Net-Zero America - colorado 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	4.422	4.7	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.056	0.145	0.372	0.826	0.92	0.927	0.927
Sale of space heating units by type - Electric Resistance	0.077	0.138	0.11	0.049	0.037	0.036	0.036
Sale of space heating units by type - Fossil	0.032	0.057	0.045	0.021	0.016	0.015	0.015
Sale of space heating units by type - Gas	0.835	0.66	0.473	0.104	0.028	0.022	0.022
Sales of cooking units - Electric Resistance	0.505	0.61	0.933	0.997	1	1	1
Sales of cooking units - Gas	0.495	0.39	0.067	0.003	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.009	0.121	0.364	0.414	0.417	0.418
Sales of water heating units by type - Electric Resistance	0.132	0.259	0.342	0.527	0.567	0.57	0.57
Sales of water heating units by type - Gas Furnace	0.857	0.72	0.524	0.096	0.007	0	0
Sales of water heating units by type - Other	0.011	0.012	0.012	0.012	0.012	0.012	0.012

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	0.018	0.02	0.013	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.032	0.129	0.429	0.804	0.962	0.993	1
End-use technology sales by technology - LDV - gasoline	0.912	0.806	0.525	0.18	0.035	0.006	0
End-use technology sales by technology - LDV - hybrid	0.037	0.04	0.03	0.011	0.003	0.001	0
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.002	0.001	0	0	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0	0	0	0
End-use technology sales by technology - MDV - diesel	0.647	0.597	0.423	0.144	0.026	0.004	0
End-use technology sales by technology - MDV - EV	0.008	0.051	0.253	0.608	0.765	0.795	0.8
End-use technology sales by technology - MDV - gasoline	0.337	0.333	0.255	0.093	0.018	0.003	0
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.003	0.001	0	0	0
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.013	0.063	0.152	0.191	0.199	0.2
End-use technology sales by technology - MDV - other	0.003	0.003	0.002	0.001	0	0	0
Light-duty vehicle capital costs - Cumulative 5-yr	0	1013899315	2643715654	4211143843	6407996071	6942757819	6636591196
Number of public EV charging plugs - DC Fast Charging	303	0	1767.2	0	7251	0	11633.2
Number of public EV charging plugs - L2 Charging	2117	0	42494	0	174359.4	0	279734

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	0	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0.01	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	0.041	0.399
Power generation capital investment - Solar PV - Base	0	0.669	0.644	2.543	2.966	3.432	2.483
Power generation capital investment - Solar PV - Constrained	0	1.948	1.035	2.193	2.607	2.018	0.721
Power generation capital investment - Wind - Base	0	0.226	1.906	0.621	2.454	2.983	1.375
Power generation capital investment - Wind - Constrained	0	1.316	2.221	2.911	6.72	6.614	3.725

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	0	0	0	0	0
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	0	9.89	9.89
Power generation by technology - biomass w/ccu power plant	0	0	0	0	0	46.228	493.963

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	1224.8	2536.1	5057.7	8973.8	14441.4	17188.6
HV transmission for wind and solar - base other intra-state	0	298.747	678.242	941.949	1938.9	3698.6	5168.9
HV transmission for wind and solar - base spur intra-state	0	191.539	309.726	456.408	846.155	1347.1	1650
HV transmission for wind and solar - constrained all	0	1967.5	3360	5441.2	10767.5	15135	20992.3
HV transmission for wind and solar - constrained other intra-state	0	536.194	853.475	1293.9	2635.3	3569.4	4234.5
HV transmission for wind and solar - constrained spur intra-state	0	173.585	276.844	549.332	1418.3	2174.3	2782

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0	0.022	0.179	0.325
Capital investment	0	0	0	0	0.311	0	4.3
Number of facilities - allam power w ccu	0	0	0	0	0	1	1
Number of facilities - beccs hydrogen	0	0	0	0	1	3	5
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	0	1	1

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	0	2	3
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	1	1
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	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	0.02	3.38	3.77	6.87	9.81
Annual - BECCS	0	0	0	0.42	3.41	6.22
Annual - Cement	0	0	3.35	3.32	3.42	3.53
Annual - NGCC	0	0.02	0.02	0.03	0.03	0.05
Cumulative - All	0	0.02	3.4	7.17	14.04	23.85
Cumulative - BECCS	0	0	0	0.42	3.83	10.05
Cumulative - Cement	0	0	3.35	6.67	10.09	13.62
Cumulative - NGCC	0	0.02	0.04	0.07	0.1	0.15

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

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	0	0.88	0.9	1.72	2.8
Injection wells	0	0	2	3	5	6
Resource characterization, appraisal and permitting costs cumulative	35.96	86.32	100.7	100.7	100.7	100.7
Wells and facilities construction costs cumulative	0	11.97	46.66	83.16	139.05	172.63

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1225205.867	1484525.895	1688174.865	1903029.7	2650798.8
CO2 pipelines - Spur	0	300.189	259620.728	463269.898	678124.194	1425893.4
CO2 pipelines - Trunk	0	1224905.367	1224905.367	1224905.367	1224905.367	1224905.367

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	225.852	227.256	238.213	217.357	150.373	225.758	311.765
Jobs by economic sector - construction	12365	11496.1	11815.5	13595.6	15058.3	16386.7	17444
Jobs by economic sector - manufacturing	12771.8	12946.9	16996.5	19901.2	17692.6	15314.6	15729.6
Jobs by economic sector - mining	17341.9	14440.1	11147.5	8608.9	5627.3	3631.5	2001.4
Jobs by economic sector - other	1101.3	907.972	995.665	1496.7	1953.2	2417.2	3324.6
Jobs by economic sector - pipeline	1252.7	1288.6	1273.2	1048.3	826.526	630.756	477.625
Jobs by economic sector - professional	7212.1	6910.5	6768.5	7408.5	8020.7	8894.8	9640.9
Jobs by economic sector - trade	8160.1	7382.6	6696.9	6720.4	6405.1	6458.5	6735.2
Jobs by economic sector - utilities	7545.7	7757.1	8116.7	9529.2	11820	13543.3	13158.6
Jobs by resource sector - Biomass	560.847	552.524	552.388	488.497	376.057	833.485	1366.9
Jobs by resource sector - CO2	0	18.721	860.954	189.828	326.389	524.032	982.024
Jobs by resource sector - Coal	3653.5	1734.9	394.998	82.282	68.344	59.314	51.92
Jobs by resource sector - Grid	6670.9	8248.4	9262.3	14112.2	18553.8	22996.3	22699.6
Jobs by resource sector - Natural Gas	15689.9	14315.1	12132.8	9626.6	8310.8	5968.5	4045.1
Jobs by resource sector - Nuclear	0	0	0.003	0.007	0.008	0.018	0.03
Jobs by resource sector - Oil	26300.8	25198.7	22581.7	20059	14538.6	10815.3	6717.9
Jobs by resource sector - Solar	11163	7220.7	8198.5	13795.9	15639.5	17400.2	23904.8
Jobs by resource sector - Wind	3937.6	6068	10064.9	10171.8	9740.6	8906	9055.5
Median wages - All	66499.7	67769.2	67623.5	67470	67965.6	68698.1	68702.8
Required Level of Education - Associates degree or some college	19959.7	18678.7	19184	20847.3	21005.1	21249	21888
Required Level of Education - Bachelors degree	15744	14729.1	14484.1	14975.3	14290.3	13974.5	13962.5
Required Level of Education - Doctoral degree	526.783	490.991	463.636	471.429	460.674	468.738	481.848
Required Level of Education - High school diploma or less	28044.5	25997.4	26575.4	28795.6	28462.9	28477.9	29132.2
Required Level of Education - Masters or professional degree	3701.5	3461	3341.6	3436.5	3334.9	3333	3359.1
Wage income - All	4520648664	4293867716	4331414325	4623757093	4591723585	4637804906	4728996837

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2835.6
Carbon sink enhancement potential - All (not counting overlap)	82169.5
Carbon sink enhancement potential - Avoid deforestation	2468.256
Carbon sink enhancement potential - corn-ethanol to energy grasses	-346.074
Carbon sink enhancement potential - cropland measures	-4044.536
Carbon sink enhancement potential - Extend rotation length	15623.4
Carbon sink enhancement potential - Improve plantations	46.863
Carbon sink enhancement potential - Increase retention of HWP	290.5
Carbon sink enhancement potential - Increase trees outside forests	2132.766
Carbon sink enhancement potential - permanent conservation cover	-321.6
Carbon sink enhancement potential - Reforest cropland	43578.3
Carbon sink enhancement potential - Reforest pasture	4981.2

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

variable_name	2050
Carbon sink enhancement potential - Restore productivity	10212.8
Carbon sink enhancement potential - total	-4712.21
Land impacted for carbon sink enhancement - Accelerate regeneration	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	662.568
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	344.248
Land impacted for carbon sink enhancement - cropland measures	6047.3
Land impacted for carbon sink enhancement - Extend rotation length	8606.6
Land impacted for carbon sink enhancement - Improve plantations	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	601.626
Land impacted for carbon sink enhancement - permanent conservation cover	493.495
Land impacted for carbon sink enhancement - Reforest cropland	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	376.654
Land impacted for carbon sink enhancement - Restore productivity	5763.2
Land impacted for carbon sink enhancement - total	6885
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	371535.6	377053.4	317834.7	254916.6	191897.4	120735.4	83738.9
Oil consumption	93805.5	87602.5	75394	57829.3	41567.6	28725.3	18802.2

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.162	0.162	0.159	0.152	0.144	0.138	0.135
Final energy demand by sector - industry	0.171	0.18	0.187	0.2	0.221	0.233	0.246
Final energy demand by sector - residential	0.237	0.229	0.221	0.199	0.17	0.148	0.133
Final energy demand by sector - transportation	0.472	0.443	0.394	0.334	0.279	0.243	0.226

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	14374138263	15990151407	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.546	0.83	0.886	0.889	0.889	0.889
Sales of cooking units - Gas	0.581	0.454	0.17	0.114	0.111	0.111	0.111
Sales of space heating units - Electric Heat Pump	0.026	0.082	0.306	0.798	0.9	0.908	0.908
Sales of space heating units - Electric Resistance	0.025	0.035	0.049	0.081	0.087	0.087	0.087
Sales of space heating units - Fossil	0	0.002	0	0	0	0	0
Sales of space heating units - Gas Furnace	0.949	0.881	0.644	0.122	0.014	0.005	0.005
Sales of water heating units - Electric Heat Pump	0	0.011	0.143	0.429	0.489	0.494	0.494
Sales of water heating units - Electric Resistance	0.011	0.025	0.154	0.438	0.497	0.502	0.502
Sales of water heating units - Gas Furnace	0.986	0.96	0.699	0.129	0.01	0	0
Sales of water heating units - Other	0.003	0.004	0.004	0.004	0.004	0.004	0.004

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	2.814	2.926	5.732	6.165	6.099	6.473

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	4.326	4.391	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.05	0.161	0.165	0.17	0.175	0.179	0.185
Sale of space heating units by type - Electric Resistance	0.077	0.134	0.133	0.132	0.131	0.127	0.121
Sale of space heating units by type - Fossil	0.033	0.054	0.055	0.054	0.051	0.05	0.051
Sale of space heating units by type - Gas	0.839	0.65	0.648	0.644	0.643	0.644	0.642
Sales of cooking units - Electric Resistance	0.498	0.498	0.498	0.498	0.498	0.498	0.498
Sales of cooking units - Gas	0.502	0.502	0.502	0.502	0.502	0.502	0.502
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	0.132	0.252	0.253	0.253	0.254	0.254	0.254
Sales of water heating units by type - Gas Furnace	0.857	0.735	0.735	0.735	0.734	0.734	0.734
Sales of water heating units by type - Other	0.011	0.012	0.012	0.012	0.012	0.012	0.012

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	0.018	0.022	0.022	0.021	0.019	0.017	0.017
End-use technology sales by technology - LDV - EV	0.028	0.046	0.053	0.065	0.079	0.093	0.105
End-use technology sales by technology - LDV - gasoline	0.915	0.881	0.864	0.848	0.829	0.81	0.793
End-use technology sales by technology - LDV - hybrid	0.037	0.046	0.056	0.062	0.068	0.075	0.081
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.004	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	2835.6
Carbon sink enhancement potential - All (not counting overlap)	0	0	82169.5
Carbon sink enhancement potential - Avoid deforestation	0	0	2468.256
Carbon sink enhancement potential - Extend rotation length	0	0	15623.4
Carbon sink enhancement potential - Improve plantations	0	0	46.863
Carbon sink enhancement potential - Increase retention of HWP	0	0	290.5
Carbon sink enhancement potential - Increase trees outside forests	0	0	2132.766
Carbon sink enhancement potential - Reforest cropland	0	0	43578.3
Carbon sink enhancement potential - Reforest pasture	0	0	4981.2
Carbon sink enhancement potential - Restore productivity	0	0	10212.8
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	662.568
Land impacted for carbon sink enhancement - Extend rotation length	0	0	8606.6
Land impacted for carbon sink enhancement - Improve plantations	0	0	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	601.626
Land impacted for carbon sink enhancement - Natural uptake	6.25	4.024	1.153
Land impacted for carbon sink enhancement - Reforest cropland	0	0	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	0	0	376.654
Land impacted for carbon sink enhancement - Restore productivity	0	0	5763.2
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-0.047	-0.099	-0.104
Land impacted for carbon sink enhancement - Total	6.203	3.925	1.05
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891

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	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.162	0.165	0.169	0.17	0.172	0.177	0.185
Final energy demand by sector - industry	0.171	0.186	0.198	0.211	0.225	0.243	0.262
Final energy demand by sector - residential	0.237	0.231	0.23	0.232	0.235	0.24	0.244
Final energy demand by sector - transportation	0.472	0.451	0.423	0.407	0.409	0.422	0.438

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	14191597192	14841423338	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.447	0.447	0.446	0.444	0.445	0.446
Sales of cooking units - Gas	0.581	0.553	0.553	0.554	0.556	0.555	0.554
Sales of space heating units - Electric Heat Pump	0.026	0.138	0.462	0.732	0.779	0.785	0.785
Sales of space heating units - Electric Resistance	0.025	0.044	0.089	0.16	0.203	0.21	0.21
Sales of space heating units - Fossil	0	0.002	0.001	0	0	0	0
Sales of space heating units - Gas Furnace	0.949	0.816	0.448	0.108	0.018	0.006	0.005
Sales of water heating units - Electric Heat Pump	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance	0.011	0.015	0.015	0.015	0.015	0.015	0.015
Sales of water heating units - Gas Furnace	0.986	0.981	0.981	0.981	0.981	0.981	0.981
Sales of water heating units - Other	0.003	0.004	0.004	0.004	0.004	0.004	0.004

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

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	2.524	2.602	3.5	3.675	4.002	4.196

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	4.408	4.698	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.056	0.133	0.158	0.243	0.44	0.684	0.827
Sale of space heating units by type - Electric Resistance	0.077	0.139	0.135	0.125	0.101	0.068	0.049
Sale of space heating units by type - Fossil	0.032	0.057	0.057	0.051	0.039	0.027	0.02
Sale of space heating units by type - Gas	0.835	0.671	0.65	0.581	0.42	0.221	0.103
Sales of cooking units - Electric Resistance	0.503	0.516	0.561	0.681	0.848	0.951	0.987
Sales of cooking units - Gas	0.497	0.484	0.439	0.319	0.152	0.049	0.013
Sales of water heating units by type - Electric Heat Pump	0	0.005	0.017	0.06	0.161	0.289	0.365
Sales of water heating units by type - Electric Resistance	0.132	0.256	0.265	0.297	0.374	0.471	0.529
Sales of water heating units by type - Gas Furnace	0.857	0.727	0.705	0.631	0.453	0.227	0.093
Sales of water heating units by type - Other	0.011	0.012	0.012	0.012	0.012	0.012	0.012

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	0.018	0.022	0.021	0.017	0.011	0.006	0.002
End-use technology sales by technology - LDV - EV	0.016	0.041	0.106	0.239	0.462	0.706	0.87
End-use technology sales by technology - LDV - gasoline	0.926	0.886	0.815	0.691	0.487	0.264	0.116
End-use technology sales by technology - LDV - hybrid	0.038	0.047	0.053	0.049	0.038	0.023	0.011
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.003	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	171889643	343696967	1177507408	3652376329	5339414802
Number of public EV charging plugs - DC Fast Charging	303	0	614.425	0	2742.1	0	7451.1
Number of public EV charging plugs - L2 Charging	2117	0	14774.6	0	65937.4	0	179169.5

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2835.6
Carbon sink enhancement potential - All (not counting overlap)	82169.5
Carbon sink enhancement potential - Avoid deforestation	2468.256
Carbon sink enhancement potential - corn-ethanol to energy grasses	-346.074
Carbon sink enhancement potential - cropland measures	-4044.536
Carbon sink enhancement potential - Extend rotation length	15623.4
Carbon sink enhancement potential - Improve plantations	46.863
Carbon sink enhancement potential - Increase retention of HWP	290.5
Carbon sink enhancement potential - Increase trees outside forests	2132.766
Carbon sink enhancement potential - permanent conservation cover	-321.6
Carbon sink enhancement potential - Reforest cropland	43578.3
Carbon sink enhancement potential - Reforest pasture	4981.2
Carbon sink enhancement potential - Restore productivity	10212.8
Carbon sink enhancement potential - total	-4712.21
Land impacted for carbon sink enhancement - Accelerate regeneration	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	662.568
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	344.248
Land impacted for carbon sink enhancement - cropland measures	6047.3
Land impacted for carbon sink enhancement - Extend rotation length	8606.6
Land impacted for carbon sink enhancement - Improve plantations	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	601.626
Land impacted for carbon sink enhancement - permanent conservation cover	493.495
Land impacted for carbon sink enhancement - Reforest cropland	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	376.654
Land impacted for carbon sink enhancement - Restore productivity	5763.2
Land impacted for carbon sink enhancement - total	6885
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.162	0.162	0.161	0.16	0.158	0.155	0.151
Final energy demand by sector - industry	0.171	0.181	0.188	0.203	0.226	0.238	0.25
Final energy demand by sector - residential	0.237	0.229	0.225	0.22	0.212	0.196	0.175
Final energy demand by sector - transportation	0.472	0.446	0.41	0.379	0.355	0.326	0.292

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	14373224557	15986443627	0	0	0	0
Sales of cooking units - Electric Resistance	0.419	0.462	0.502	0.608	0.754	0.846	0.878
Sales of cooking units - Gas	0.581	0.538	0.498	0.392	0.246	0.154	0.122
Sales of space heating units - Electric Heat Pump	0.026	0.073	0.098	0.183	0.387	0.646	0.8
Sales of space heating units - Electric Resistance	0.025	0.034	0.036	0.041	0.054	0.071	0.08
Sales of space heating units - Fossil	0	0.002	0.002	0.002	0.001	0	0
Sales of space heating units - Gas Furnace	0.949	0.891	0.864	0.774	0.558	0.283	0.12
Sales of water heating units - Electric Heat Pump	0	0.006	0.021	0.07	0.19	0.341	0.431
Sales of water heating units - Electric Resistance	0.011	0.02	0.035	0.083	0.201	0.351	0.44
Sales of water heating units - Gas Furnace	0.986	0.971	0.941	0.842	0.605	0.304	0.125
Sales of water heating units - Other	0.003	0.004	0.004	0.004	0.004	0.004	0.004

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

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	2.324	2.377	3.28	3.434	5.128	5.466

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

variable_name	2025	2030	2035	2040	2045	2050
Power generation capital investment - Solar PV - Base	0	2.45	2.574	4.264	7.702	35.677
Power generation capital investment - Wind - Base	0.715	1.611	2.183	6.641	8.389	38.443

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	1430.2	2935.9	7836.6	20037.5	30764.1	68222.5
HV transmission for wind and solar - base other intra-state	0	336.533	671.738	1444.4	4675.2	7689.8	18281.9
HV transmission for wind and solar - base spur intra-state	0	184.04	375.177	632.476	1402.3	2903.6	11367.2

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2835.6
Carbon sink enhancement potential - All (not counting overlap)	82169.5
Carbon sink enhancement potential - Avoid deforestation	2468.256
Carbon sink enhancement potential - corn-ethanol to energy grasses	-346.074
Carbon sink enhancement potential - cropland measures	-4044.536
Carbon sink enhancement potential - Extend rotation length	15623.4
Carbon sink enhancement potential - Improve plantations	46.863
Carbon sink enhancement potential - Increase retention of HWP	290.5
Carbon sink enhancement potential - Increase trees outside forests	2132.766
Carbon sink enhancement potential - permanent conservation cover	-321.6
Carbon sink enhancement potential - Reforest cropland	43578.3
Carbon sink enhancement potential - Reforest pasture	4981.2
Carbon sink enhancement potential - Restore productivity	10212.8
Carbon sink enhancement potential - total	-4712.21
Land impacted for carbon sink enhancement - Accelerate regeneration	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	662.568
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	344.248
Land impacted for carbon sink enhancement - cropland measures	6047.3
Land impacted for carbon sink enhancement - Extend rotation length	8606.6
Land impacted for carbon sink enhancement - Improve plantations	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	601.626
Land impacted for carbon sink enhancement - permanent conservation cover	493.495
Land impacted for carbon sink enhancement - Reforest cropland	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	376.654
Land impacted for carbon sink enhancement - Restore productivity	5763.2
Land impacted for carbon sink enhancement - total	6885
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4

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	0.009	0	0.042
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0.139	0	0.584

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	9.003	9.003	51.015
Power generation by technology - biomass w/ccu power plant	0	0	0	0	156.477	156.477	812.422

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	0.11	0.431	0.472
Capital investment	0	0	0	0	1.282	0	4.218
Number of facilities - allam power w ccu	0	0	0	0	1	1	2
Number of facilities - beccs hydrogen	0	0	0	0	1	5	5
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	0	1	1	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	0	0	1	1	2
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	1	1	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 38: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	3.38	5.08	10.18	10.97
Annual - BECCS	0	0	0	1.72	6.72	7.4
Annual - Cement	0	0	3.35	3.32	3.42	3.53
Annual - NGCC	0	0	0.03	0.04	0.04	0.04
Cumulative - All	0	0	3.38	8.46	18.64	29.61
Cumulative - BECCS	0	0	0	1.72	8.44	15.84
Cumulative - Cement	0	0	3.35	6.67	10.09	13.62
Cumulative - NGCC	0	0	0.03	0.07	0.11	0.15

Table 39: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage*

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	0	2.14	3.56	4.92	5.02
Injection wells	0	1	3	6	9	12
Resource characterization, appraisal and permitting costs cumulative	35.96	100.7	129.47	129.47	129.47	129.47
Wells and facilities construction costs cumulative	0	23.95	93.33	166.32	278.1	345.26

Table 40: *RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1225204.867	1699784.895	2013763.9	2577156.6	2838494.4
CO2 pipelines - Spur	0	299.16	360465.528	674445.083	1237837.2	1499175.1
CO2 pipelines - Trunk	0	1224905.367	1339319.367	1339319.367	1339319.367	1339319.367

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2835.6
Carbon sink enhancement potential - All (not counting overlap)	82169.5
Carbon sink enhancement potential - Avoid deforestation	2468.256
Carbon sink enhancement potential - corn-ethanol to energy grasses	-751.032
Carbon sink enhancement potential - cropland measures	-3910.443
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	15623.4
Carbon sink enhancement potential - Improve plantations	46.863
Carbon sink enhancement potential - Increase retention of HWP	290.5
Carbon sink enhancement potential - Increase trees outside forests	2132.766
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-306.972
Carbon sink enhancement potential - Reforest cropland	43578.3
Carbon sink enhancement potential - Reforest pasture	4981.2
Carbon sink enhancement potential - Restore productivity	10212.8

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

variable_name	2050
Carbon sink enhancement potential - total	-4968.446
Land impacted for carbon sink enhancement - Accelerate regeneration	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	662.568
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	626.162
Land impacted for carbon sink enhancement - cropland measures	11485.9
Land impacted for carbon sink enhancement - Cropland to woody energy crops	17.34
Land impacted for carbon sink enhancement - Extend rotation length	8606.6
Land impacted for carbon sink enhancement - Improve plantations	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	601.626
Land impacted for carbon sink enhancement - pasture to energy crops	0.808
Land impacted for carbon sink enhancement - permanent conservation cover	471.051
Land impacted for carbon sink enhancement - Reforest cropland	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	376.654
Land impacted for carbon sink enhancement - Restore productivity	5763.2
Land impacted for carbon sink enhancement - total	12601.3
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	2835.6
Carbon sink enhancement potential - All (not counting overlap)	82169.5
Carbon sink enhancement potential - Avoid deforestation	2468.256
Carbon sink enhancement potential - corn-ethanol to energy grasses	-346.074
Carbon sink enhancement potential - cropland measures	-4044.536
Carbon sink enhancement potential - Extend rotation length	15623.4
Carbon sink enhancement potential - Improve plantations	46.863
Carbon sink enhancement potential - Increase retention of HWP	290.5
Carbon sink enhancement potential - Increase trees outside forests	2132.766
Carbon sink enhancement potential - permanent conservation cover	-321.6
Carbon sink enhancement potential - Reforest cropland	43578.3
Carbon sink enhancement potential - Reforest pasture	4981.2
Carbon sink enhancement potential - Restore productivity	10212.8
Carbon sink enhancement potential - total	-4712.21
Land impacted for carbon sink enhancement - Accelerate regeneration	1142.842
Land impacted for carbon sink enhancement - All (not counting overlap)	19894.9
Land impacted for carbon sink enhancement - Avoid deforestation	662.568
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	344.248
Land impacted for carbon sink enhancement - cropland measures	6047.3
Land impacted for carbon sink enhancement - Extend rotation length	8606.6
Land impacted for carbon sink enhancement - Improve plantations	26.045
Land impacted for carbon sink enhancement - Increase retention of HWP	58.1
Land impacted for carbon sink enhancement - Increase trees outside forests	601.626
Land impacted for carbon sink enhancement - permanent conservation cover	493.495

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

variable_name	2050
Land impacted for carbon sink enhancement - Reforest cropland	14509.004
Land impacted for carbon sink enhancement - Reforest pasture	376.654
Land impacted for carbon sink enhancement - Restore productivity	5763.2
Land impacted for carbon sink enhancement - total	6885
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	11851.7

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	265.007
Business-as-usual carbon sink - Avoid deforestation	211.063
Business-as-usual carbon sink - Extend rotation length	4708.4
Business-as-usual carbon sink - Improve plantations	9.891
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	120.962
Business-as-usual carbon sink - Reforest cropland	1646.4
Business-as-usual carbon sink - Reforest pasture	92.016
Business-as-usual carbon sink - Restore productivity	2028.8
Business-as-usual carbon sink - Total impacted (over 30 years)	1646.4