Net-Zero America - new york 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).

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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	14.3	15.2	0	0	0	0
Sales of cooking units - Electric Resistance (%)	34.6	48.6	91.2	99.6	100	100	100
Sales of cooking units - Gas (%)	65.4	51.4	8.8	0.443	0	0	0
Sales of space heating units - Electric Heat Pump (%)	3.63	16.2	66.1	89	91.7	91.9	92
Sales of space heating units - Electric Resistance (%)	8.47	10.5	6.04	3.28	2.89	2.96	3.08
Sales of space heating units - Fossil (%)	24.2	32.1	10.3	4.74	4.39	4.24	4.06
Sales of space heating units - Gas (%)	63.7	41.2	17.6	3.03	0.991	0.876	0.88
Sales of water heating units - Electric Heat Pump (%)	0	6.54	37.2	51.7	53.5	53.6	53.6
Sales of water heating units - Electric Resistance (%)	18.7	35.7	39.8	45.4	46.3	46.4	46.3
Sales of water heating units - Gas Furnace (%)	71.1	52	21.9	2.85	0.155	0	0
Sales of water heating units - Other (%)	10.3	5.8	1.12	0.083	0.037	0.038	0.038

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	2,187	5,658	9,084	13,794	14,977	14,299
Public EV charging plugs - DC Fast (1000 units)	0.56	0	3.54	0	15	0	24.1
Public EV charging plugs - L2 (1000 units)	4.23	0	85.1	0	360	0	579
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 (%)	1.44	1.72	1.21	0.387	0.073	0.013	0
Vehicle sales - Light-duty - EV (%)	4.28	16.3	48.1	82.5	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.3	76.7	47.1	15.8	3.2	0.587	0
Vehicle sales - Light-duty - hybrid (%)	4.78	4.8	3.33	1.23	0.301	0.066	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.333	0.194	0.06	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.097	0.093	0.059	0.021	0.004	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)	690	677	650	604	560	538	533
Final energy use - Industry (PJ)	488	505	512	521	523	530	532
Final energy use - Residential (PJ)	880	819	735	612	496	413	364
Final energy use - Transportation (PJ)	1,161	1,104	995	858	731	647	604

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	89,684	98,037	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	33.7	75.3	83.5	83.9	84	84
Sales of cooking units - Gas (%)	81.5	66.3	24.7	16.5	16.1	16	16
Sales of space heating units - Electric Heat Pump (%)	0.625	15.6	51.1	76.3	79.8	80.3	80.2
Sales of space heating units - Electric Resistance (%)	2.13	4.73	12.8	18	19.1	18.8	18.9
Sales of space heating units - Fossil (%)	19.1	14.5	2.85	0.124	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 (%)	78.2	65.2	33.3	5.6	1.11	0.87	0.863
Sales of water heating units - Electric Heat Pump (%)	0.224	7.35	41	58.7	61	61.2	61.2
Sales of water heating units - Electric Resistance (%)	1.34	5.14	22.3	36.4	38.5	38.7	38.7
Sales of water heating units - Gas Furnace (%)	97	86.3	36.3	4.73	0.256	0	0
Sales of water heating units - Other (%)	1.45	1.19	0.377	0.184	0.175	0.176	0.176

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	7.59	7.79	18.2	19.6	18.4	19.5

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	0	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.005	0.001	0	0.013
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	0.008	0	0.001	0	0
Capital invested - Offshore Wind - Base (billion $2018)	0	0.393	0.409	15.9	10.9	11	11.3
Capital invested - Offshore Wind - Constrained (billion $2018)	0	0.782	0.412	15.4	10.8	9.53	12.4
Capital invested - Solar PV - Base (billion $2018)	0	6.82	6.34	2.75	6.46	14.1	7.55
Capital invested - Solar PV - Constrained (billion $2018)	0	11.5	11.2	5.23	7.17	8.6	3.67
Capital invested - Wind - Base (billion $2018)	0	0	5.05	7.37	1.23	3.44	1.04
Capital invested - Wind - Constrained (billion $2018)	0	0	8.47	7.67	1.8	3.59	1.05

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	0	0	0	0	0	0
Biomass w/ccu allam power plant (GWh)	0	0	0	4.5	5.42	5.42	18.8
Biomass w/ccu power plant (GWh)	0	0	8.55	8.55	9.28	9.28	9.28
OffshoreWind - Base land use assumptions (GWh)	0	562	687	31,510	22,203	28,224	36,190
OffshoreWind - Constrained land use assumptions (GWh)	0	562	687	31,510	22,203	28,224	36,190
Solar - Base land use assumptions (GWh)	2,912	8,743	9,008	4,160	10,465	24,337	13,832
Solar - Constrained land use assumptions (GWh)	935	9,932	16,979	7,578	11,882	15,990	9,640
Wind - Base land use assumptions (GWh)	14,244	0	7,891	11,920	2,068	6,000	1,894
Wind - Constrained land use assumptions (GWh)	14,244	0	7,812	12,176	2,987	6,102	1,899

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	0	0.322	0.902	1.04	1.04	235
Conversion capital investment - Cumulative 5-yr (million $2018)	0	0	7.03	19.2	4.22	0	4,926
Number of facilities - Allam power w ccu (quantity)	0	0	0	1	1	1	2
Number of facilities - Beccs hydrogen (quantity)	0	0	0	1	1	1	3
Number of facilities - Diesel (quantity)	0	0	0	0	0	0	0
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	2
Number of facilities - Power (quantity)	0	0	0	0	0	0	0
Number of facilities - Power ccu (quantity)	0	0	1	1	1	1	1
Number of facilities - Pyrolysis (quantity)	0	0	0	0	0	0	2
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	1	1	1	1

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

Item	2020	2025	2030	2035	2040	2045	2050
Number of facilities - Sng (quantity)	0	0	0	0	0	0	0
Number of facilities - Sng ccu (quantity)	0	0	1	1	1	1	2

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	0.01	3.38	3.35	3.45	7.35
Annual - BECCS (MMT)	0	0	0.01	0.02	0.02	0.02	3.8
Annual - Cement and lime (MMT)	0	0	0	3.35	3.32	3.42	3.53
Annual - NGCC (MMT)	0	0	0	0.01	0.01	0.01	0.01
Cumulative - All (MMT)	0	0	0.01	3.39	6.74	10.2	17.5
Cumulative - BECCS (MMT)	0	0	0.01	0.03	0.05	0.07	3.87
Cumulative - Cement and lime (MMT)	0	0	0	3.35	6.67	10.1	13.6
Cumulative - NGCC (MMT)	0	0	0	0.01	0.02	0.03	0.04

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

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	0	0	0	0	0
Injection wells (wells)	0	0	0	0	0	0	0
Resource characterization, appraisal, permitting costs (million $2020)	0	0	0	0	0	0	0
Wells and facilities construction costs (million $2020)	0	0	0	0	0	0	0

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

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	0	279	437	612	612	1,309
Cumulative investment - All (million $2018)	0	0	225	402	493	496	905
Cumulative investment - Spur (million $2018)	0	0	111	288	379	382	791
Cumulative investment - Trunk (million $2018)	0	0	114	114	114	114	114
Spur (km)	0	0	216	374	549	549	1,246
Trunk (km)	0	0	63	63	63	63	63

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	-264
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,322
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-89.7
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-2,675
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-264
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-1,224
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-44.8
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-1,532
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	1,489
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	163

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	1,738
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	785
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	81.5
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	953

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	273
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	9,448
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	459
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	1,605

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	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	724
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	1,164
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	350
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,317
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,182

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	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	13.5
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	6,464

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	1,892	2.03	2.02	1.91	1.19	0.064
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,230	1,631	1,158	1,101	849	318
Monetary damages from air pollution - Transportation (million 2019$)	0	7,317	7,231	5,804	3,530	1,675	662
Premature deaths from air pollution - Coal (deaths)	0	212	0.228	0.227	0.215	0.134	0.007
Premature deaths from air pollution - Natural Gas (deaths)	0	252	184	131	124	95.9	35.9
Premature deaths from air pollution - Transportation (deaths)	0	823	813	653	397	188	74.4

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

Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Agriculture (jobs)	456	481	669	431	268	106	368
By economic sector - Construction (jobs)	20,988	20,387	20,455	27,156	32,689	39,643	48,993
By economic sector - Manufacturing (jobs)	8,058	11,546	19,113	19,203	21,505	29,080	42,590
By economic sector - Mining (jobs)	5,963	4,807	3,439	2,289	1,447	864	516
By economic sector - Other (jobs)	2,510	2,536	2,751	3,294	4,521	6,473	8,647
By economic sector - Pipeline (jobs)	1,247	1,235	1,063	877	669	460	416
By economic sector - Professional (jobs)	8,564	8,724	8,961	12,804	16,053	20,586	29,307
By economic sector - Trade (jobs)	6,914	6,685	6,452	8,127	9,941	12,838	17,587
By economic sector - Utilities (jobs)	15,248	16,105	15,702	26,570	32,114	37,844	61,268
By education level - All sectors - Associates degree or some college (jobs)	21,816	22,844	24,849	32,391	38,634	47,903	66,739
By education level - All sectors - Bachelors degree (jobs)	14,387	14,775	15,756	19,991	23,552	29,435	43,855
By education level - All sectors - Doctoral degree (jobs)	505	500	504	655	789	1,005	1,549
By education level - All sectors - High school diploma or less (jobs)	29,771	30,861	33,823	42,897	50,492	62,360	86,719
By education level - All sectors - Masters or professional degree (jobs)	3,469	3,525	3,673	4,817	5,738	7,188	10,829
By resource sector - Biomass (jobs)	1,375	1,481	1,700	1,049	700	400	1,622
By resource sector - CO2 (jobs)	0	0	120	359	357	356	1,028
By resource sector - Coal (jobs)	706	481	139	10.1	9.64	9.2	3.53
By resource sector - Grid (jobs)	15,495	16,815	20,756	44,821	54,716	64,769	79,742
By resource sector - Natural Gas (jobs)	13,329	14,747	10,460	8,380	9,432	7,326	5,429
By resource sector - Nuclear (jobs)	2,655	1,883	1,369	1,224	1,031	3,074	24,820
By resource sector - Oil (jobs)	11,856	10,343	8,327	6,120	4,320	3,031	2,063
By resource sector - Solar (jobs)	21,874	23,548	26,599	20,144	27,960	44,430	54,376
By resource sector - Wind (jobs)	2,657	3,206	9,135	18,645	20,680	24,498	40,607
Median wages - Annual - All ($2019 per job)	68,927	69,341	68,899	71,169	72,306	73,075	75,182

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)	11,457	11,888	12,800	16,684	19,821	24,460	34,114
On-Site or In-Plant Training - Total jobs - 4 to 10 years (jobs)	4,904	4,987	5,092	6,883	8,241	10,009	13,555
On-Site or In-Plant Training - Total jobs - None (jobs)	11,379	11,786	12,831	16,219	19,218	24,032	34,555
On-Site or In-Plant Training - Total jobs - Over 10 years (jobs)	590	621	667	897	1,074	1,313	1,762
On-Site or In-Plant Training - Total jobs - Up to 1 year (jobs)	41,618	43,223	47,216	60,069	70,852	88,078	125,705
On-the-Job Training - All sectors - 1 to 4 years (jobs)	14,768	15,319	16,425	21,524	25,613	31,579	44,038
On-the-Job Training - All sectors - 4 to 10 years (jobs)	4,800	4,883	4,978	6,806	8,188	9,944	13,312
On-the-Job Training - All sectors - None (jobs)	3,903	3,976	4,253	5,329	6,299	7,901	11,520
On-the-Job Training - All sectors - Over 10 years (jobs)	705	734	820	988	1,159	1,458	2,096
On-the-Job Training - All sectors - Up to 1 year (jobs)	45,771	47,593	52,129	66,105	77,945	97,011	138,725
Related work experience - All sectors - 1 to 4 years (jobs)	25,144	26,014	28,034	36,052	42,667	52,900	75,236
Related work experience - All sectors - 4 to 10 years (jobs)	16,311	16,897	18,134	23,486	27,855	34,480	48,899
Related work experience - All sectors - None (jobs)	10,104	10,497	11,336	14,604	17,304	21,370	29,856
Related work experience - All sectors - Over 10 years (jobs)	4,295	4,490	4,944	6,293	7,417	9,249	13,425
Related work experience - All sectors - Up to 1 year (jobs)	14,092	14,607	16,155	20,317	23,963	29,894	42,274
Wage income - All (million $2019)	4,822	5,028	5,416	7,171	8,620	10,809	15,767

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

Item	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption - Annual (tcf)	1,030	1,045	881	707	532	335	232
Natural gas consumption - Cumulative (tcf)	0	0	0	0	0	0	21,286
Natural gas production - Annual (tcf)	13	14.4	13.6	11.9	10	7.95	6.18
Oil consumption - Annual (million bbls)	241	230	202	160	122	91.3	66.3
Oil consumption - Cumulative (million bbls)	0	0	0	0	0	0	4,947
Oil production - Annual (million bbls)	0.265	0.286	0.287	0.287	0.227	0.185	0.123

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	14.3	16.3	0	0	0	0
Sales of cooking units - Electric Resistance (%)	34.4	36.1	42.1	57.9	80	93.5	98.3
Sales of cooking units - Gas (%)	65.6	63.9	57.9	42.1	20	6.47	1.74
Sales of space heating units - Electric Heat Pump (%)	3.63	7.47	12.9	28.9	55.2	75.3	83.7
Sales of space heating units - Electric Resistance (%)	8.47	11.2	10.6	9.22	6.74	4.65	3.8
Sales of space heating units - Fossil (%)	24.2	36.3	34	27.2	16.6	9.64	6.99
Sales of space heating units - Gas (%)	63.7	45.1	42.4	34.7	21.5	10.4	5.47
Sales of water heating units - Electric Heat Pump (%)	0	1.21	4.63	14.7	31.2	43.9	49.3
Sales of water heating units - Electric Resistance (%)	18.7	35.3	35.6	36.9	39.6	42.6	44.2
Sales of water heating units - Gas Furnace (%)	71.1	56.8	53.6	43.7	26.7	12.4	5.95
Sales of water heating units - Other (%)	10.3	6.7	6.2	4.75	2.54	1.09	0.587

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	363	742	2,526	7,889	11,514
Public EV charging plugs - DC Fast (1000 units)	0.56	0	1.17	0	5.61	0	15.4
Public EV charging plugs - L2 (1000 units)	4.23	0	28.1	0	135	0	371
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 (%)	1.45	1.88	2.04	1.61	1.02	0.524	0.225
Vehicle sales - Light-duty - EV (%)	2.02	4.97	12.4	26.8	49.4	72.7	87.8
Vehicle sales - Light-duty - gasoline (%)	91.4	86.9	78.7	65.5	45.1	24.2	10.7
Vehicle sales - Light-duty - hybrid (%)	4.96	5.75	6.41	5.79	4.28	2.5	1.2
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.377	0.32	0.242	0.17	0.094	0.044
Vehicle sales - Light-duty - other (%)	0.098	0.102	0.092	0.08	0.057	0.031	0.014
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)	690	679	673	667	654	636	618
Final energy use - Industry (PJ)	488	505	514	526	531	538	538
Final energy use - Residential (PJ)	880	823	783	735	664	579	494
Final energy use - Transportation (PJ)	1,163	1,112	1,033	964	905	837	757

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	89,637	97,820	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	21.6	27.5	43	64.5	77.7	82.3
Sales of cooking units - Gas (%)	81.5	78.4	72.5	57	35.5	22.3	17.7
Sales of space heating units - Electric Heat Pump (%)	0.625	10	13.9	25.5	45.9	63.9	72.2
Sales of space heating units - Electric Resistance (%)	2.13	3.41	4.29	6.96	11.7	15.4	17.3
Sales of space heating units - Fossil (%)	19.1	16.8	16.2	12.8	7.04	2.9	1.58
Sales of space heating units - Gas Furnace (%)	78.2	69.8	65.6	54.7	35.3	17.8	8.88
Sales of water heating units - Electric Heat Pump (%)	0.224	1.65	5.4	16.4	34.9	49.5	55.9
Sales of water heating units - Electric Resistance (%)	1.34	2.6	4.47	10.1	20.3	29.6	34
Sales of water heating units - Gas Furnace (%)	97	94.4	88.8	72.4	44.1	20.6	9.85
Sales of water heating units - Other (%)	1.45	1.35	1.33	1.05	0.642	0.377	0.282

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	6.03	6.04	8.86	9.2	14.7	15.6

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	-264

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	-2,322
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-89.7
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-2,675
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-264
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-1,224
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-44.8
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-1,532
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	1,489
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	163
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	1,738
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	785
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	81.5
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	953

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	273
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	9,448

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	459
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	1,605
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	724
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	1,164
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	350

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	2,317
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,182
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	13.5
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	6,464

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	1,892	2.03	2.02	1.91	1.19	0.064
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,198	1,242	561	221	56.9	78
Monetary damages from air pollution - Transportation (million 2019$)	0	7,451	7,988	8,203	7,769	6,492	4,675
Premature deaths from air pollution - Coal (deaths)	0	212	0.228	0.227	0.215	0.134	0.007
Premature deaths from air pollution - Natural Gas (deaths)	0	248	140	63.4	25	6.42	8.81
Premature deaths from air pollution - Transportation (deaths)	0	838	898	923	874	730	526

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	14.3	15.2	0	0	0	0
Sales of cooking units - Electric Resistance (%)	34.6	48.6	91.2	99.6	100	100	100
Sales of cooking units - Gas (%)	65.4	51.4	8.8	0.443	0	0	0
Sales of space heating units - Electric Heat Pump (%)	3.63	16.2	66.1	89	91.7	91.9	92

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 (%)	8.47	10.5	6.04	3.28	2.89	2.96	3.08
Sales of space heating units - Fossil (%)	24.2	32.1	10.3	4.74	4.39	4.24	4.06
Sales of space heating units - Gas (%)	63.7	41.2	17.6	3.03	0.991	0.876	0.88
Sales of water heating units - Electric Heat Pump (%)	0	6.54	37.2	51.7	53.5	53.6	53.6
Sales of water heating units - Electric Resistance (%)	18.7	35.7	39.8	45.4	46.3	46.4	46.3
Sales of water heating units - Gas Furnace (%)	71.1	52	21.9	2.85	0.155	0	0
Sales of water heating units - Other (%)	10.3	5.8	1.12	0.083	0.037	0.038	0.038

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	2,187	5,658	9,084	13,794	14,977	14,299
Public EV charging plugs - DC Fast (1000 units)	0.56	0	3.54	0	15	0	24.1
Public EV charging plugs - L2 (1000 units)	4.23	0	85.1	0	360	0	579
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 (%)	1.44	1.72	1.21	0.387	0.073	0.013	0
Vehicle sales - Light-duty - EV (%)	4.28	16.3	48.1	82.5	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.3	76.7	47.1	15.8	3.2	0.587	0
Vehicle sales - Light-duty - hybrid (%)	4.78	4.8	3.33	1.23	0.301	0.066	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.333	0.194	0.06	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.097	0.093	0.059	0.021	0.004	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)	690	677	650	604	560	538	533
Final energy use - Industry (PJ)	488	505	512	521	523	530	532
Final energy use - Residential (PJ)	880	819	735	612	496	413	364
Final energy use - Transportation (PJ)	1,161	1,104	995	858	731	647	604

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	89,684	98,037	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	33.7	75.3	83.5	83.9	84	84
Sales of cooking units - Gas (%)	81.5	66.3	24.7	16.5	16.1	16	16
Sales of space heating units - Electric Heat Pump (%)	0.625	15.6	51.1	76.3	79.8	80.3	80.2
Sales of space heating units - Electric Resistance (%)	2.13	4.73	12.8	18	19.1	18.8	18.9
Sales of space heating units - Fossil (%)	19.1	14.5	2.85	0.124	0	0	0
Sales of space heating units - Gas Furnace (%)	78.2	65.2	33.3	5.6	1.11	0.87	0.863
Sales of water heating units - Electric Heat Pump (%)	0.224	7.35	41	58.7	61	61.2	61.2
Sales of water heating units - Electric Resistance (%)	1.34	5.14	22.3	36.4	38.5	38.7	38.7
Sales of water heating units - Gas Furnace (%)	97	86.3	36.3	4.73	0.256	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 (%)	1.45	1.19	0.377	0.184	0.175	0.176	0.176

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	7.59	7.79	18.2	19.6	18.4	19.5

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	0.393	0.409	25.7	17.3	18.6	28.4
Capital invested - Solar PV - Base (billion $2018)	0	8.73	8.17	9.85	8.95	12.1	4.29
Capital invested - Wind - Base (billion $2018)	0	0	5.05	8.67	2.98	8.08	5.03

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	562	687	51,201	35,945	47,900	94,412
OffshoreWind - Constrained land use assumptions (GWh)	0	1,121	694	50,066	27,607	0	127,156
Solar - Base land use assumptions (GWh)	4,001	11,206	11,525	15,022	14,631	20,848	7,859
Solar - Constrained land use assumptions (GWh)	3,079	15,489	12,427	12,765	14,133	16,711	7,456
Wind - Base land use assumptions (GWh)	14,244	0	7,891	13,988	4,937	13,792	8,839
Wind - Constrained land use assumptions (GWh)	14,244	0	7,812	15,056	5,132	13,095	7,925

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	-264
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,322
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-89.7
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-2,675
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-264
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-1,224
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-44.8
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-1,532
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	1,489
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	163
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	1,738
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	785

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	81.5
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	953

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	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	273
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	9,448
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	459
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	1,605
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	724

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	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	1,164
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	350
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,317
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,182
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	13.5

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	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	6,464

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	1,892	2.03	2.02	1.91	1.19	0.064
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,114	1,540	874	719	302	70.4
Monetary damages from air pollution - Transportation (million 2019$)	0	7,317	7,231	5,804	3,530	1,675	662
Premature deaths from air pollution - Coal (deaths)	0	212	0.228	0.227	0.215	0.134	0.007
Premature deaths from air pollution - Natural Gas (deaths)	0	239	174	98.7	81.2	34.1	7.95
Premature deaths from air pollution - Transportation (deaths)	0	823	813	653	397	188	74.4

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	14.3	15.2	0	0	0	0
Sales of cooking units - Electric Resistance (%)	34.6	48.6	91.2	99.6	100	100	100
Sales of cooking units - Gas (%)	65.4	51.4	8.8	0.443	0	0	0
Sales of space heating units - Electric Heat Pump (%)	3.63	16.2	66.1	89	91.7	91.9	92
Sales of space heating units - Electric Resistance (%)	8.47	10.5	6.04	3.28	2.89	2.96	3.08
Sales of space heating units - Fossil (%)	24.2	32.1	10.3	4.74	4.39	4.24	4.06
Sales of space heating units - Gas (%)	63.7	41.2	17.6	3.03	0.991	0.876	0.88
Sales of water heating units - Electric Heat Pump (%)	0	6.54	37.2	51.7	53.5	53.6	53.6
Sales of water heating units - Electric Resistance (%)	18.7	35.7	39.8	45.4	46.3	46.4	46.3
Sales of water heating units - Gas Furnace (%)	71.1	52	21.9	2.85	0.155	0	0
Sales of water heating units - Other (%)	10.3	5.8	1.12	0.083	0.037	0.038	0.038

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	2,187	5,658	9,084	13,794	14,977	14,299
Public EV charging plugs - DC Fast (1000 units)	0.56	0	3.54	0	15	0	24.1
Public EV charging plugs - L2 (1000 units)	4.23	0	85.1	0	360	0	579
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 (%)	1.44	1.72	1.21	0.387	0.073	0.013	0
Vehicle sales - Light-duty - EV (%)	4.28	16.3	48.1	82.5	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.3	76.7	47.1	15.8	3.2	0.587	0
Vehicle sales - Light-duty - hybrid (%)	4.78	4.8	3.33	1.23	0.301	0.066	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.333	0.194	0.06	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.097	0.093	0.059	0.021	0.004	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)	690	677	650	604	560	538	533
Final energy use - Industry (PJ)	488	505	512	521	523	530	532
Final energy use - Residential (PJ)	880	819	735	612	496	413	364
Final energy use - Transportation (PJ)	1,161	1,104	995	858	731	647	604

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	89,684	98,037	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	33.7	75.3	83.5	83.9	84	84
Sales of cooking units - Gas (%)	81.5	66.3	24.7	16.5	16.1	16	16
Sales of space heating units - Electric Heat Pump (%)	0.625	15.6	51.1	76.3	79.8	80.3	80.2
Sales of space heating units - Electric Resistance (%)	2.13	4.73	12.8	18	19.1	18.8	18.9
Sales of space heating units - Fossil (%)	19.1	14.5	2.85	0.124	0	0	0
Sales of space heating units - Gas Furnace (%)	78.2	65.2	33.3	5.6	1.11	0.87	0.863
Sales of water heating units - Electric Heat Pump (%)	0.224	7.35	41	58.7	61	61.2	61.2
Sales of water heating units - Electric Resistance (%)	1.34	5.14	22.3	36.4	38.5	38.7	38.7
Sales of water heating units - Gas Furnace (%)	97	86.3	36.3	4.73	0.256	0	0
Sales of water heating units - Other (%)	1.45	1.19	0.377	0.184	0.175	0.176	0.176

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	7.59	7.79	18.2	19.6	18.4	19.5

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	7.13	6.26	9.69	2.94	0.085	2.86
Capital invested - Offshore Wind - Constrained (billion $2018)	0	7.43	6.23	9.75	2.95	0	2.61
Capital invested - Solar PV - Base (billion $2018)	0	1.75	0.092	0.837	0.659	1.62	14.5
Capital invested - Solar PV - Constrained (billion $2018)	0	0.54	0	0.646	1.19	1.28	18
Capital invested - Wind - Base (billion $2018)	0	0	0	1.36	4.2	5.29	3.58
Capital invested - Wind - Constrained (billion $2018)	0	0	0.072	1.29	4.31	5.29	3.55

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	10,024	10,525	19,501	5,987	217	8,940
OffshoreWind - Constrained land use assumptions (GWh)	0	10,664	10,507	19,480	6,047	0	8,225
Solar - Base land use assumptions (GWh)	3,185	2,259	128	1,285	1,084	2,807	26,467
Solar - Constrained land use assumptions (GWh)	1,883	711	0	998	1,997	2,210	32,774

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)	14,244	0	0	2,321	7,327	9,437	6,665
Wind - Constrained land use assumptions (GWh)	14,244	0	111	2,221	7,449	9,330	6,526

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	-264
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,322
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-89.7
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-2,675
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-264
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-1,224
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-44.8
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-1,532
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	1,489
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	163
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	1,738
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	85.7
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	785
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	81.5
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	953

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	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	273

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	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	9,448
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	459
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	1,605
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	724
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	1,164

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	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	350
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,317
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,182
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	13.5
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	6,464

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	1,892	2.03	2.02	1.91	1.19	0.064
Monetary damages from air pollution - Natural Gas (million 2019$)	0	2,123	1,300	1,572	1,387	961	156
Monetary damages from air pollution - Transportation (million 2019$)	0	7,317	7,231	5,804	3,530	1,675	662
Premature deaths from air pollution - Coal (deaths)	0	212	0.228	0.227	0.215	0.134	0.007
Premature deaths from air pollution - Natural Gas (deaths)	0	240	147	178	157	109	17.6
Premature deaths from air pollution - Transportation (deaths)	0	823	813	653	397	188	74.4

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	14.3	16.3	0	0	0	0
Sales of cooking units - Electric Resistance (%)	34.4	36.1	42.1	57.9	80	93.5	98.3
Sales of cooking units - Gas (%)	65.6	63.9	57.9	42.1	20	6.47	1.74
Sales of space heating units - Electric Heat Pump (%)	3.63	7.47	12.9	28.9	55.2	75.3	83.7
Sales of space heating units - Electric Resistance (%)	8.47	11.2	10.6	9.22	6.74	4.65	3.8
Sales of space heating units - Fossil (%)	24.2	36.3	34	27.2	16.6	9.64	6.99
Sales of space heating units - Gas (%)	63.7	45.1	42.4	34.7	21.5	10.4	5.47
Sales of water heating units - Electric Heat Pump (%)	0	1.21	4.63	14.7	31.2	43.9	49.3
Sales of water heating units - Electric Resistance (%)	18.7	35.3	35.6	36.9	39.6	42.6	44.2
Sales of water heating units - Gas Furnace (%)	71.1	56.8	53.6	43.7	26.7	12.4	5.95
Sales of water heating units - Other (%)	10.3	6.7	6.2	4.75	2.54	1.09	0.587

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	363	742	2,526	7,889	11,514
Public EV charging plugs - DC Fast (1000 units)	0.56	0	1.17	0	5.61	0	15.4
Public EV charging plugs - L2 (1000 units)	4.23	0	28.1	0	135	0	371
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 (%)	1.45	1.88	2.04	1.61	1.02	0.524	0.225
Vehicle sales - Light-duty - EV (%)	2.02	4.97	12.4	26.8	49.4	72.7	87.8
Vehicle sales - Light-duty - gasoline (%)	91.4	86.9	78.7	65.5	45.1	24.2	10.7
Vehicle sales - Light-duty - hybrid (%)	4.96	5.75	6.41	5.79	4.28	2.5	1.2
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.377	0.32	0.242	0.17	0.094	0.044
Vehicle sales - Light-duty - other (%)	0.098	0.102	0.092	0.08	0.057	0.031	0.014
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)	690	679	673	667	654	636	618
Final energy use - Industry (PJ)	488	505	514	526	531	538	538
Final energy use - Residential (PJ)	880	823	783	735	664	579	494
Final energy use - Transportation (PJ)	1,163	1,112	1,033	964	905	837	757

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	89,637	97,820	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	21.6	27.5	43	64.5	77.7	82.3
Sales of cooking units - Gas (%)	81.5	78.4	72.5	57	35.5	22.3	17.7
Sales of space heating units - Electric Heat Pump (%)	0.625	10	13.9	25.5	45.9	63.9	72.2
Sales of space heating units - Electric Resistance (%)	2.13	3.41	4.29	6.96	11.7	15.4	17.3
Sales of space heating units - Fossil (%)	19.1	16.8	16.2	12.8	7.04	2.9	1.58

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 (%)	78.2	69.8	65.6	54.7	35.3	17.8	8.88
Sales of water heating units - Electric Heat Pump (%)	0.224	1.65	5.4	16.4	34.9	49.5	55.9
Sales of water heating units - Electric Resistance (%)	1.34	2.6	4.47	10.1	20.3	29.6	34
Sales of water heating units - Gas Furnace (%)	97	94.4	88.8	72.4	44.1	20.6	9.85
Sales of water heating units - Other (%)	1.45	1.35	1.33	1.05	0.642	0.377	0.282

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	6.03	6.04	8.86	9.2	14.7	15.6

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	0	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.005	0.001	0	0.011
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	0.007	0	0.001	0	0.011

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	0	0	0	0	0	0
Biomass w/ccu allam power plant (GWh)	0	0	0	4.49	5.23	5.45	16.9
Biomass w/ccu power plant (GWh)	0	0	8.38	8.38	9.01	9.12	21.7

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	0	0.652	1.94	2.2	6.27	1,070
Conversion capital investment - Cumulative 5-yr (million $2018)	0	0	6.95	22.2	4.22	47.7	12,245
Number of facilities - Allam power w ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Beccs hydrogen (quantity)	0	0	0	1	1	1	1
Number of facilities - Diesel (quantity)	0	0	0	0	0	1	1
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Power (quantity)	0	0	0	0	0	0	0
Number of facilities - Power ccu (quantity)	0	0	1	1	1	1	1
Number of facilities - Pyrolysis (quantity)	0	0	0	0	0	1	13
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Sng (quantity)	0	0	0	0	0	0	0
Number of facilities - Sng ccu (quantity)	0	0	1	1	1	1	1

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	0.01	3.38	3.35	3.45	3.67
Annual - BECCS (MMT)	0	0	0.01	0.02	0.02	0.03	0.12
Annual - Cement and lime (MMT)	0	0	0	3.35	3.32	3.42	3.53
Annual - NGCC (MMT)	0	0	0	0.01	0.01	0.01	0.01
Cumulative - All (MMT)	0	0	0.01	3.39	6.74	10.2	13.9
Cumulative - BECCS (MMT)	0	0	0.01	0.03	0.05	0.08	0.2
Cumulative - Cement and lime (MMT)	0	0	0	3.35	6.67	10.1	13.6
Cumulative - NGCC (MMT)	0	0	0	0.01	0.02	0.03	0.04

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

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	0	0	0	0	0
Injection wells (wells)	0	0	0	0	0	0	0
Resource characterization, appraisal, permitting costs (million $2020)	0	0	0	0	0	0	0
Wells and facilities construction costs (million $2020)	0	0	0	0	0	0	0

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

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	0	279	612	612	437	612
Cumulative investment - All (million $2018)	0	0	223	490	489	400	499
Cumulative investment - Spur (million $2018)	0	0	109	376	375	286	385
Cumulative investment - Trunk (million $2018)	0	0	114	114	114	114	114
Spur (km)	0	0	216	549	549	374	549
Trunk (km)	0	0	63	63	63	63	63

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	-414
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-2,200
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	-84.9
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-2,698
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-414
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-1,160
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	-42.4
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-1,616
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	172
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	3,483
Land impacted for carbon sink - Aggressive deployment - Cropland to woody energy crops (1000 hectares)	0	0	1.31
Land impacted for carbon sink - Aggressive deployment - Pasture to energy crops (1000 hectares)	0	0	78.3
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	154
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	3,889
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	172

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	744
Land impacted for carbon sink - Moderate deployment - Cropland to woody energy crops (1000 hectares)	0	0	1.31
Land impacted for carbon sink - Moderate deployment - Pasture to energy crops (1000 hectares)	0	0	78.3
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	77.2
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	1,072

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	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	273
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	9,448
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	459
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	1,605

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	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	724
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	1,164
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	350
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,317
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	4,182

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	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	13.5
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	6,464

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	13.5	14.1	0	0	0	0
Sales of cooking units - Electric Resistance (%)	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Sales of cooking units - Gas (%)	66.2	66.2	66.2	66.2	66.2	66.2	66.2
Sales of space heating units - Electric Heat Pump (%)	1.94	19.2	20	21	21.5	22.1	22.9
Sales of space heating units - Electric Resistance (%)	8.69	9.88	9.71	9.54	9.43	8.85	8.05
Sales of space heating units - Fossil (%)	24.6	30	16	7.63	6.8	6.76	6.79
Sales of space heating units - Gas (%)	64.8	40.9	54.3	61.9	62.2	62.3	62.3
Sales of water heating units - Electric Heat Pump (%)	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance (%)	18.7	35.1	35	35	35	34.9	34.9
Sales of water heating units - Gas Furnace (%)	71.1	58	58.1	58.1	58.1	58.2	58.2
Sales of water heating units - Other (%)	10.3	6.88	6.87	6.87	6.88	6.87	6.87

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 (%)	1.44	1.87	2.17	2.02	1.81	1.69	1.6
Vehicle sales - Light-duty - EV (%)	3.92	6.07	6.88	8.48	10.3	11.8	13
Vehicle sales - Light-duty - gasoline (%)	89.6	86	83.7	81.7	79.5	77.6	76.1
Vehicle sales - Light-duty - hybrid (%)	4.8	5.63	6.86	7.42	7.96	8.48	8.86
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.373	0.339	0.3	0.296	0.296	0.306
Vehicle sales - Light-duty - other (%)	0.097	0.101	0.097	0.098	0.097	0.096	0.098
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)	690	686	690	689	696	725	772
Final energy use - Industry (PJ)	488	516	537	550	569	586	604
Final energy use - Residential (PJ)	880	816	779	749	730	718	709

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Transportation (PJ)	1,162	1,127	1,072	1,042	1,053	1,087	1,129

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	88,595	91,263	0	0	0	0
Sales of cooking units - Electric Resistance (%)	18.5	19.4	19.4	19.6	19.7	19.8	19.9
Sales of cooking units - Gas (%)	81.5	80.6	80.6	80.4	80.3	80.2	80.1
Sales of space heating units - Electric Heat Pump (%)	0.625	14.7	40.7	61.9	65.1	65.7	65.5
Sales of space heating units - Electric Resistance (%)	2.13	4.03	8.89	21.3	31.8	33.3	33.6
Sales of space heating units - Fossil (%)	19.1	16.3	12.8	5.74	0.874	0.07	0
Sales of space heating units - Gas Furnace (%)	78.2	65	37.7	11	2.19	0.952	0.86
Sales of water heating units - Electric Heat Pump (%)	0.224	0.326	0.327	0.328	0.329	0.331	0.331
Sales of water heating units - Electric Resistance (%)	1.34	1.93	1.92	1.93	1.93	1.92	1.93
Sales of water heating units - Gas Furnace (%)	97	96.4	96.3	96.3	96.3	96.3	96.3
Sales of water heating units - Other (%)	1.45	1.38	1.45	1.44	1.45	1.49	1.49

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	6.35	6.41	12.1	12.8	14.6	15.5

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

Item	2020	2025	2030	2050
Business-as-usual carbon sink - Natural uptake (Mt CO2e/y)	-10.2	0	-16.4	-14.7
Business-as-usual carbon sink - Retained in Hardwood Products (Mt CO2e/y)	-1.49	0	-2.67	-2.78
Business-as-usual carbon sink - Total (Mt CO2e/y)	-11.7	0	-19.1	-17.5
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	0	383
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	0	31,435
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	0	2,752
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	0	11,858
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0	604
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	0	5,464
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	0	1,072
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0	273
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	0	5,516
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	0	3,513
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	0	192
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	0	9,448
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	0	459

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	4,555
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0	307
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	0	1,821
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	0	375
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0	136
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	0	418
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	0	1,184
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	0	287
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	0	20,436
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	0	1,605
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	0	8,206
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0	450
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	0	3,642
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	0	724
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0	205
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	0	2,967
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	0	2,349
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	0	62.6
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	373
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	0	6,047
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0	223
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	102
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0	18
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	0	157
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	0	1,164
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	0	8,146
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	0	31.3
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	350
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	0	2,317

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	111
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	53.6
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0	9.02
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	0	27.2
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	0	705
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	0	3,603
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	0	47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	361
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	0	4,182
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0	167
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	77.7
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0	13.5
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	0	196
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	0	1,419
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	0	6,464

Table 64: *REF scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	5,195	3,239	2,997	2,900	2,839	2,551
Monetary damages from air pollution - Natural Gas (million 2019$)	0	1,652	1,595	2,179	2,161	2,470	2,731
Monetary damages from air pollution - Transportation (million 2019$)	0	7,434	8,078	8,725	9,431	10,167	10,949
Premature deaths from air pollution - Coal (deaths)	0	583	364	336	325	319	286
Premature deaths from air pollution - Natural Gas (deaths)	0	187	180	246	244	279	309
Premature deaths from air pollution - Transportation (deaths)	0	836	909	981	1,061	1,143	1,231