Net-Zero America - tennessee state report v2

Larson et al. 2020

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Reading guide

IN DRAFT

List of Tables

1 E- scenario - PILLAR 1: Efficiency/Electrification - Residential 3
2 E- scenario - PILLAR 1: Efficiency/Electrification - Transportation 3
3 E- scenario - PILLAR 6: Land carbon sinks - Agriculture 3
4 E- scenario - PILLAR 6: Land carbon sinks - Forests 3
5 E- scenario - PILLAR 1: Efficiency/Electrification - Overview 4
6 E- scenario - PILLAR 1: Efficiency/Electrification - Commercial 4
7 E- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand 4
8 RE- scenario - PILLAR 1: Efficiency/Electrification - Residential 4
9 RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation 4
10 RE- scenario - PILLAR 2: Clean Electricity - Generating capacity 5
11 RE- scenario - PILLAR 2: Clean Electricity - Generation 5
12 RE- scenario - PILLAR 2: Clean Electricity - Transmission 5
13 RE- scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion 5
14 RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture 5
15 RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage 5
16 RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation 5
17 RE- scenario - IMPACTS - Jobs 5
18 RE- scenario - PILLAR 6: Land carbon sinks - Agriculture 6
19 RE- scenario - PILLAR 6: Land carbon sinks - Forests 6
20 RE- scenario - IMPACTS - Fossil fuel industries 7
21 RE- scenario - PILLAR 1: Efficiency/Electrification - Overview 7
22 RE- scenario - PILLAR 1: Efficiency/Electrification - Commercial 7
23 RE- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand 7

24 REF scenario - PILLAR 1: Efficiency/Electrification - Residential 7
25 REF scenario - PILLAR 1: Efficiency/Electrification - Transportation 7
26 REF scenario - PILLAR 6: Land carbon sinks - Agriculture 7
27 REF scenario - PILLAR 6: Land carbon sinks - Forests 8
28 REF scenario - PILLAR 1: Efficiency/Electrification - Overview 8
29 REF scenario - PILLAR 1: Efficiency/Electrification - Commercial 8
30 REF scenario - PILLAR 1: Efficiency/Electrification - Electricity demand 8
31 E+ scenario - PILLAR 2: Clean Electricity - Generating capacity 9
32 E+ scenario - PILLAR 2: Clean Electricity - Transmission 9
33 E+ scenario - PILLAR 6: Land carbon sinks - Agriculture 9
34 E+ scenario - PILLAR 6: Land carbon sinks - Forests 9
35 RE+ scenario - PILLAR 2: Clean Electricity - Generating capacity 9
36 RE+ scenario - PILLAR 2: Clean Electricity - Generation 10
37 RE+ scenario - PILLAR 3: Bioenergy and Hydrogen - Bioconversion 10
38 RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture 10
39 RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage 10
40 RE+ scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation 10
41 RE+ scenario - PILLAR 6: Land carbon sinks - Agriculture 10
42 RE+ scenario - PILLAR 6: Land carbon sinks - Forests 11
43 B+ scenario - PILLAR 6: Land carbon sinks - Agriculture 11
44 B+ scenario - PILLAR 6: Land carbon sinks - Forests 12

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	5.151	4.965	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.306	0.538	0.546	0.559	0.572	0.589	0.616
Sale of space heating units by type - Electric Resistance	0.32	0.272	0.267	0.259	0.249	0.233	0.206
Sale of space heating units by type - Fossil	0.042	0.033	0.033	0.033	0.032	0.032	0.032
Sale of space heating units by type - Gas	0.332	0.158	0.154	0.149	0.147	0.146	0.146
Sales of cooking units - Electric Resistance	0.829	0.829	0.829	0.829	0.829	0.829	0.829
Sales of cooking units - Gas	0.171	0.171	0.171	0.171	0.171	0.171	0.171
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	0.689	0.8	0.801	0.8	0.799	0.799	0.799
Sales of water heating units by type - Gas Furnace	0.274	0.175	0.173	0.175	0.176	0.175	0.176
Sales of water heating units by type - Other	0.037	0.026	0.025	0.026	0.026	0.026	0.026

Table 2: *E- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.981	0.982	0.979	0.97	0.956	0.935	0.916
End-use technology sales by technology - HDV - EV	0	0	0	0	0	0	0
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.003	0.003	0.003	0.003	0.003
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0.001	0.002	0.002	0.002
End-use technology sales by technology - HDV - hydrogen FC	0.001	0.001	0.002	0.002	0.002	0.002	0.003
End-use technology sales by technology - HDV - other	0.015	0.013	0.016	0.024	0.037	0.057	0.076
End-use technology sales by technology - LDV - diesel	0.016	0.02	0.022	0.02	0.018	0.017	0.016
End-use technology sales by technology - LDV - EV	0.036	0.056	0.064	0.078	0.096	0.111	0.122
End-use technology sales by technology - LDV - gasoline	0.902	0.867	0.845	0.827	0.806	0.786	0.771
End-use technology sales by technology - LDV - hybrid	0.044	0.053	0.065	0.07	0.076	0.082	0.086
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.003	0.003	0.003	0.003
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0.001	0.001	0.001	0.001
End-use technology sales by technology - MDV - diesel	0.652	0.635	0.616	0.596	0.58	0.565	0.552
End-use technology sales by technology - MDV - EV	0	0.001	0.003	0.007	0.009	0.01	0.01
End-use technology sales by technology - MDV - gasoline	0.34	0.355	0.37	0.385	0.397	0.408	0.417
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.005	0.006	0.007	0.008	0.009
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.002	0.002	0.003	0.003	0.004	0.005
End-use technology sales by technology - MDV - other	0.003	0.003	0.003	0.003	0.004	0.005	0.007

Table 3: *E- scenario - PILLAR 6: Land carbon sinks - Agriculture*

variable_name	2020	2030	2050
Carbon sink enhancement potential - Accelerate regeneration	0	0	202.436
Carbon sink enhancement potential - All (not counting overlap)	0	0	51202.8
Carbon sink enhancement potential - Avoid deforestation	0	0	3449.2
Carbon sink enhancement potential - Extend rotation length	0	0	9784.8
Carbon sink enhancement potential - Improve plantations	0	0	1031.693
Carbon sink enhancement potential - Increase retention of HWP	0	0	11390.8
Carbon sink enhancement potential - Increase trees outside forests	0	0	1554.3
Carbon sink enhancement potential - Reforest cropland	0	0	2668.9
Carbon sink enhancement potential - Reforest pasture	0	0	14741.3
Carbon sink enhancement potential - Restore productivity	0	0	6379.2
Land impacted for carbon sink enhancement - Accelerate regeneration	0	0	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	0	0	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	0	0	925.892
Land impacted for carbon sink enhancement - Extend rotation length	0	0	5390.2
Land impacted for carbon sink enhancement - Improve plantations	0	0	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	0	0	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	0	0	438.452
Land impacted for carbon sink enhancement - Natural uptake	-8.29	-10.746	-8.709
Land impacted for carbon sink enhancement - Reforest cropland	0	0	888.609
Land impacted for carbon sink enhancement - Reforest pasture	0	0	1114.68
Land impacted for carbon sink enhancement - Restore productivity	0	0	3599.797
Land impacted for carbon sink enhancement - Retained in Hardwood Products	-1.86	-3.102	-3.265
Land impacted for carbon sink enhancement - Total	-10.15	-13.848	-11.974
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	0	0	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744

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	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.171	0.174	0.176	0.176	0.177	0.181	0.19
Final energy demand by sector - industry	0.755	0.847	0.903	0.938	0.959	0.961	0.976
Final energy demand by sector - residential	0.26	0.244	0.236	0.23	0.227	0.228	0.229
Final energy demand by sector - transportation	0.68	0.628	0.576	0.545	0.545	0.562	0.584

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	19056069784	19846189584	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.456	0.459	0.457	0.46	0.459	0.457
Sales of cooking units - Gas	0.565	0.544	0.541	0.543	0.54	0.541	0.543
Sales of space heating units - Electric Heat Pump	0.096	0.275	0.569	0.761	0.79	0.794	0.794
Sales of space heating units - Electric Resistance	0.048	0.057	0.1	0.154	0.187	0.192	0.192
Sales of space heating units - Fossil	0	0.029	0.013	0.002	0	0	0
Sales of space heating units - Gas Furnace	0.856	0.639	0.318	0.083	0.023	0.015	0.014
Sales of water heating units - Electric Heat Pump	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Sales of water heating units - Electric Resistance	0.057	0.057	0.056	0.057	0.056	0.056	0.056
Sales of water heating units - Gas Furnace	0.925	0.925	0.927	0.926	0.926	0.927	0.927
Sales of water heating units - Other	0.016	0.016	0.016	0.016	0.016	0.016	0.016

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	4.865	4.996	5.951	6.18	5.739	5.888

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	5.225	5.684	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.322	0.478	0.802	0.875	0.878	0.877	0.877
Sale of space heating units by type - Electric Resistance	0.313	0.298	0.125	0.086	0.085	0.086	0.086
Sale of space heating units by type - Fossil	0.041	0.045	0.018	0.012	0.012	0.012	0.012
Sale of space heating units by type - Gas	0.324	0.179	0.054	0.027	0.026	0.025	0.025
Sales of cooking units - Electric Resistance	0.832	0.867	0.977	0.999	1	1	1
Sales of cooking units - Gas	0.168	0.133	0.023	0.001	0	0	0
Sales of water heating units by type - Electric Heat Pump	0	0.091	0.481	0.568	0.572	0.572	0.572
Sales of water heating units by type - Electric Resistance	0.689	0.737	0.467	0.406	0.403	0.403	0.403
Sales of water heating units by type - Gas Furnace	0.274	0.147	0.028	0.001	0	0	0
Sales of water heating units by type - Other	0.037	0.026	0.025	0.025	0.025	0.025	0.025

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	0.015	0.018	0.013	0.004	0.001	0	0
End-use technology sales by technology - LDV - EV	0.039	0.152	0.465	0.818	0.963	0.993	1
End-use technology sales by technology - LDV - gasoline	0.899	0.78	0.488	0.165	0.033	0.006	0
End-use technology sales by technology - LDV - hybrid	0.044	0.045	0.032	0.012	0.003	0.001	0
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.003	0.002	0.001	0	0	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0	0	0	0
End-use technology sales by technology - MDV - diesel	0.647	0.597	0.423	0.144	0.026	0.004	0
End-use technology sales by technology - MDV - EV	0.008	0.051	0.253	0.608	0.765	0.795	0.8
End-use technology sales by technology - MDV - gasoline	0.337	0.333	0.255	0.093	0.018	0.003	0
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.003	0.001	0	0	0
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.013	0.063	0.152	0.191	0.199	0.2
End-use technology sales by technology - MDV - other	0.003	0.003	0.002	0.001	0	0	0
Light-duty vehicle capital costs - Cumulative 5-yr	0	1105294904	2839409941	4590747583	6958226473	7568596529	7218670847
Number of public EV charging plugs - DC Fast Charging	165	0	2152.4	0	9362.1	0	15123.4
Number of public EV charging plugs - L2 Charging	888	0	51733.2	0	225019.1	0	363492.9

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation capital investment - biomass power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	0	0	0	3.782	0
Power generation capital investment - Solar PV - Base	0	0.364	0.667	1.409	2.876	6.835	10.984
Power generation capital investment - Solar PV - Constrained	0	0.173	0	1.865	2.567	9.475	6.996
Power generation capital investment - Wind - Base	0	0.069	0.052	0	0	0	0

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Power generation by technology - biomass power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu allam power plant	0	0	0	0	0	0	0
Power generation by technology - biomass w/ccu power plant	0	0	0	0	0	4245	4245

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	176.913	555.633	1121.1	2235.6	3323.7	5227.6
HV transmission for wind and solar - base other intra-state	0	0	103.724	215.705	487.04	802.531	1186.1
HV transmission for wind and solar - base spur intra-state	0	26.755	48.445	95.525	217.05	494.826	999.515
HV transmission for wind and solar - constrained all	0	2550.6	5974.8	10269.1	13051.7	13702.4	14136.4
HV transmission for wind and solar - constrained other intra-state	0	0	311.27	741.373	875.736	975.134	1077.2
HV transmission for wind and solar - constrained spur intra-state	0	5.92	10.729	104.31	202.232	420.005	751.957

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0	0.161	0.161	0.477	0.477
Capital investment	0	0	0	0	3.028	0	6.407
Number of facilities - allam power w ccu	0	0	0	0	0	0	0
Number of facilities - beccs hydrogen	0	0	0	3	3	7	7
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	2	2
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	0	0	0	0	0

Table 14: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 capture*

variable_name	2025	2030	2035	2040	2045	2050
Annual - All	0	0	5.99	5.7	17.16	16.53
Annual - BECCS	0	0	4.13	4.13	12.48	12.47
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	1.86	1.57	4.69	4.06
Cumulative - All	0	0	5.99	11.69	28.85	45.38
Cumulative - BECCS	0	0	4.13	8.26	20.74	33.21
Cumulative - Cement	0	0	0	0	0	0
Cumulative - NGCC	0	0	1.86	3.43	8.12	12.18

Table 15: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 storage*

variable_name	2025	2030	2035	2040	2045	2050
Annual	0	0	0.88	1.81	2.58	3.73
Injection wells	0	1	2	4	7	8
Resource characterization, appraisal and permitting costs cumulative	25.41	71.16	91.49	91.49	91.49	91.49
Wells and facilities construction costs cumulative	0	16.92	65.95	117.53	196.52	243.98

Table 16: *RE- scenario - PILLAR 4: CO2 capture, use, storage - CO2 transportation*

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1110639.854	2685345.626	2984679.1	3658172.3	3493405.3
CO2 pipelines - Spur	0	0	464065.917	763399.632	1436892.6	1272125.6
CO2 pipelines - Trunk	0	1110639.854	2221279.709	2221279.709	2221279.709	2221279.709

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - agriculture	437.902	446.171	510.511	765.008	538.765	790.981	629.803
Jobs by economic sector - construction	4711.7	4928.3	5282	6728.1	7187.7	9183.2	13635
Jobs by economic sector - manufacturing	4145.6	8493	10165.4	13465.6	12832.2	10500.3	13560.3
Jobs by economic sector - mining	3072.7	2237.4	1603.1	1042.6	636.968	387.884	238.239
Jobs by economic sector - other	318.879	336.38	393.09	622.312	971.404	1756.8	3311

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Jobs by economic sector - pipeline	465.924	452.427	516.987	487.434	295.822	258.001	237.287
Jobs by economic sector - professional	2854.3	2679.5	2460.2	3172.6	3386.9	4783.8	6906.6
Jobs by economic sector - trade	2799.7	2314.5	2008.6	2093.1	2174	2915.3	4617.4
Jobs by economic sector - utilities	7557.5	7809.2	7736.5	9462.8	8714.4	7834.4	9364.9
Jobs by resource sector - Biomass	1150.3	1165.9	1222.6	1947.6	1486.1	2902.7	2752.4
Jobs by resource sector - CO2	0	13.506	1134	1618	735.126	1111.3	1373.4
Jobs by resource sector - Coal	1986.9	519.02	20.462	17.843	15.599	14.106	12.509
Jobs by resource sector - Grid	6946.7	8096.3	8072.1	11426.9	11624.2	12058.3	15882
Jobs by resource sector - Natural Gas	4057	4373.4	3585.7	3247.3	2992.3	1665.8	1554.5
Jobs by resource sector - Nuclear	2555.2	2514	2473.8	2434.7	1914.2	956.039	349.06
Jobs by resource sector - Oil	6548.7	5546.1	4341.8	3023.5	1949	1189.2	650.056
Jobs by resource sector - Solar	2459	4256.6	5307.2	8129.2	10533.6	14613.6	25062.2
Jobs by resource sector - Wind	660.246	3212.1	4518.6	5994.6	5488	3899.7	4864.3
Median wages - All	56367.4	55957.9	55914	55960.6	56361.7	56704.1	56970
Required Level of Education - Associates degree or some college	7924.9	9089.7	9483.4	11833.5	11609.4	12123	16800.4
Required Level of Education - Bachelors degree	5840.6	6373	6380.4	7650.4	7344.5	7570.7	10227.2
Required Level of Education - Doctoral degree	188.505	184.966	174.554	206.496	204.934	247.236	344.096
Required Level of Education - High school diploma or less	11018.7	12589.4	13206.4	16435.7	15921.7	16683.7	22695.9
Required Level of Education - Masters or professional degree	1391.3	1459.9	1431.5	1713.4	1657.6	1786.1	2432.9
Wage income - All	1486135513	1661845223	1715302688	2117627426	2070780378	2178312575	2991439388

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	202.436
Carbon sink enhancement potential - All (not counting overlap)	51202.8
Carbon sink enhancement potential - Avoid deforestation	3449.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-548.378
Carbon sink enhancement potential - cropland measures	-5125.851
Carbon sink enhancement potential - Extend rotation length	9784.8
Carbon sink enhancement potential - Improve plantations	1031.693
Carbon sink enhancement potential - Increase retention of HWP	11390.8
Carbon sink enhancement potential - Increase trees outside forests	1554.3
Carbon sink enhancement potential - permanent conservation cover	-162.099
Carbon sink enhancement potential - Reforest cropland	2668.9
Carbon sink enhancement potential - Reforest pasture	14741.3
Carbon sink enhancement potential - Restore productivity	6379.2
Carbon sink enhancement potential - total	-5836.327
Land impacted for carbon sink enhancement - Accelerate regeneration	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	925.892
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	224.328
Land impacted for carbon sink enhancement - cropland measures	2797.46
Land impacted for carbon sink enhancement - Extend rotation length	5390.2
Land impacted for carbon sink enhancement - Improve plantations	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	438.452
Land impacted for carbon sink enhancement - permanent conservation cover	294.828
Land impacted for carbon sink enhancement - Reforest cropland	888.609
Land impacted for carbon sink enhancement - Reforest pasture	1114.68
Land impacted for carbon sink enhancement - Restore productivity	3599.797
Land impacted for carbon sink enhancement - total	3316.7
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption	298821	303258.9	255630.1	205025.9	154340.4	97105.8	67350.1
Oil consumption	133055.6	123372.9	105060.5	78923.7	54657.2	35539.2	20614.7

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.171	0.171	0.165	0.155	0.148	0.145	0.145
Final energy demand by sector - industry	0.755	0.838	0.888	0.904	0.913	0.905	0.904
Final energy demand by sector - residential	0.26	0.243	0.223	0.197	0.176	0.163	0.157
Final energy demand by sector - transportation	0.679	0.622	0.545	0.451	0.367	0.315	0.293

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	19412222261	22036672863	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.553	0.834	0.889	0.892	0.892	0.891
Sales of cooking units - Gas	0.565	0.447	0.166	0.111	0.108	0.108	0.108
Sales of space heating units - Electric Heat Pump	0.096	0.306	0.773	0.908	0.919	0.92	0.92
Sales of space heating units - Electric Resistance	0.048	0.046	0.049	0.063	0.066	0.066	0.066
Sales of space heating units - Fossil	0	0.028	0.005	0	0	0	0
Sales of space heating units - Gas Furnace	0.856	0.62	0.173	0.029	0.015	0.014	0.014
Sales of water heating units - Electric Heat Pump	0.002	0.106	0.557	0.657	0.661	0.662	0.661
Sales of water heating units - Electric Resistance	0.057	0.1	0.28	0.321	0.323	0.323	0.323
Sales of water heating units - Gas Furnace	0.925	0.778	0.147	0.006	0	0	0
Sales of water heating units - Other	0.016	0.016	0.016	0.016	0.016	0.016	0.016

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

variable_name	2025	2030	2035	2040	2045	2050
Electricity distribution peak load (capital invested) - Cumulative 5-yr	4.814	4.938	6.831	7.166	5.852	5.99

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	5.174	5.406	0	0	0	0
Sale of space heating units by type - Electric Heat Pump	0.322	0.416	0.453	0.56	0.723	0.828	0.865
Sale of space heating units by type - Electric Resistance	0.313	0.331	0.31	0.252	0.166	0.111	0.092
Sale of space heating units by type - Fossil	0.041	0.05	0.047	0.038	0.024	0.016	0.013
Sale of space heating units by type - Gas	0.324	0.203	0.189	0.149	0.087	0.045	0.03
Sales of cooking units - Electric Resistance	0.831	0.835	0.851	0.892	0.948	0.983	0.996
Sales of cooking units - Gas	0.169	0.165	0.149	0.108	0.052	0.017	0.004
Sales of water heating units by type - Electric Heat Pump	0	0.016	0.06	0.188	0.384	0.511	0.556
Sales of water heating units by type - Electric Resistance	0.689	0.789	0.759	0.67	0.533	0.445	0.414
Sales of water heating units by type - Gas Furnace	0.274	0.17	0.155	0.117	0.058	0.018	0.005
Sales of water heating units by type - Other	0.037	0.026	0.025	0.025	0.026	0.025	0.025

Table 25: *REF scenario - PILLAR 1: Efficiency/Electrification - Transportation*

variable_name	2020	2025	2030	2035	2040	2045	2050
End-use technology sales by technology - HDV - diesel	0.974	0.96	0.913	0.798	0.582	0.321	0.137
End-use technology sales by technology - HDV - EV	0.005	0.015	0.041	0.108	0.236	0.394	0.51
End-use technology sales by technology - HDV - gasoline	0.002	0.002	0.002	0.002	0.002	0.001	0.001
End-use technology sales by technology - HDV - hybrid	0.001	0.001	0.001	0.001	0.001	0.001	0
End-use technology sales by technology - HDV - hydrogen FC	0.003	0.01	0.027	0.072	0.157	0.263	0.34
End-use technology sales by technology - HDV - other	0.015	0.013	0.015	0.019	0.022	0.02	0.011
End-use technology sales by technology - LDV - diesel	0.016	0.02	0.021	0.016	0.01	0.005	0.002
End-use technology sales by technology - LDV - EV	0.019	0.047	0.119	0.259	0.484	0.72	0.876
End-use technology sales by technology - LDV - gasoline	0.917	0.875	0.796	0.667	0.462	0.249	0.11
End-use technology sales by technology - LDV - hybrid	0.046	0.054	0.061	0.055	0.041	0.024	0.012
End-use technology sales by technology - LDV - hydrogen FC	0.001	0.004	0.003	0.002	0.002	0.001	0
End-use technology sales by technology - LDV - other	0.001	0.001	0.001	0.001	0.001	0	0
End-use technology sales by technology - MDV - diesel	0.648	0.622	0.577	0.494	0.356	0.196	0.084
End-use technology sales by technology - MDV - EV	0.007	0.019	0.055	0.143	0.314	0.526	0.68
End-use technology sales by technology - MDV - gasoline	0.338	0.347	0.347	0.319	0.244	0.142	0.063
End-use technology sales by technology - MDV - hybrid	0.004	0.004	0.005	0.005	0.004	0.003	0.001
End-use technology sales by technology - MDV - hydrogen FC	0.002	0.005	0.014	0.036	0.079	0.132	0.17
End-use technology sales by technology - MDV - other	0.003	0.003	0.003	0.003	0.003	0.002	0.001
Light-duty vehicle capital costs - Cumulative 5-yr	0	0	179916948	375574347	1270693566	3991128770	5817227557
Number of public EV charging plugs - DC Fast Charging	165	0	676.884	0	3480.9	0	9686.5
Number of public EV charging plugs - L2 Charging	888	0	16269	0	83662.8	0	232817

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	202.436
Carbon sink enhancement potential - All (not counting overlap)	51202.8
Carbon sink enhancement potential - Avoid deforestation	3449.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-548.378

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

variable_name	2050
Carbon sink enhancement potential - cropland measures	-5125.851
Carbon sink enhancement potential - Extend rotation length	9784.8
Carbon sink enhancement potential - Improve plantations	1031.693
Carbon sink enhancement potential - Increase retention of HWP	11390.8
Carbon sink enhancement potential - Increase trees outside forests	1554.3
Carbon sink enhancement potential - permanent conservation cover	-162.099
Carbon sink enhancement potential - Reforest cropland	2668.9
Carbon sink enhancement potential - Reforest pasture	14741.3
Carbon sink enhancement potential - Restore productivity	6379.2
Carbon sink enhancement potential - total	-5836.327
Land impacted for carbon sink enhancement - Accelerate regeneration	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	925.892
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	224.328
Land impacted for carbon sink enhancement - cropland measures	2797.46
Land impacted for carbon sink enhancement - Extend rotation length	5390.2
Land impacted for carbon sink enhancement - Improve plantations	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	438.452
Land impacted for carbon sink enhancement - permanent conservation cover	294.828
Land impacted for carbon sink enhancement - Reforest cropland	888.609
Land impacted for carbon sink enhancement - Reforest pasture	1114.68
Land impacted for carbon sink enhancement - Restore productivity	3599.797
Land impacted for carbon sink enhancement - total	3316.7
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Final energy demand by sector - commercial	0.171	0.171	0.169	0.166	0.161	0.156	0.153
Final energy demand by sector - industry	0.755	0.838	0.889	0.91	0.921	0.912	0.909
Final energy demand by sector - residential	0.26	0.244	0.232	0.219	0.204	0.187	0.173
Final energy demand by sector - transportation	0.68	0.628	0.57	0.525	0.49	0.449	0.4

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	19400890062	22002830800	0	0	0	0
Sales of cooking units - Electric Resistance	0.435	0.471	0.513	0.616	0.761	0.85	0.88
Sales of cooking units - Gas	0.565	0.529	0.487	0.384	0.239	0.15	0.12
Sales of space heating units - Electric Heat Pump	0.096	0.217	0.269	0.424	0.666	0.833	0.897
Sales of space heating units - Electric Resistance	0.048	0.046	0.047	0.048	0.052	0.059	0.063
Sales of space heating units - Fossil	0	0.033	0.031	0.023	0.012	0.004	0.001
Sales of space heating units - Gas Furnace	0.856	0.704	0.653	0.505	0.27	0.104	0.039
Sales of water heating units - Electric Heat Pump	0.002	0.02	0.071	0.218	0.444	0.592	0.643
Sales of water heating units - Electric Resistance	0.057	0.065	0.084	0.144	0.235	0.295	0.316
Sales of water heating units - Gas Furnace	0.925	0.9	0.83	0.622	0.304	0.097	0.025
Sales of water heating units - Other	0.016	0.016	0.016	0.016	0.016	0.016	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	4.137	4.181	4.768	4.877	5.834	6.044

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	1.818	5.34	14.961	16.376	37.243
Power generation capital investment - Wind - Base	0.069	0.052	0	0	0	0

Table 32: *E+ scenario - PILLAR 2: Clean Electricity - Transmission*

variable_name	2020	2025	2030	2035	2040	2045	2050
HV transmission for wind and solar - base all	0	18.789	350.435	1264.3	3189	6119.8	12875.8
HV transmission for wind and solar - base other intra-state	0	0	139.617	536.443	1134.3	2002.8	4436.9
HV transmission for wind and solar - base spur intra-state	0	8.073	56.046	229.312	815.113	1610.2	3654.9

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	202.436
Carbon sink enhancement potential - All (not counting overlap)	51202.8
Carbon sink enhancement potential - Avoid deforestation	3449.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-548.378
Carbon sink enhancement potential - cropland measures	-5125.851
Carbon sink enhancement potential - Extend rotation length	9784.8
Carbon sink enhancement potential - Improve plantations	1031.693
Carbon sink enhancement potential - Increase retention of HWP	11390.8
Carbon sink enhancement potential - Increase trees outside forests	1554.3
Carbon sink enhancement potential - permanent conservation cover	-162.099
Carbon sink enhancement potential - Reforest cropland	2668.9
Carbon sink enhancement potential - Reforest pasture	14741.3
Carbon sink enhancement potential - Restore productivity	6379.2
Carbon sink enhancement potential - total	-5836.327
Land impacted for carbon sink enhancement - Accelerate regeneration	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	925.892
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	224.328
Land impacted for carbon sink enhancement - cropland measures	2797.46
Land impacted for carbon sink enhancement - Extend rotation length	5390.2
Land impacted for carbon sink enhancement - Improve plantations	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	438.452
Land impacted for carbon sink enhancement - permanent conservation cover	294.828
Land impacted for carbon sink enhancement - Reforest cropland	888.609
Land impacted for carbon sink enhancement - Reforest pasture	1114.68
Land impacted for carbon sink enhancement - Restore productivity	3599.797
Land impacted for carbon sink enhancement - total	3316.7
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835

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	0.046	0	0	0
Power generation capital investment - biomass w/ccu power plant	0	0	2.969	0.004	6.615	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	45.542	45.542	45.542	45.542
Power generation by technology - biomass w/ccu power plant	0	0	3332.2	3336.8	10761.5	10761.5	10761.5

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

variable_name	2020	2025	2030	2035	2040	2045	2050
Biomass purchases	0	0	0.202	0.542	1.777	2.049	2.049
Capital investment	0	0	2.567	0	18.192	0	2.998
Number of facilities - allam power w ccu	0	0	0	1	1	1	1
Number of facilities - beccs hydrogen	0	0	0	4	15	18	18
Number of facilities - diesel	0	0	0	0	0	0	0
Number of facilities - diesel ccu	0	0	0	1	1	1	1
Number of facilities - power	0	0	0	0	0	0	0
Number of facilities - power ccu	0	0	2	3	9	9	9
Number of facilities - pyrolysis	0	0	0	0	0	0	0
Number of facilities - pyrolysis ccu	0	0	0	0	0	0	0
Number of facilities - sng	0	0	0	0	0	0	0
Number of facilities - sng ccu	0	0	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	3.3	8.41	27.61	31.7	31.67
Annual - BECCS	0	3.3	8.41	27.61	31.7	31.66
Annual - Cement	0	0	0	0	0	0
Annual - NGCC	0	0	0	0	0	0.01
Cumulative - All	0	3.3	11.71	39.32	71.02	102.69
Cumulative - BECCS	0	3.3	11.71	39.32	71.02	102.68
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	0.92	3.21	7.13	9.85	10.03
Injection wells	0	2	7	12	20	24
Resource characterization, appraisal and permitting costs cumulative	25.41	111.83	172.82	172.82	172.82	172.82
Wells and facilities construction costs cumulative	0	50.77	197.85	352.59	589.56	731.95

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

variable_name	2025	2030	2035	2040	2045	2050
CO2 pipelines - All	0	1603427.998	3873273.4	6643477.5	6311350.1	6857287.6
CO2 pipelines - Spur	0	310606.943	1287631.7	2765013.9	2432887.6	2978824.1
CO2 pipelines - Trunk	0	1292820.854	2585641.709	3878462.563	3878462.563	3878462.563

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	202.436
Carbon sink enhancement potential - All (not counting overlap)	51202.8
Carbon sink enhancement potential - Avoid deforestation	3449.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-1304.084
Carbon sink enhancement potential - cropland measures	-4747.444
Carbon sink enhancement potential - Cropland to woody energy crops	0
Carbon sink enhancement potential - Extend rotation length	9784.8
Carbon sink enhancement potential - Improve plantations	1031.693
Carbon sink enhancement potential - Increase retention of HWP	11390.8
Carbon sink enhancement potential - Increase trees outside forests	1554.3
Carbon sink enhancement potential - pasture to energy crops	0
Carbon sink enhancement potential - permanent conservation cover	-146.725
Carbon sink enhancement potential - Reforest cropland	2668.9
Carbon sink enhancement potential - Reforest pasture	14741.3
Carbon sink enhancement potential - Restore productivity	6379.2
Carbon sink enhancement potential - total	-6198.253
Land impacted for carbon sink enhancement - Accelerate regeneration	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	925.892
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	583.572
Land impacted for carbon sink enhancement - cropland measures	4986.516

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	220.308
Land impacted for carbon sink enhancement - Extend rotation length	5390.2
Land impacted for carbon sink enhancement - Improve plantations	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	438.452
Land impacted for carbon sink enhancement - pasture to energy crops	883.928
Land impacted for carbon sink enhancement - permanent conservation cover	266.866
Land impacted for carbon sink enhancement - Reforest cropland	888.609
Land impacted for carbon sink enhancement - Reforest pasture	1114.68
Land impacted for carbon sink enhancement - Restore productivity	3599.797
Land impacted for carbon sink enhancement - total	6941.2
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835

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

variable_name	2050
Carbon sink enhancement potential - Accelerate regeneration	202.436
Carbon sink enhancement potential - All (not counting overlap)	51202.8
Carbon sink enhancement potential - Avoid deforestation	3449.2
Carbon sink enhancement potential - corn-ethanol to energy grasses	-548.378
Carbon sink enhancement potential - cropland measures	-5125.851
Carbon sink enhancement potential - Extend rotation length	9784.8
Carbon sink enhancement potential - Improve plantations	1031.693
Carbon sink enhancement potential - Increase retention of HWP	11390.8
Carbon sink enhancement potential - Increase trees outside forests	1554.3
Carbon sink enhancement potential - permanent conservation cover	-162.099
Carbon sink enhancement potential - Reforest cropland	2668.9
Carbon sink enhancement potential - Reforest pasture	14741.3
Carbon sink enhancement potential - Restore productivity	6379.2
Carbon sink enhancement potential - total	-5836.327
Land impacted for carbon sink enhancement - Accelerate regeneration	81.589
Land impacted for carbon sink enhancement - All (not counting overlap)	8323.3
Land impacted for carbon sink enhancement - Avoid deforestation	925.892
Land impacted for carbon sink enhancement - corn-ethanol to energy grasses	224.328
Land impacted for carbon sink enhancement - cropland measures	2797.46
Land impacted for carbon sink enhancement - Extend rotation length	5390.2
Land impacted for carbon sink enhancement - Improve plantations	573.393
Land impacted for carbon sink enhancement - Increase retention of HWP	2278.2
Land impacted for carbon sink enhancement - Increase trees outside forests	438.452
Land impacted for carbon sink enhancement - permanent conservation cover	294.828
Land impacted for carbon sink enhancement - Reforest cropland	888.609
Land impacted for carbon sink enhancement - Reforest pasture	1114.68
Land impacted for carbon sink enhancement - Restore productivity	3599.797
Land impacted for carbon sink enhancement - total	3316.7
Land impacted for carbon sink enhancement - Total impacted (over 30 years)	6967.6

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

variable_name	2050
Business-as-usual carbon sink - Accelerate regeneration	18.919
Business-as-usual carbon sink - Avoid deforestation	294.946
Business-as-usual carbon sink - Extend rotation length	2948.8
Business-as-usual carbon sink - Improve plantations	217.744
Business-as-usual carbon sink - Increase retention of HWP	0
Business-as-usual carbon sink - Increase trees outside forests	88.154
Business-as-usual carbon sink - Reforest cropland	100.835
Business-as-usual carbon sink - Reforest pasture	272.316
Business-as-usual carbon sink - Restore productivity	1267.3
Business-as-usual carbon sink - Total impacted (over 30 years)	100.835