494	0.231	0.075
Sales of water heating units - Other	0.03	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	1.913	1.912	3.036	3.169	5.625	6.035

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	1.72	8.252	26.035	18.468	2.738	0
Power generation capital investment - Solar PV - Base	0	2.485	4.937	8.239	2.036	0
Power generation capital investment - Wind - Base	0.105	1.708	0.488	0.32	0	0.218

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	954.465	6596.2	29841.2	52540.5	58050.9	58924.6
HV transmission for wind and solar - base other intra-state	0	717.998	4770.1	19680.1	31526	33498.2	33799.3
HV transmission for wind and solar - base spur intra-state	0	217.351	1461.7	9106.7	18980.2	22070.7	22079.3

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	63.803
Carbon sink enhancement potential - All (not counting overlap)	7799.9
Carbon sink enhancement potential - Avoid deforestation	1814.635
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-160.37
Carbon sink enhancement potential - Extend rotation length	3308.1
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	862.843
Carbon sink enhancement potential - Increase trees outside forests	352.549
Carbon sink enhancement potential - permanent conservation cover	-4.929
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	472.42
Carbon sink enhancement potential - Restore productivity	925.723
Carbon sink enhancement potential - total	-165.299
Land impacted for carbon sink enhancement - Accelerate regeneration	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	487.102
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	96.713
Land impacted for carbon sink enhancement - Extend rotation length	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	99.451
Land impacted for carbon sink enhancement - permanent conservation cover	8.964
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	35.723
Land impacted for carbon sink enhancement - Restore productivity	522.395
Land impacted for carbon sink enhancement - total	105.678
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	1748.513

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
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	0.403	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0.006	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0.006	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	791.597	791.597	791.597	791.597	791.597
Power generation by technology - biomass w/ccu allam power plant	0	0	0	5.532	5.814	6.238	6.238
Power generation by technology - biomass w/ccu power plant	0	0	7.086	7.086	7.22	7.571	7.571

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.045	0.049	0.052	0.053	0.355
Capital investment	0	0	0.429	0	0.105	0	4.381
Number of facilities - allam power w ccu	0	0	0	1	1	1	1
Number of facilities - beccs hydrogen	0	0	0	1	1	1	2
Number of facilities - diesel	0	0	0	1	1	1	1
Number of facilities - diesel ccu	0	0	0	1	1	1	1
Number of facilities - power	0	0	1	1	1	1	1
Number of facilities - power ccu	0	0	1	1	1	1	1
Number of facilities - pyrolysis	0	0	0	1	1	1	3
Number of facilities - pyrolysis ccu	0	0	0	1	1	1	1
Number of facilities - sng	0	0	1	1	1	1	1
Number of facilities - sng ccu	0	0	1	1	1	1	1

Table 38: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0.01	0.02	0.03	0.03	2.76
Annual - BECCS	0	0.01	0.02	0.02	0.02	2.75
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0.01
Cumulative - All	0	0.01	0.03	0.06	0.09	2.85
Cumulative - BECCS	0	0.01	0.03	0.05	0.07	2.82
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	0	0	0	0.01

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	263850.658	339089.68	339095.38	339107.78	407411.445
CO2 pipelines - Spur	0	19142.007	94381.028	94386.728	94399.128	162702.794
CO2 pipelines - Trunk	0	244708.651	244708.651	244708.651	244708.651	244708.651

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	63.803
Carbon sink enhancement potential - All (not counting overlap)	7799.9
Carbon sink enhancement potential - Avoid deforestation	1814.635
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-160.37
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	3308.1
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	862.843
Carbon sink enhancement potential - Increase trees outside forests	352.549
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-4.929
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	472.42
Carbon sink enhancement potential - Restore productivity	925.723

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

variable_name	2050
Carbon sink enhancement potential - total	-165.299
Land impacted for carbon sink enhancement - Accelerate regeneration	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	487.102
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	189.973
Land impacted for carbon sink enhancement - Cropland to woody energy crops	0
Land impacted for carbon sink enhancement - Extend rotation length	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	99.451
Land impacted for carbon sink enhancement - pasture to energy crops	2.996
Land impacted for carbon sink enhancement - permanent conservation cover	8.964
Land impacted for carbon sink enhancement - Reforest cropland	0
Land impacted for carbon sink enhancement - Reforest pasture	35.723
Land impacted for carbon sink enhancement - Restore productivity	522.395
Land impacted for carbon sink enhancement - total	201.935
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	1748.513

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
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	63.803
Carbon sink enhancement potential - All (not counting overlap)	7799.9
Carbon sink enhancement potential - Avoid deforestation	1814.635
Carbon sink enhancement potential - corn-ethanol to energy grasses	0
Carbon sink enhancement potential - cropland measures	-160.37
Carbon sink enhancement potential - Extend rotation length	3308.1
Carbon sink enhancement potential - Improve plantations	0
Carbon sink enhancement potential - Increase retention of HWP	862.843
Carbon sink enhancement potential - Increase trees outside forests	352.549
Carbon sink enhancement potential - permanent conservation cover	-4.929
Carbon sink enhancement potential - Reforest cropland	0
Carbon sink enhancement potential - Reforest pasture	472.42
Carbon sink enhancement potential - Restore productivity	925.723
Carbon sink enhancement potential - total	-165.299
Land impacted for carbon sink enhancement - Accelerate regeneration	25.714
Land impacted for carbon sink enhancement - All (not counting overlap)	1416.7
Land impacted for carbon sink enhancement - Avoid deforestation	487.102
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	0
Land impacted for carbon sink enhancement - cropland measures	96.713
Land impacted for carbon sink enhancement - Extend rotation length	1822.346
Land impacted for carbon sink enhancement - Improve plantations	0
Land impacted for carbon sink enhancement - Increase retention of HWP	172.569
Land impacted for carbon sink enhancement - Increase trees outside forests	99.451
Land impacted for carbon sink enhancement - permanent conservation cover	8.964

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	35.723
Land impacted for carbon sink enhancement - Restore productivity	522.395
Land impacted for carbon sink enhancement - total	105.678
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	1748.513

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	5.963
Business-as-usual carbon sink - Avoid deforestation	155.168
Business-as-usual carbon sink - Extend rotation length	996.95
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	19.995
Business-as-usual carbon sink - Reforest cropland	0
Business-as-usual carbon sink - Reforest pasture	8.727
Business-as-usual carbon sink - Restore productivity	183.898
Business-as-usual carbon sink - Total impacted (over 30 years)	0