Net-Zero America - california state report

Larson et al. 2020

February 2021

These data underlie graphs and tables presented in the Princeton Net-Zero America study (E. Larson, C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, R. Williams, S. Pacala, R. Socolow, EJ Baik, R. Birdsey, R. Duke, R. Jones, B. Haley, E. Leslie, K. Paustian, and A. Swan, Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interim report, Princeton University, Princeton, NJ, December 15, 2020. Report available at https://netzeroamerica.princeton.edu.)

Notes

- These data are a subset of all data from the study available at https://netzeroamerica.princeton.edu.
- The Net-Zero America study describes five pathways to reach net-zero emissions and one "no new policies" reference scenario. In this document, state-level results are grouped by scenario. For some scenarios, the study generated national, but not state-level results.
- Within results for a given scenario, data tables are organized into corresponding sections of the full net-zero study (e.g., Pillar 1, Pillar 2, etc.)
- Some results are not model outputs, but rather they are limits that apply across all scenarios (e.g., maximum carbon storage potential in agricultural soils).

List of Tables

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	27.7	36.5	0	0	0	0
Sales of cooking units - Electric Resistance (%)	40	52.8	91.9	99.6	100	100	100
Sales of cooking units - Gas (%)	60	47.2	8.07	0.406	0	0	0
Sales of space heating units - Electric Heat Pump (%)	5.99	23.4	70.8	81.7	82.3	82.2	82.2
Sales of space heating units - Electric Resistance (%)	16.4	23.7	15.2	13.3	13.2	13.3	13.4
Sales of space heating units - Fossil (%)	3.33	5.85	3.58	3.05	3	2.95	2.91
Sales of space heating units - Gas (%)	74.3	47	10.3	1.95	1.53	1.52	1.52
Sales of water heating units - Electric Heat Pump (%)	0	11.2	59.4	70.3	70.8	70.8	70.8
Sales of water heating units - Electric Resistance (%)	17.5	31.3	27.2	26.4	26.4	26.4	26.4
Sales of water heating units - Gas Furnace (%)	79.8	54.8	10.6	0.486	0.003	0	0
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.79	2.8	2.82	2.83

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

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs - Cumulative 5-yr (million $2018)	0	5,550	15,540	23,053	35,766	38,007	36,736
Public EV charging plugs - DC Fast (1000 units)	4.35	0	11.9	0	38.9	0	60.4
Public EV charging plugs - L2 (1000 units)	21.5	0	285	0	934	0	1,452
Vehicle sales - Heavy-duty - diesel (%)	97.2	92.1	67	23.3	4.22	0.628	0
Vehicle sales - Heavy-duty - EV (%)	0.588	3.81	19	45.6	57.4	59.6	60
Vehicle sales - Heavy-duty - gasoline (%)	0.227	0.227	0.176	0.066	0.013	0.002	0
Vehicle sales - Heavy-duty - hybrid (%)	0.082	0.09	0.077	0.031	0.007	0.001	0
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.392	2.54	12.7	30.4	38.2	39.7	40
Vehicle sales - Heavy-duty - other (%)	1.5	1.23	1.07	0.568	0.163	0.038	0
Vehicle sales - Light-duty - diesel (%)	1.18	1.49	1.11	0.353	0.069	0.013	0
Vehicle sales - Light-duty - EV (%)	5.15	19	52	84	96.6	99.3	100
Vehicle sales - Light-duty - gasoline (%)	87.8	73.7	43	14.3	3	0.581	0
Vehicle sales - Light-duty - hybrid (%)	5.63	5.42	3.61	1.3	0.323	0.072	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.108	0.318	0.174	0.052	0.011	0.002	0
Vehicle sales - Light-duty - other (%)	0.085	0.08	0.049	0.017	0.003	0.001	0
Vehicle sales - Medium-duty - diesel (%)	64.7	59.7	42.3	14.4	2.59	0.384	0
Vehicle sales - Medium-duty - EV (%)	0.784	5.07	25.3	60.8	76.5	79.5	80
Vehicle sales - Medium-duty - gasoline (%)	33.7	33.3	25.5	9.32	1.77	0.277	0
Vehicle sales - Medium-duty - hybrid (%)	0.363	0.402	0.341	0.14	0.03	0.005	0
Vehicle sales - Medium-duty - hydrogen FC (%)	0.196	1.27	6.33	15.2	19.1	19.9	20
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

Table 3: *E+ scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	798	775	732	700	692	702
Final energy use - Industry (PJ)	1,021	1,057	1,074	1,125	1,184	1,218	1,259
Final energy use - Residential (PJ)	878	820	708	579	478	418	385
Final energy use - Transportation (PJ)	3,056	2,945	2,657	2,291	1,958	1,742	1,635

Table 4: *E+ scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	120,478	131,958	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	41.7	78.2	85.4	85.8	85.8	85.8
Sales of cooking units - Gas (%)	72.5	58.3	21.8	14.6	14.2	14.2	14.2
Sales of space heating units - Electric Heat Pump (%)	1.74	20.9	62.9	75.6	76.7	76.7	76.7
Sales of space heating units - Electric Resistance (%)	11.4	14.3	19.6	22.2	22.6	22.6	22.6
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0

Table 4: *E+ scenario - PILLAR 1: Efficiency/Electrification - Commercial (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Sales of space heating units - Gas Furnace (%)	86.9	64.8	17.5	2.29	0.731	0.685	0.683
Sales of water heating units - Electric Heat Pump (%)	0.63	11.5	57.5	68	68.5	68.5	68.5
Sales of water heating units - Electric Resistance (%)	2.03	6.87	26.2	30.7	30.9	30.9	30.9
Sales of water heating units - Gas Furnace (%)	96.8	81	15.7	0.718	0.005	0	0
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 5: *E+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	12.6	13	29.3	31.6	24.6	25.8

Table 6: *E+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Biomass power plant (billion $2018)	0	0.007	0.811	0	0.169	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.073	0.003	0.003	0.022
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	0.556	0.001	0	0	0
Capital invested - Offshore Wind - Base (billion $2018)	0	0.292	0	0	0.987	1.09	7.32
Capital invested - Offshore Wind - Constrained (billion $2018)	0	0.153	0	0.119	0.769	1.26	6.35
Capital invested - Solar PV - Base (billion $2018)	0	4.1	10.5	19.8	29.2	38.6	39.9
Capital invested - Solar PV - Constrained (billion $2018)	0	13.6	9.2	26.8	27.8	30.2	38.8
Capital invested - Wind - Base (billion $2018)	0	0	0	0	0.06	0.103	0
Capital invested - Wind - Constrained (billion $2018)	0	0.068	0	0.657	1.24	0.43	0.3

Table 7: *E+ scenario - PILLAR 2: Clean Electricity - Generation*

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	13.5	1,606	1,606	1,952	1,952	1,952
Biomass w/ccu allam power plant (GWh)	0	0	0	72.5	75.5	78.9	101
Biomass w/ccu power plant (GWh)	0	0	624	625	625	625	625
OffshoreWind - Base land use assumptions (GWh)	0	418	0	0	2,691	3,654	30,304
OffshoreWind - Constrained land use assumptions (GWh)	0	418	0	0	2,691	3,654	30,304
Solar - Base land use assumptions (GWh)	66,975	7,653	21,799	43,561	64,041	87,469	96,812
Solar - Constrained land use assumptions (GWh)	64,339	4,088	18,460	44,297	78,955	67,372	99,729
Wind - Base land use assumptions (GWh)	28,124	0	0	0	136	238	0
Wind - Constrained land use assumptions (GWh)	28,240	124	0	1,772	1,758	555	2,866

Table 8: *E+ scenario - PILLAR 3: Clean fuels - Bioenergy*

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	8.07	113	386	525	652	722
Conversion capital investment - Cumulative 5-yr (million $2018)	0	7.67	1,415	7,867	3,886	3,650	2,020
Number of facilities - Allam power w ccu (quantity)	0	0	0	4	5	6	7
Number of facilities - Beccs hydrogen (quantity)	0	0	0	8	14	18	21
Number of facilities - Diesel (quantity)	0	0	0	1	1	1	1
Number of facilities - Diesel ccu (quantity)	0	0	0	4	6	7	8
Number of facilities - Power (quantity)	0	1	1	1	2	2	2
Number of facilities - Power ccu (quantity)	0	0	4	6	6	6	6
Number of facilities - Pyrolysis (quantity)	0	0	0	1	1	1	1
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	4	6	7	8

Table 8: *E+ scenario - PILLAR 3: Clean fuels - Bioenergy (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Number of facilities - Sng (quantity)	0	1	1	1	1	1	1
Number of facilities - Sng ccu (quantity)	0	0	4	4	4	4	4

Table 9: *E+ scenario - PILLAR 4: CCUS - CO2 capture*

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	0.75	26.1	37.5	49.8	57.6
Annual - BECCS (MMT)	0	0	0.62	10.6	15.3	20	22.5
Annual - Cement and lime (MMT)	0	0	0	6.71	9.95	13.7	14.1
Annual - NGCC (MMT)	0	0	0.13	8.85	12.3	16.2	21
Cumulative - All (MMT)	0	0	0.75	26.9	64.4	114	172
Cumulative - BECCS (MMT)	0	0	0.62	11.2	26.5	46.5	69
Cumulative - Cement and lime (MMT)	0	0	0	6.71	16.7	30.4	44.5
Cumulative - NGCC (MMT)	0	0	0.13	8.98	21.3	37.4	58.4

Table 10: *E+ scenario - PILLAR 4: CCUS - CO2 storage*

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	0	28.2	41.6	53.4	80.1
Injection wells (wells)	0	0	0	62	92	122	174
Resource characterization, appraisal, permitting costs (million $2020)	0	250	900	1,370	1,370	1,370	1,370
Wells and facilities construction costs (million $2020)	0	0	0	1,860	2,760	3,660	5,220

Table 11: *E+ scenario - PILLAR 4: CCUS - CO2 pipelines*

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	0	2,083	4,688	5,992	6,553	7,748
Cumulative investment - All (million $2018)	0	0	5,343	7,698	8,531	8,996	9,769
Cumulative investment - Spur (million $2018)	0	0	423	2,013	2,845	3,310	4,083
Cumulative investment - Trunk (million $2018)	0	0	4,920	5,686	5,686	5,686	5,686
Spur (km)	0	0	798	3,159	4,463	5,023	6,219
Trunk (km)	0	0	1,285	1,529	1,529	1,529	1,529

Table 12: *E+ scenario - PILLAR 6: Land sinks - Agriculture*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-4,034
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-47.2
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-4,082
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,030
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-23.6
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-2,054
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	3,813
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	73.8

Table 12: *E+ scenario - PILLAR 6: Land sinks - Agriculture (continued)*

Item	2020	2025	2050
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	3,887
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	1,925
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	36.9
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,962

Table 13: *E+ scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	288
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	14,511
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	876
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,065

Table 13: *E+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	1,365
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	2,598
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	668
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,646
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,777

Table 13: *E+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	14.3
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	9,712

Table 14: *E+ scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	252	0.332	0.33	0.174	0.1	0
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,146	1,203	1,077	929	524	234
Monetary damages from air pollution - Transportation (million 2019$)	0	31,487	29,710	22,808	13,295	6,015	2,235
Premature deaths from air pollution - Coal (deaths)	0	28.3	0.037	0.037	0.019	0.011	0
Premature deaths from air pollution - Natural Gas (deaths)	0	242	136	122	105	59.2	26.4
Premature deaths from air pollution - Transportation (deaths)	0	3,541	3,341	2,565	1,495	676	251

Table 15: *E+ scenario - IMPACTS - Jobs*

Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Agriculture (jobs)	750	807	1,386	1,883	1,859	1,653	1,456
By economic sector - Construction (jobs)	72,212	58,143	61,482	76,374	88,452	98,058	134,483
By economic sector - Manufacturing (jobs)	44,137	45,728	65,320	80,973	73,649	64,840	72,019
By economic sector - Mining (jobs)	37,899	32,912	26,356	20,984	13,552	9,002	5,320
By economic sector - Other (jobs)	10,425	7,993	9,224	12,621	16,586	20,593	33,114
By economic sector - Pipeline (jobs)	2,742	2,738	3,005	2,338	1,855	1,425	1,184
By economic sector - Professional (jobs)	30,079	27,553	28,474	35,760	40,983	46,258	64,799
By economic sector - Trade (jobs)	26,292	23,488	23,021	26,403	29,088	32,630	46,719
By economic sector - Utilities (jobs)	25,311	32,003	34,620	51,426	61,771	69,870	89,340
By education level - All sectors - Associates degree or some college (jobs)	75,553	70,243	77,778	96,475	103,858	110,069	144,679
By education level - All sectors - Bachelors degree (jobs)	53,963	50,531	53,560	63,482	65,655	68,043	87,443
By education level - All sectors - Doctoral degree (jobs)	1,911	1,724	1,739	2,039	2,180	2,344	3,146
By education level - All sectors - High school diploma or less (jobs)	105,624	96,899	107,379	131,958	140,501	147,387	191,596
By education level - All sectors - Masters or professional degree (jobs)	12,797	11,968	12,431	14,808	15,603	16,484	21,570
By resource sector - Biomass (jobs)	2,461	2,736	3,641	5,139	5,465	6,045	6,279
By resource sector - CO2 (jobs)	0	127	5,222	3,730	3,209	3,425	4,510
By resource sector - Coal (jobs)	24.2	21.8	7.3	0	0	0	0
By resource sector - Grid (jobs)	30,513	43,985	50,184	87,779	109,695	127,593	169,013
By resource sector - Natural Gas (jobs)	22,779	24,459	18,978	17,499	16,093	13,996	11,074
By resource sector - Nuclear (jobs)	1,192	691	0	0	0	0	0
By resource sector - Oil (jobs)	79,520	74,368	64,969	55,609	40,007	29,393	18,443
By resource sector - Solar (jobs)	104,062	68,196	77,935	106,739	126,628	145,178	216,773
By resource sector - Wind (jobs)	9,296	16,781	31,953	32,267	26,700	18,699	22,341
Median wages - Annual - All ($2019 per job)	67,848	69,497	69,307	70,110	71,266	72,596	73,492

Table 15: *E+ scenario - IMPACTS - Jobs (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
On-Site or In-Plant Training - Total jobs - 1 to 4 years (jobs)	40,183	37,209	40,698	50,024	53,579	56,579	73,861
On-Site or In-Plant Training - Total jobs - 4 to 10 years (jobs)	16,294	14,870	15,777	19,442	21,444	23,178	30,715
On-Site or In-Plant Training - Total jobs - None (jobs)	41,130	37,707	41,275	50,239	53,265	55,918	73,204
On-Site or In-Plant Training - Total jobs - Over 10 years (jobs)	1,945	1,828	2,029	2,555	2,796	2,995	3,942
On-Site or In-Plant Training - Total jobs - Up to 1 year (jobs)	150,296	139,752	153,108	186,502	196,711	205,658	266,711
On-the-Job Training - All sectors - 1 to 4 years (jobs)	51,344	47,534	51,906	63,890	68,631	72,629	94,966
On-the-Job Training - All sectors - 4 to 10 years (jobs)	15,613	14,161	15,087	18,811	21,043	22,953	30,703
On-the-Job Training - All sectors - None (jobs)	14,307	12,946	13,902	16,732	17,755	18,731	24,717
On-the-Job Training - All sectors - Over 10 years (jobs)	2,675	2,389	2,670	3,210	3,335	3,424	4,419
On-the-Job Training - All sectors - Up to 1 year (jobs)	165,909	154,335	169,324	206,119	217,032	226,592	293,629
Related work experience - All sectors - 1 to 4 years (jobs)	90,425	84,169	91,353	111,035	117,537	123,350	160,232
Related work experience - All sectors - 4 to 10 years (jobs)	57,917	53,830	58,408	71,122	75,508	79,360	103,194
Related work experience - All sectors - None (jobs)	35,166	32,643	35,839	44,108	47,296	50,040	65,548
Related work experience - All sectors - Over 10 years (jobs)	15,754	14,741	16,179	19,619	20,444	21,152	27,138
Related work experience - All sectors - Up to 1 year (jobs)	50,585	45,982	51,108	62,878	67,011	70,425	92,321
Wage income - All (million $2019)	16,954	16,081	17,529	21,650	23,364	25,001	32,962

Table 16: *E+ scenario - IMPACTS - Fossil fuel industries*

Item	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption - Annual (tcf)	1,630	1,654	1,394	1,118	842	530	367
Natural gas consumption - Cumulative (tcf)	0	0	0	0	0	0	33,681
Natural gas production - Annual (tcf)	213	236	223	194	164	130	101
Oil consumption - Annual (million bbls)	579	546	474	371	277	202	142
Oil consumption - Cumulative (million bbls)	0	0	0	0	0	0	11,511
Oil production - Annual (million bbls)	206	222	223	223	177	143	95.5

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	27.5	36.2	0	0	0	0
Sales of cooking units - Electric Resistance (%)	39.8	41.4	46.9	61.4	81.6	94.1	98.4
Sales of cooking units - Gas (%)	60.2	58.6	53.1	38.6	18.4	5.94	1.6
Sales of space heating units - Electric Heat Pump (%)	5.99	14.3	19.7	35.3	59.2	74.8	80.3
Sales of space heating units - Electric Resistance (%)	16.4	25.3	24.3	21.5	17.3	14.5	13.6
Sales of space heating units - Fossil (%)	3.33	6.29	6.05	5.3	4.13	3.36	3.07
Sales of space heating units - Gas (%)	74.3	54.1	50	38	19.4	7.29	3.04
Sales of water heating units - Electric Heat Pump (%)	0	1.93	7.42	23.2	47.5	63.3	68.9
Sales of water heating units - Electric Resistance (%)	17.5	32.1	31.6	30.2	28.2	26.9	26.5
Sales of water heating units - Gas Furnace (%)	79.8	63.2	58.2	43.8	21.5	6.93	1.83
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.78	2.8	2.81	2.83

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

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs - Cumulative 5-yr (million $2018)	0	0	1,128	1,859	6,771	19,756	29,318
Public EV charging plugs - DC Fast (1000 units)	4.35	0	5.46	0	15.8	0	38.7
Public EV charging plugs - L2 (1000 units)	21.5	0	131	0	380	0	930
Vehicle sales - Heavy-duty - diesel (%)	97.4	96	91.3	79.8	58.2	32.1	13.7
Vehicle sales - Heavy-duty - EV (%)	0.498	1.45	4.11	10.8	23.6	39.5	51
Vehicle sales - Heavy-duty - gasoline (%)	0.228	0.236	0.239	0.225	0.179	0.109	0.051
Vehicle sales - Heavy-duty - hybrid (%)	0.083	0.094	0.104	0.107	0.092	0.06	0.03
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.332	0.969	2.74	7.17	15.7	26.3	34
Vehicle sales - Heavy-duty - other (%)	1.5	1.28	1.46	1.95	2.25	1.96	1.14
Vehicle sales - Light-duty - diesel (%)	1.19	1.67	1.99	1.57	0.974	0.494	0.213
Vehicle sales - Light-duty - EV (%)	2.32	5.65	13.7	28.9	51.7	74.1	88.4
Vehicle sales - Light-duty - gasoline (%)	90.4	85.6	76.6	62.8	42.5	22.7	10.1
Vehicle sales - Light-duty - hybrid (%)	5.86	6.61	7.25	6.42	4.63	2.63	1.24
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.369	0.305	0.225	0.155	0.085	0.04
Vehicle sales - Light-duty - other (%)	0.087	0.09	0.08	0.069	0.049	0.026	0.012
Vehicle sales - Medium-duty - diesel (%)	64.8	62.2	57.7	49.4	35.6	19.6	8.37
Vehicle sales - Medium-duty - EV (%)	0.664	1.94	5.49	14.3	31.4	52.6	68
Vehicle sales - Medium-duty - gasoline (%)	33.8	34.7	34.7	31.9	24.4	14.2	6.33
Vehicle sales - Medium-duty - hybrid (%)	0.363	0.418	0.464	0.478	0.414	0.275	0.141
Vehicle sales - Medium-duty - hydrogen FC (%)	0.166	0.485	1.37	3.58	7.86	13.2	17
Vehicle sales - Medium-duty - other (%)	0.253	0.266	0.279	0.286	0.258	0.184	0.102

Table 19: *E- scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	800	806	802	788	770	759
Final energy use - Industry (PJ)	1,021	1,058	1,081	1,146	1,217	1,253	1,293
Final energy use - Residential (PJ)	878	825	766	706	626	537	459
Final energy use - Transportation (PJ)	3,060	2,970	2,767	2,590	2,445	2,267	2,054

Table 20: *E- scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	120,137	130,140	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	31	36.1	49.7	68.6	80.2	84.3
Sales of cooking units - Gas (%)	72.5	69	63.9	50.3	31.4	19.8	15.7
Sales of space heating units - Electric Heat Pump (%)	1.74	13	17.8	31.6	53.4	68.7	74.5
Sales of space heating units - Electric Resistance (%)	11.4	13.3	14	15.8	18.8	21.2	22.2
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	86.9	73.7	68.3	52.6	27.8	10.2	3.31
Sales of water heating units - Electric Heat Pump (%)	0.63	2.65	7.89	23	46.1	61.3	66.6
Sales of water heating units - Electric Resistance (%)	2.03	3.16	5.36	11.7	21.4	27.8	30.1
Sales of water heating units - Gas Furnace (%)	96.8	93.6	86.1	64.7	31.8	10.2	2.7
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 21: *E- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	9.31	9.32	16.2	17	25.6	27.3

Table 22: *E- scenario - PILLAR 6: Land sinks - Agriculture*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0

Table 22: *E- scenario - PILLAR 6: Land sinks - Agriculture (continued)*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-4,034
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-47.2
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-4,082
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,030
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-23.6
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-2,054
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	3,813
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	73.8
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	3,887
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	1,925
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	36.9
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,962

Table 23: *E- scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	288
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	14,511

Table 23: *E- scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	876
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,065
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	1,365
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	2,598
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	668

Table 23: *E- scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,646
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,777
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	14.3
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	9,712

Table 24: *E- scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	252	0.332	0.33	0.174	0.1	0
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,036	1,010	587	227	70.7	31.3
Monetary damages from air pollution - Transportation (million 2019$)	0	32,107	32,984	32,552	29,690	23,875	16,465
Premature deaths from air pollution - Coal (deaths)	0	28.3	0.037	0.037	0.019	0.011	0
Premature deaths from air pollution - Natural Gas (deaths)	0	230	114	66.3	25.6	7.98	3.54
Premature deaths from air pollution - Transportation (deaths)	0	3,611	3,710	3,661	3,339	2,685	1,852

Table 25: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Residential*

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	27.7	36.5	0	0	0	0
Sales of cooking units - Electric Resistance (%)	40	52.8	91.9	99.6	100	100	100
Sales of cooking units - Gas (%)	60	47.2	8.07	0.406	0	0	0
Sales of space heating units - Electric Heat Pump (%)	5.99	23.4	70.8	81.7	82.3	82.2	82.2

Table 25: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Residential (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Sales of space heating units - Electric Resistance (%)	16.4	23.7	15.2	13.3	13.2	13.3	13.4
Sales of space heating units - Fossil (%)	3.33	5.85	3.58	3.05	3	2.95	2.91
Sales of space heating units - Gas (%)	74.3	47	10.3	1.95	1.53	1.52	1.52
Sales of water heating units - Electric Heat Pump (%)	0	11.2	59.4	70.3	70.8	70.8	70.8
Sales of water heating units - Electric Resistance (%)	17.5	31.3	27.2	26.4	26.4	26.4	26.4
Sales of water heating units - Gas Furnace (%)	79.8	54.8	10.6	0.486	0.003	0	0
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.79	2.8	2.82	2.83

Table 26: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Transportation*

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs - Cumulative 5-yr (million $2018)	0	5,550	15,540	23,053	35,766	38,007	36,736
Public EV charging plugs - DC Fast (1000 units)	4.35	0	11.9	0	38.9	0	60.4
Public EV charging plugs - L2 (1000 units)	21.5	0	285	0	934	0	1,452
Vehicle sales - Heavy-duty - diesel (%)	97.2	92.1	67	23.3	4.22	0.628	0
Vehicle sales - Heavy-duty - EV (%)	0.588	3.81	19	45.6	57.4	59.6	60
Vehicle sales - Heavy-duty - gasoline (%)	0.227	0.227	0.176	0.066	0.013	0.002	0
Vehicle sales - Heavy-duty - hybrid (%)	0.082	0.09	0.077	0.031	0.007	0.001	0
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.392	2.54	12.7	30.4	38.2	39.7	40
Vehicle sales - Heavy-duty - other (%)	1.5	1.23	1.07	0.568	0.163	0.038	0
Vehicle sales - Light-duty - diesel (%)	1.18	1.49	1.11	0.353	0.069	0.013	0
Vehicle sales - Light-duty - EV (%)	5.15	19	52	84	96.6	99.3	100
Vehicle sales - Light-duty - gasoline (%)	87.8	73.7	43	14.3	3	0.581	0
Vehicle sales - Light-duty - hybrid (%)	5.63	5.42	3.61	1.3	0.323	0.072	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.108	0.318	0.174	0.052	0.011	0.002	0
Vehicle sales - Light-duty - other (%)	0.085	0.08	0.049	0.017	0.003	0.001	0
Vehicle sales - Medium-duty - diesel (%)	64.7	59.7	42.3	14.4	2.59	0.384	0
Vehicle sales - Medium-duty - EV (%)	0.784	5.07	25.3	60.8	76.5	79.5	80
Vehicle sales - Medium-duty - gasoline (%)	33.7	33.3	25.5	9.32	1.77	0.277	0
Vehicle sales - Medium-duty - hybrid (%)	0.363	0.402	0.341	0.14	0.03	0.005	0
Vehicle sales - Medium-duty - hydrogen FC (%)	0.196	1.27	6.33	15.2	19.1	19.9	20
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

Table 27: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	798	775	732	700	692	702
Final energy use - Industry (PJ)	1,021	1,057	1,074	1,125	1,184	1,218	1,259
Final energy use - Residential (PJ)	878	820	708	579	478	418	385
Final energy use - Transportation (PJ)	3,056	2,945	2,657	2,291	1,958	1,742	1,635

Table 28: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	120,478	131,958	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	41.7	78.2	85.4	85.8	85.8	85.8
Sales of cooking units - Gas (%)	72.5	58.3	21.8	14.6	14.2	14.2	14.2
Sales of space heating units - Electric Heat Pump (%)	1.74	20.9	62.9	75.6	76.7	76.7	76.7
Sales of space heating units - Electric Resistance (%)	11.4	14.3	19.6	22.2	22.6	22.6	22.6
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	86.9	64.8	17.5	2.29	0.731	0.685	0.683
Sales of water heating units - Electric Heat Pump (%)	0.63	11.5	57.5	68	68.5	68.5	68.5
Sales of water heating units - Electric Resistance (%)	2.03	6.87	26.2	30.7	30.9	30.9	30.9
Sales of water heating units - Gas Furnace (%)	96.8	81	15.7	0.718	0.005	0	0

Table 28: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Commercial (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 29: *E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	12.6	13	29.3	31.6	24.6	25.8

Table 30: *E+RE+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Offshore Wind - Base (billion $2018)	0	0.292	0	0	1.57	9.82	13.5
Capital invested - Solar PV - Base (billion $2018)	0	13.7	13.4	28.6	46.9	44.6	58.4
Capital invested - Wind - Base (billion $2018)	0	0	0	0.063	0.24	0.154	0.11

Table 31: *E+RE+ scenario - PILLAR 2: Clean Electricity - Generation*

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use assumptions (GWh)	0	418	0	0	4,278	32,836	49,000
OffshoreWind - Constrained land use assumptions (GWh)	0	219	0	258	4,448	27,471	55,173
Solar - Base land use assumptions (GWh)	66,975	25,359	27,186	60,860	101,804	101,166	139,885
Solar - Constrained land use assumptions (GWh)	66,975	18,085	29,578	55,997	116,784	105,857	119,585
Wind - Base land use assumptions (GWh)	28,124	0	0	136	517	336	239
Wind - Constrained land use assumptions (GWh)	28,240	124	148	2,955	1,852	1,997	5,835

Table 32: *E+RE+ scenario - PILLAR 6: Land sinks - Agriculture*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-4,034
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-47.2
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-4,082
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,030
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-23.6
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-2,054
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	3,813
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	73.8
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	3,887
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	1,925

Table 32: *E+RE+ scenario - PILLAR 6: Land sinks - Agriculture (continued)*

Item	2020	2025	2050
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	36.9
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,962

Table 33: *E+RE+ scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	288
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	14,511
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	876
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,065
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	1,365

Table 33: *E+RE+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	2,598
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	668
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,646
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,777
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	14.3

Table 33: *E+RE+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	9,712

Table 34: *E+RE+ scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	252	0.332	0.33	0.174	0.1	0
Monetary damages from air pollution - Natural Gas (million 2019$)	0	1,497	1,136	580	320	121	25.6
Monetary damages from air pollution - Transportation (million 2019$)	0	31,487	29,710	22,808	13,295	6,015	2,235
Premature deaths from air pollution - Coal (deaths)	0	28.3	0.037	0.037	0.019	0.011	0
Premature deaths from air pollution - Natural Gas (deaths)	0	169	128	65.5	36.1	13.7	2.89
Premature deaths from air pollution - Transportation (deaths)	0	3,541	3,341	2,565	1,495	676	251

Table 35: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Residential*

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	27.7	36.5	0	0	0	0
Sales of cooking units - Electric Resistance (%)	40	52.8	91.9	99.6	100	100	100
Sales of cooking units - Gas (%)	60	47.2	8.07	0.406	0	0	0
Sales of space heating units - Electric Heat Pump (%)	5.99	23.4	70.8	81.7	82.3	82.2	82.2
Sales of space heating units - Electric Resistance (%)	16.4	23.7	15.2	13.3	13.2	13.3	13.4
Sales of space heating units - Fossil (%)	3.33	5.85	3.58	3.05	3	2.95	2.91
Sales of space heating units - Gas (%)	74.3	47	10.3	1.95	1.53	1.52	1.52
Sales of water heating units - Electric Heat Pump (%)	0	11.2	59.4	70.3	70.8	70.8	70.8
Sales of water heating units - Electric Resistance (%)	17.5	31.3	27.2	26.4	26.4	26.4	26.4
Sales of water heating units - Gas Furnace (%)	79.8	54.8	10.6	0.486	0.003	0	0
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.79	2.8	2.82	2.83

Table 36: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation*

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs - Cumulative 5-yr (million $2018)	0	5,550	15,540	23,053	35,766	38,007	36,736
Public EV charging plugs - DC Fast (1000 units)	4.35	0	11.9	0	38.9	0	60.4
Public EV charging plugs - L2 (1000 units)	21.5	0	285	0	934	0	1,452
Vehicle sales - Heavy-duty - diesel (%)	97.2	92.1	67	23.3	4.22	0.628	0
Vehicle sales - Heavy-duty - EV (%)	0.588	3.81	19	45.6	57.4	59.6	60
Vehicle sales - Heavy-duty - gasoline (%)	0.227	0.227	0.176	0.066	0.013	0.002	0
Vehicle sales - Heavy-duty - hybrid (%)	0.082	0.09	0.077	0.031	0.007	0.001	0
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.392	2.54	12.7	30.4	38.2	39.7	40
Vehicle sales - Heavy-duty - other (%)	1.5	1.23	1.07	0.568	0.163	0.038	0
Vehicle sales - Light-duty - diesel (%)	1.18	1.49	1.11	0.353	0.069	0.013	0
Vehicle sales - Light-duty - EV (%)	5.15	19	52	84	96.6	99.3	100
Vehicle sales - Light-duty - gasoline (%)	87.8	73.7	43	14.3	3	0.581	0
Vehicle sales - Light-duty - hybrid (%)	5.63	5.42	3.61	1.3	0.323	0.072	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.108	0.318	0.174	0.052	0.011	0.002	0
Vehicle sales - Light-duty - other (%)	0.085	0.08	0.049	0.017	0.003	0.001	0
Vehicle sales - Medium-duty - diesel (%)	64.7	59.7	42.3	14.4	2.59	0.384	0

Table 36: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Vehicle sales - Medium-duty - EV (%)	0.784	5.07	25.3	60.8	76.5	79.5	80
Vehicle sales - Medium-duty - gasoline (%)	33.7	33.3	25.5	9.32	1.77	0.277	0
Vehicle sales - Medium-duty - hybrid (%)	0.363	0.402	0.341	0.14	0.03	0.005	0
Vehicle sales - Medium-duty - hydrogen FC (%)	0.196	1.27	6.33	15.2	19.1	19.9	20
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

Table 37: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	798	775	732	700	692	702
Final energy use - Industry (PJ)	1,021	1,057	1,074	1,125	1,184	1,218	1,259
Final energy use - Residential (PJ)	878	820	708	579	478	418	385
Final energy use - Transportation (PJ)	3,056	2,945	2,657	2,291	1,958	1,742	1,635

Table 38: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	120,478	131,958	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	41.7	78.2	85.4	85.8	85.8	85.8
Sales of cooking units - Gas (%)	72.5	58.3	21.8	14.6	14.2	14.2	14.2
Sales of space heating units - Electric Heat Pump (%)	1.74	20.9	62.9	75.6	76.7	76.7	76.7
Sales of space heating units - Electric Resistance (%)	11.4	14.3	19.6	22.2	22.6	22.6	22.6
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	86.9	64.8	17.5	2.29	0.731	0.685	0.683
Sales of water heating units - Electric Heat Pump (%)	0.63	11.5	57.5	68	68.5	68.5	68.5
Sales of water heating units - Electric Resistance (%)	2.03	6.87	26.2	30.7	30.9	30.9	30.9
Sales of water heating units - Gas Furnace (%)	96.8	81	15.7	0.718	0.005	0	0
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 39: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	12.6	13	29.3	31.6	24.6	25.8

Table 40: *E+RE- scenario - PILLAR 2: Clean Electricity - Generating capacity*

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Offshore Wind - Base (billion $2018)	0	0.292	0	0	0	0.588	0.429
Capital invested - Offshore Wind - Constrained (billion $2018)	0	0.153	0	0	0.097	0.622	0.374
Capital invested - Solar PV - Base (billion $2018)	0	11.9	7.32	6.33	16.7	12.1	21.6
Capital invested - Solar PV - Constrained (billion $2018)	0	11.2	9.7	10.7	14.1	12.5	21
Capital invested - Wind - Base (billion $2018)	0	0	0	0	0	0	0.054
Capital invested - Wind - Constrained (billion $2018)	0	0	0.062	0	0.347	0.265	1.01

Table 41: *E+RE- scenario - PILLAR 2: Clean Electricity - Generation*

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use assumptions (GWh)	0	418	0	0	0	1,981	1,797
OffshoreWind - Constrained land use assumptions (GWh)	0	219	0	0	258	2,081	1,548
Solar - Base land use assumptions (GWh)	76,176	21,833	15,166	13,885	37,793	28,125	52,351
Solar - Constrained land use assumptions (GWh)	78,455	20,589	19,529	22,536	30,224	28,190	49,937

Table 41: *E+RE- scenario - PILLAR 2: Clean Electricity - Generation (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Wind - Base land use assumptions (GWh)	27,863	0	0	0	0	0	136
Wind - Constrained land use assumptions (GWh)	27,871	0	124	0	629	500	1,880

Table 42: *E+RE- scenario - PILLAR 6: Land sinks - Agriculture*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-4,034
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-47.2
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-4,082
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,030
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-23.6
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-2,054
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	3,813
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	73.8
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	3,887
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	1,925
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	36.9
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,962

Table 43: *E+RE- scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	288

Table 43: *E+RE- scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	14,511
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	876
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,065
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	1,365
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	2,598

Table 43: *E+RE- scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	668
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,646
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,777
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	14.3
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	9,712

Table 44: *E+RE- scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	252	0.332	0.33	0.174	0.1	0
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,097	678	1,028	1,342	673	172
Monetary damages from air pollution - Transportation (million 2019$)	0	31,487	29,710	22,808	13,295	6,015	2,235
Premature deaths from air pollution - Coal (deaths)	0	28.3	0.037	0.037	0.019	0.011	0
Premature deaths from air pollution - Natural Gas (deaths)	0	237	76.6	116	152	76.1	19.5
Premature deaths from air pollution - Transportation (deaths)	0	3,541	3,341	2,565	1,495	676	251

Table 45: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Residential*

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	27.5	36.2	0	0	0	0
Sales of cooking units - Electric Resistance (%)	39.8	41.4	46.9	61.4	81.6	94.1	98.4
Sales of cooking units - Gas (%)	60.2	58.6	53.1	38.6	18.4	5.94	1.6
Sales of space heating units - Electric Heat Pump (%)	5.99	14.3	19.7	35.3	59.2	74.8	80.3
Sales of space heating units - Electric Resistance (%)	16.4	25.3	24.3	21.5	17.3	14.5	13.6
Sales of space heating units - Fossil (%)	3.33	6.29	6.05	5.3	4.13	3.36	3.07
Sales of space heating units - Gas (%)	74.3	54.1	50	38	19.4	7.29	3.04
Sales of water heating units - Electric Heat Pump (%)	0	1.93	7.42	23.2	47.5	63.3	68.9
Sales of water heating units - Electric Resistance (%)	17.5	32.1	31.6	30.2	28.2	26.9	26.5
Sales of water heating units - Gas Furnace (%)	79.8	63.2	58.2	43.8	21.5	6.93	1.83
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.78	2.8	2.81	2.83

Table 46: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Transportation*

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs - Cumulative 5-yr (million $2018)	0	0	1,128	1,859	6,771	19,756	29,318
Public EV charging plugs - DC Fast (1000 units)	4.35	0	5.46	0	15.8	0	38.7
Public EV charging plugs - L2 (1000 units)	21.5	0	131	0	380	0	930
Vehicle sales - Heavy-duty - diesel (%)	97.4	96	91.3	79.8	58.2	32.1	13.7
Vehicle sales - Heavy-duty - EV (%)	0.498	1.45	4.11	10.8	23.6	39.5	51
Vehicle sales - Heavy-duty - gasoline (%)	0.228	0.236	0.239	0.225	0.179	0.109	0.051
Vehicle sales - Heavy-duty - hybrid (%)	0.083	0.094	0.104	0.107	0.092	0.06	0.03
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.332	0.969	2.74	7.17	15.7	26.3	34
Vehicle sales - Heavy-duty - other (%)	1.5	1.28	1.46	1.95	2.25	1.96	1.14
Vehicle sales - Light-duty - diesel (%)	1.19	1.67	1.99	1.57	0.974	0.494	0.213
Vehicle sales - Light-duty - EV (%)	2.32	5.65	13.7	28.9	51.7	74.1	88.4
Vehicle sales - Light-duty - gasoline (%)	90.4	85.6	76.6	62.8	42.5	22.7	10.1
Vehicle sales - Light-duty - hybrid (%)	5.86	6.61	7.25	6.42	4.63	2.63	1.24
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.369	0.305	0.225	0.155	0.085	0.04
Vehicle sales - Light-duty - other (%)	0.087	0.09	0.08	0.069	0.049	0.026	0.012
Vehicle sales - Medium-duty - diesel (%)	64.8	62.2	57.7	49.4	35.6	19.6	8.37
Vehicle sales - Medium-duty - EV (%)	0.664	1.94	5.49	14.3	31.4	52.6	68
Vehicle sales - Medium-duty - gasoline (%)	33.8	34.7	34.7	31.9	24.4	14.2	6.33
Vehicle sales - Medium-duty - hybrid (%)	0.363	0.418	0.464	0.478	0.414	0.275	0.141
Vehicle sales - Medium-duty - hydrogen FC (%)	0.166	0.485	1.37	3.58	7.86	13.2	17
Vehicle sales - Medium-duty - other (%)	0.253	0.266	0.279	0.286	0.258	0.184	0.102

Table 47: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	800	806	802	788	770	759
Final energy use - Industry (PJ)	1,021	1,058	1,081	1,146	1,217	1,253	1,293
Final energy use - Residential (PJ)	878	825	766	706	626	537	459
Final energy use - Transportation (PJ)	3,060	2,970	2,767	2,590	2,445	2,267	2,054

Table 48: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	120,137	130,140	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	31	36.1	49.7	68.6	80.2	84.3
Sales of cooking units - Gas (%)	72.5	69	63.9	50.3	31.4	19.8	15.7
Sales of space heating units - Electric Heat Pump (%)	1.74	13	17.8	31.6	53.4	68.7	74.5
Sales of space heating units - Electric Resistance (%)	11.4	13.3	14	15.8	18.8	21.2	22.2
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0

Table 48: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Commercial (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Sales of space heating units - Gas Furnace (%)	86.9	73.7	68.3	52.6	27.8	10.2	3.31
Sales of water heating units - Electric Heat Pump (%)	0.63	2.65	7.89	23	46.1	61.3	66.6
Sales of water heating units - Electric Resistance (%)	2.03	3.16	5.36	11.7	21.4	27.8	30.1
Sales of water heating units - Gas Furnace (%)	96.8	93.6	86.1	64.7	31.8	10.2	2.7
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 49: *E-B+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	9.31	9.32	16.2	17	25.6	27.3

Table 50: *E-B+ scenario - PILLAR 2: Clean Electricity - Generating capacity*

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Biomass power plant (billion $2018)	0	0.012	0.833	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.105	0.017	0.003	0.03
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	1.31	0.033	0.129	0	0

Table 51: *E-B+ scenario - PILLAR 2: Clean Electricity - Generation*

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	22.5	1,658	1,658	1,658	1,658	1,658
Biomass w/ccu allam power plant (GWh)	0	0	0	105	122	125	155
Biomass w/ccu power plant (GWh)	0	0	1,475	1,512	1,657	1,657	1,657

Table 52: *E-B+ scenario - PILLAR 3: Clean fuels - Bioenergy*

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	9.04	119	484	687	752	768
Conversion capital investment - Cumulative 5-yr (million $2018)	0	12.9	2,135	12,011	6,685	2,104	577
Number of facilities - Allam power w ccu (quantity)	0	0	0	4	5	6	6
Number of facilities - Beccs hydrogen (quantity)	0	0	0	12	18	20	21
Number of facilities - Diesel (quantity)	0	0	0	2	2	2	2
Number of facilities - Diesel ccu (quantity)	0	0	0	4	5	6	6
Number of facilities - Power (quantity)	0	2	2	2	2	2	2
Number of facilities - Power ccu (quantity)	0	0	4	6	7	7	7
Number of facilities - Pyrolysis (quantity)	0	0	0	2	2	2	2
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	4	5	6	6
Number of facilities - Sng (quantity)	0	2	2	2	2	2	2
Number of facilities - Sng ccu (quantity)	0	0	4	4	4	4	4

Table 53: *E-B+ scenario - PILLAR 4: CCUS - CO2 capture*

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	1.48	30.2	45	54.6	61
Annual - BECCS (MMT)	0	0	1.47	16.7	25.2	27.9	28.5
Annual - Cement and lime (MMT)	0	0	0	6.71	9.95	13.7	14.1
Annual - NGCC (MMT)	0	0	0.01	6.82	9.85	13	18.3
Cumulative - All (MMT)	0	0	1.48	31.7	76.7	131	192
Cumulative - BECCS (MMT)	0	0	1.47	18.1	43.4	71.3	99.8
Cumulative - Cement and lime (MMT)	0	0	0	6.71	16.7	30.4	44.5
Cumulative - NGCC (MMT)	0	0	0.01	6.83	16.7	29.6	47.9

Table 54: *E-B+ scenario - PILLAR 4: CCUS - CO2 storage*

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	0	34.2	57	61.1	75.2
Injection wells (wells)	0	0	0	66	96	128	182
Resource characterization, appraisal, permitting costs (million $2020)	0	250	918	1,410	1,410	1,410	1,410
Wells and facilities construction costs (million $2020)	0	0	0	1,946	2,887	3,828	5,460

Table 55: *E-B+ scenario - PILLAR 4: CCUS - CO2 pipelines*

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	0	2,057	5,127	6,088	6,545	7,397
Cumulative investment - All (million $2018)	0	0	5,343	7,995	8,768	9,111	9,664
Cumulative investment - Spur (million $2018)	0	0	423	2,309	3,082	3,425	3,978
Cumulative investment - Trunk (million $2018)	0	0	4,920	5,686	5,686	5,686	5,686
Spur (km)	0	0	772	3,598	4,559	5,016	5,868
Trunk (km)	0	0	1,285	1,529	1,529	1,529	1,529

Table 56: *E-B+ scenario - PILLAR 6: Land sinks - Agriculture*

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-4,034
Carbon sink potential - Aggressive deployment - Cropland to woody energy crops (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Pasture to energy crops (1000 tCO2e/y)	0	0	0
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-47.2
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-4,081
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,030
Carbon sink potential - Moderate deployment - Cropland to woody energy crops (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Pasture to energy crops (1000 tCO2e/y)	0	0	0
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-23.6
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-2,054
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	9,415
Land impacted for carbon sink - Aggressive deployment - Cropland to woody energy crops (1000 hectares)	0	0	0.125
Land impacted for carbon sink - Aggressive deployment - Pasture to energy crops (1000 hectares)	0	0	10.6
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	73.8
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	9,499
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	0

Table 56: *E-B+ scenario - PILLAR 6: Land sinks - Agriculture (continued)*

Item	2020	2025	2050
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	1,925
Land impacted for carbon sink - Moderate deployment - Cropland to woody energy crops (1000 hectares)	0	0	0.126
Land impacted for carbon sink - Moderate deployment - Pasture to energy crops (1000 hectares)	0	0	10.6
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	36.9
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,973

Table 57: *E-B+ scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	288
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	14,511
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	876
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,065

Table 57: *E-B+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	1,365
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	2,598
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	668
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,646
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,777

Table 57: *E-B+ scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2050
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	14.3
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	9,712

Table 58: *REF scenario - PILLAR 1: Efficiency/Electrification - Residential*

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs. REF - Cumulative 5-yr (billion $2018)	0	26.2	28.8	0	0	0	0
Sales of cooking units - Electric Resistance (%)	39.3	39.3	39.3	39.3	39.3	39.3	39.3
Sales of cooking units - Gas (%)	60.7	60.7	60.7	60.7	60.7	60.7	60.7
Sales of space heating units - Electric Heat Pump (%)	4.04	25.4	26.3	27.8	29.1	30.6	32.8
Sales of space heating units - Electric Resistance (%)	16.9	22.7	22.3	21.7	21	19.5	17.3
Sales of space heating units - Fossil (%)	3.38	4.97	5	5	4.95	4.95	4.96
Sales of space heating units - Gas (%)	75.7	46.9	46.4	45.5	45	44.9	44.9
Sales of water heating units - Electric Heat Pump (%)	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance (%)	17.5	32.2	32.2	32.2	32.2	32.1	32.1
Sales of water heating units - Gas Furnace (%)	79.8	65	65	65	65.1	65.1	65.1
Sales of water heating units - Other (%)	2.7	2.75	2.76	2.78	2.79	2.81	2.82

Table 59: *REF scenario - PILLAR 1: Efficiency/Electrification - Transportation*

Item	2020	2025	2030	2035	2040	2045	2050
Vehicle sales - Heavy-duty - diesel (%)	98.1	98.2	97.9	97	95.6	93.5	91.6
Vehicle sales - Heavy-duty - EV (%)	0	0	0	0	0	0	0
Vehicle sales - Heavy-duty - gasoline (%)	0.229	0.242	0.257	0.274	0.294	0.317	0.343
Vehicle sales - Heavy-duty - hybrid (%)	0.083	0.096	0.112	0.13	0.15	0.174	0.202
Vehicle sales - Heavy-duty - hydrogen FC (%)	0.119	0.138	0.16	0.186	0.216	0.25	0.29
Vehicle sales - Heavy-duty - other (%)	1.51	1.31	1.57	2.37	3.69	5.71	7.57
Vehicle sales - Light-duty - diesel (%)	1.18	1.65	2.12	1.98	1.77	1.65	1.57
Vehicle sales - Light-duty - EV (%)	4.79	7.2	8.03	9.95	12	13.5	14.8
Vehicle sales - Light-duty - gasoline (%)	88.2	84.3	81.7	79.4	77.1	75.3	73.9
Vehicle sales - Light-duty - hybrid (%)	5.65	6.45	7.76	8.29	8.76	9.15	9.38
Vehicle sales - Light-duty - hydrogen FC (%)	0.109	0.363	0.325	0.284	0.278	0.277	0.286
Vehicle sales - Light-duty - other (%)	0.085	0.089	0.085	0.086	0.085	0.084	0.085
Vehicle sales - Medium-duty - diesel (%)	65.2	63.5	61.6	59.6	58	56.5	55.2
Vehicle sales - Medium-duty - EV (%)	0.027	0.105	0.329	0.671	0.895	0.973	0.993
Vehicle sales - Medium-duty - gasoline (%)	34	35.5	37	38.5	39.7	40.8	41.7
Vehicle sales - Medium-duty - hybrid (%)	0.365	0.427	0.496	0.577	0.674	0.793	0.929
Vehicle sales - Medium-duty - hydrogen FC (%)	0.175	0.208	0.242	0.285	0.339	0.409	0.487
Vehicle sales - Medium-duty - other (%)	0.255	0.271	0.298	0.345	0.42	0.528	0.671

Table 60: *REF scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	793	809	826	837	860	902	960
Final energy use - Industry (PJ)	1,021	1,088	1,143	1,208	1,279	1,368	1,470
Final energy use - Residential (PJ)	878	827	784	756	740	729	719

Table 60: *REF scenario - PILLAR 1: Efficiency/Electrification - Overview (continued)*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Transportation (PJ)	3,057	2,998	2,847	2,765	2,800	2,893	3,001

Table 61: *REF scenario - PILLAR 1: Efficiency/Electrification - Commercial*

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s - Cumulative 5-yr (million $2018)	0	119,229	123,203	0	0	0	0
Sales of cooking units - Electric Resistance (%)	27.5	29	29	29	29	28.9	28.9
Sales of cooking units - Gas (%)	72.5	71	71	71	71	71.1	71.1
Sales of space heating units - Electric Heat Pump (%)	1.74	24.2	61.6	69.2	69.7	69.7	69.6
Sales of space heating units - Electric Resistance (%)	11.4	15.3	21.9	26.1	29.1	29.6	29.7
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	86.9	60.6	16.5	4.65	1.21	0.731	0.683
Sales of water heating units - Electric Heat Pump (%)	0.63	0.808	0.81	0.813	0.819	0.823	0.824
Sales of water heating units - Electric Resistance (%)	2.03	2.38	2.39	2.4	2.4	2.4	2.41
Sales of water heating units - Gas Furnace (%)	96.8	96.2	96.2	96.2	96.2	96.1	96.1
Sales of water heating units - Other (%)	0.501	0.619	0.623	0.624	0.623	0.624	0.625

Table 62: *REF scenario - PILLAR 1: Efficiency/Electrification - Electricity demand*

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested - Cumulative 5-yr (billion $2018)	0	11.4	11.7	20.7	22	18.4	19.1

Table 63: *REF scenario - PILLAR 6: Land sinks - Forests*

Item	2020	2025	2030	2050
Business-as-usual carbon sink - Natural uptake (Mt CO2e/y)	-13.7	0	-7.63	-6.35
Business-as-usual carbon sink - Retained in Hardwood Products (Mt CO2e/y)	-1.79	0	-3	-3.16
Business-as-usual carbon sink - Total (Mt CO2e/y)	-15.5	0	-10.6	-9.51
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	0	3,748
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	0	43,341
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	0	5,255
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	0	13,545
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0	1,299
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	0	6,568
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	0	2,022
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0	288
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	0	2,778
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	0	7,838
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	0	1,878
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	0	14,511
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	0	876

Table 63: *REF scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2030	2050
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	0	5,203
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0	661
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	0	2,189
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	0	708
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0	144
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	0	210
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	0	2,642
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	0	2,813
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	0	28,914
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	0	3,065
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	0	9,374
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0	968
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	0	4,379
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	0	1,365
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0	216
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	0	1,494
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	0	5,240
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	0	613
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	711
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	0	6,907
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0	479
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)	0	0	0	192
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0	19
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	0	78.9
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	0	2,598
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	0	11,598
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	0	307
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	668
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	0	2,646

Table 63: *REF scenario - PILLAR 6: Land sinks - Forests (continued)*

Item	2020	2025	2030	2050
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0	239
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	0	101
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0	9.51
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	0	13.7
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	0	1,572
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	0	5,556
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	0	460
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	690
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	0	4,777
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0	360
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - Mid - Increase trees outside forests (1000 hectares)	0	0	0	147
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0	14.3
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	0	98.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	0	3,166
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	0	9,712

Table 64: *REF scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	439	230	118	87	79.9	75.5
Monetary damages from air pollution - Natural Gas (million 2019$)	0	1,785	1,196	1,491	1,694	1,892	1,767
Monetary damages from air pollution - Transportation (million 2019$)	0	32,012	33,340	34,643	36,132	37,595	39,009
Premature deaths from air pollution - Coal (deaths)	0	49.2	25.9	13.3	9.76	8.97	8.47
Premature deaths from air pollution - Natural Gas (deaths)	0	202	135	168	191	214	200
Premature deaths from air pollution - Transportation (deaths)	0	3,600	3,750	3,896	4,064	4,228	4,387