Net-Zero America - massachusetts state report

Larson et al. 2020

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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	5.62	6.19	0	0	0	0
Sales of cooking units - Electric Resistance (%)	64.1	71.7	95.2	99.8	100	100	100
Sales of cooking units - Gas (%)	35.9	28.3	4.84	0.243	0	0	0
Sales of space heating units - Electric Heat Pump (%)	6.91	13.1	53.5	87.8	93.1	93.4	93.4
Sales of space heating units - Electric Resistance (%)	6.17	9.15	7.14	3.07	2.34	2.27	2.46
Sales of space heating units - Fossil (%)	32.4	41.6	13.8	4.85	4.07	4.05	3.91
Sales of space heating units - Gas (%)	54.5	36.2	25.6	4.29	0.5	0.264	0.249
Sales of water heating units - Electric Heat Pump (%)	0	1.22	12.2	31.8	35.2	35.4	35.4
Sales of water heating units - Electric Resistance (%)	30.5	48.9	54.7	62.9	64.4	64.5	64.5
Sales of water heating units - Gas Furnace (%)	60	44.2	31.9	5.09	0.3	0	0
Sales of water heating units - Other (%)	9.47	5.72	1.16	0.145	0.102	0.103	0.103

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	962	2,495	3,997	6,074	6,591	6,294
Public EV charging plugs - DC Fast (1000 units)	0.317	0	1.49	0	6.24	0	10
Public EV charging plugs - L2 (1000 units)	2.26	0	35.7	0	150	0	241
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 (%)	1.4	1.68	1.2	0.382	0.072	0.013	0
Vehicle sales - Light-duty - EV (%)	4.41	16.7	48.7	82.7	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.1	76.3	46.4	15.6	3.17	0.586	0
Vehicle sales - Light-duty - hybrid (%)	4.9	4.89	3.38	1.24	0.304	0.067	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.331	0.191	0.059	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.095	0.091	0.058	0.02	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)	253	241	230	215	199	188	181
Final energy use - Industry (PJ)	81.4	79.3	79.4	79.4	80.6	81.8	83.4
Final energy use - Residential (PJ)	286	269	250	218	185	159	144
Final energy use - Transportation (PJ)	500	466	414	349	289	250	231

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	13,317	14,546	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	49.9	81.2	87.4	87.7	87.7	87.7
Sales of cooking units - Gas (%)	63.1	50.1	18.8	12.6	12.3	12.3	12.3
Sales of space heating units - Electric Heat Pump (%)	4.31	10.7	38.6	72.2	77.8	78.1	78.1
Sales of space heating units - Electric Resistance (%)	2.07	4.58	16.4	21.3	21.9	21.9	21.9
Sales of space heating units - Fossil (%)	23.7	29.9	5.74	0.244	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 (%)	69.9	54.9	39.2	6.26	0.372	0	0
Sales of water heating units - Electric Heat Pump (%)	2.04	3.48	15.8	41.1	45.6	46	45.9
Sales of water heating units - Electric Resistance (%)	10.2	12.4	23.9	48	52.3	52.5	52.5
Sales of water heating units - Gas Furnace (%)	84.8	80.4	58.4	9.31	0.551	0	0
Sales of water heating units - Other (%)	2.99	3.76	1.89	1.58	1.56	1.56	1.58

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	2.59	2.67	6.63	7.17	6.63	7.04

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	1.13	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.005	0.001	0	0
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	0.006	0	0.001	0	0.015
Capital invested - Offshore Wind - Base (billion $2018)	0	1.95	8.25	14.1	18.8	9.71	0.655
Capital invested - Offshore Wind - Constrained (billion $2018)	0	0	8.66	15.6	15	0	4.55
Capital invested - Solar PV - Base (billion $2018)	0	0	1.33	1.91	4.38	5.83	0
Capital invested - Solar PV - Constrained (billion $2018)	0	0.202	0.495	3.92	2.72	7.22	0
Capital invested - Wind - Base (billion $2018)	0	0.105	1.71	0.488	0.32	0	0.218
Capital invested - Wind - Constrained (billion $2018)	0	0.105	1.92	0.167	0.279	0.17	0.21

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	0	2,220	2,220	2,220	2,220	2,220
Biomass w/ccu allam power plant (GWh)	0	0	0	5.42	6.26	6.26	6.26
Biomass w/ccu power plant (GWh)	0	0	6.99	6.99	7.72	7.72	24.1
OffshoreWind - Base land use assumptions (GWh)	282	2,772	12,880	26,328	39,406	27,308	2,448
OffshoreWind - Constrained land use assumptions (GWh)	282	2,772	12,880	26,328	39,406	27,308	2,448
Solar - Base land use assumptions (GWh)	744	0	1,962	3,077	7,380	10,303	0
Solar - Constrained land use assumptions (GWh)	0	0	3,587	5,146	7,192	13,396	0
Wind - Base land use assumptions (GWh)	502	153	2,604	775	538	0	405
Wind - Constrained land use assumptions (GWh)	502	153	2,904	423	307	298	498

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	0	73.3	74.6	75	75.5	151
Conversion capital investment - Cumulative 5-yr (million $2018)	0	0	1,267	43.3	12.5	12.6	2,040
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	2
Number of facilities - Diesel (quantity)	0	0	0	1	1	1	1
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Power (quantity)	0	0	2	2	2	2	2
Number of facilities - Power ccu (quantity)	0	0	1	1	1	1	2
Number of facilities - Pyrolysis (quantity)	0	0	0	1	1	1	2
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	1	1	1	2

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	1	1	1	1	1
Number of facilities - Sng ccu (quantity)	0	0	1	1	1	1	1

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	0.01	0.02	0.03	0.03	1.32
Annual - BECCS (MMT)	0	0	0.01	0.02	0.02	0.02	1.31
Annual - Cement and lime (MMT)	0	0	0	0	0	0	0
Annual - NGCC (MMT)	0	0	0	0.01	0.01	0	0.01
Cumulative - All (MMT)	0	0	0.01	0.03	0.06	0.09	1.41
Cumulative - BECCS (MMT)	0	0	0.01	0.03	0.05	0.07	1.38
Cumulative - Cement and lime (MMT)	0	0	0	0	0	0	0
Cumulative - NGCC (MMT)	0	0	0	0.01	0.02	0.02	0.03

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	171	314	314	314	549
Cumulative investment - All (million $2018)	0	0	264	339	339	339	494
Cumulative investment - Spur (million $2018)	0	0	19.1	94.2	94.2	94.2	249
Cumulative investment - Trunk (million $2018)	0	0	245	245	245	245	245
Spur (km)	0	0	36.2	179	179	179	414
Trunk (km)	0	0	135	135	135	135	135

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	-105
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-3.29
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-109
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	-55
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-1.64
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-56.7
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	63.5
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	5.98

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	69.5
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	33.2
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	2.99
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	36.2

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	1,417
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	191
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	669

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	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	142
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	184
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	146
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	382
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	689

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	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	1,095

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	561	0.602	0.601	0.571	0.347	0.018
Monetary damages from air pollution - Natural Gas (million 2019$)	0	288	155	107	108	66	35.6
Monetary damages from air pollution - Transportation (million 2019$)	0	2,027	1,872	1,408	804	356	128
Premature deaths from air pollution - Coal (deaths)	0	62.9	0.068	0.067	0.064	0.039	0.002
Premature deaths from air pollution - Natural Gas (deaths)	0	32.5	17.5	12.1	12.2	7.46	4.02
Premature deaths from air pollution - Transportation (deaths)	0	228	211	158	90.4	40	14.3

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

Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Agriculture (jobs)	97.4	112	304	293	247	198	283
By economic sector - Construction (jobs)	16,497	13,426	11,963	16,967	24,459	25,943	26,720
By economic sector - Manufacturing (jobs)	3,216	4,933	8,934	9,220	11,052	14,311	19,224
By economic sector - Mining (jobs)	2,156	1,719	1,228	795	484	273	151
By economic sector - Other (jobs)	2,658	2,212	1,664	2,324	3,509	4,214	5,723
By economic sector - Pipeline (jobs)	431	423	387	281	208	135	113
By economic sector - Professional (jobs)	5,487	5,017	5,504	8,234	12,721	14,433	16,236
By economic sector - Trade (jobs)	4,158	3,698	3,519	4,916	7,459	8,665	10,294
By economic sector - Utilities (jobs)	4,423	5,496	8,636	14,907	22,673	22,600	18,210
By education level - All sectors - Associates degree or some college (jobs)	12,355	11,757	13,447	18,695	26,901	29,456	31,307
By education level - All sectors - Bachelors degree (jobs)	7,454	7,188	8,334	11,372	16,322	18,044	19,500
By education level - All sectors - Doctoral degree (jobs)	294	266	281	395	588	660	738
By education level - All sectors - High school diploma or less (jobs)	17,209	16,095	18,089	24,679	34,909	38,093	40,553
By education level - All sectors - Masters or professional degree (jobs)	1,812	1,732	1,987	2,797	4,092	4,518	4,857
By resource sector - Biomass (jobs)	404	482	839	834	744	722	1,210
By resource sector - CO2 (jobs)	0	0	243	2.22	5.64	5.63	185
By resource sector - Grid (jobs)	5,076	7,278	14,160	28,053	42,603	43,034	34,301
By resource sector - Natural Gas (jobs)	4,220	4,338	3,538	2,624	3,481	2,501	1,473
By resource sector - Nuclear (jobs)	0	0	0.012	0.027	0.03	0.058	0.074
By resource sector - Oil (jobs)	4,599	3,930	3,107	2,204	1,475	957	589
By resource sector - Solar (jobs)	24,465	20,140	14,280	13,698	18,680	24,790	34,338
By resource sector - Wind (jobs)	361	870	5,971	10,522	15,823	18,760	24,859
Median wages - Annual - All ($2019 per job)	66,743	67,705	68,862	70,930	72,487	73,095	72,989

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)	6,496	6,120	6,920	9,628	13,822	15,048	15,833
On-Site or In-Plant Training - Total jobs - 4 to 10 years (jobs)	2,900	2,637	2,822	4,051	5,910	6,327	6,464
On-Site or In-Plant Training - Total jobs - None (jobs)	6,476	6,096	6,877	9,350	13,353	14,750	16,036
On-Site or In-Plant Training - Total jobs - Over 10 years (jobs)	336	319	366	521	756	819	849
On-Site or In-Plant Training - Total jobs - Up to 1 year (jobs)	22,915	21,864	25,155	34,388	48,971	53,826	57,773
On-the-Job Training - All sectors - 1 to 4 years (jobs)	8,373	7,880	8,903	12,435	17,900	19,465	20,415
On-the-Job Training - All sectors - 4 to 10 years (jobs)	2,906	2,627	2,788	4,037	5,911	6,320	6,438
On-the-Job Training - All sectors - None (jobs)	2,252	2,083	2,268	3,077	4,391	4,854	5,313
On-the-Job Training - All sectors - Over 10 years (jobs)	428	394	431	560	782	871	969
On-the-Job Training - All sectors - Up to 1 year (jobs)	25,165	24,053	27,749	37,829	53,828	59,261	63,819
Related work experience - All sectors - 1 to 4 years (jobs)	13,859	13,171	15,037	20,733	29,684	32,503	34,617
Related work experience - All sectors - 4 to 10 years (jobs)	9,020	8,555	9,755	13,502	19,403	21,222	22,501
Related work experience - All sectors - None (jobs)	5,674	5,371	6,087	8,415	12,040	13,142	13,964
Related work experience - All sectors - Over 10 years (jobs)	2,300	2,225	2,617	3,564	5,074	5,593	5,992
Related work experience - All sectors - Up to 1 year (jobs)	8,271	7,714	8,643	11,725	16,611	18,310	19,879
Wage income - All (million $2019)	2,612	2,508	2,902	4,110	6,004	6,636	7,078

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

Item	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption - Annual (tcf)	335	340	286	230	173	109	75.5
Natural gas consumption - Cumulative (tcf)	0	0	0	0	0	0	6,921
Natural gas production - Annual (tcf)	0	0	0	0	0	0	0
Oil consumption - Annual (million bbls)	94.3	88.4	76.2	58.5	42.2	29.3	19.2
Oil consumption - Cumulative (million bbls)	0	0	0	0	0	0	1,813
Oil production - Annual (million bbls)	0	0	0	0	0	0	0

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	5.63	6.47	0	0	0	0
Sales of cooking units - Electric Resistance (%)	64	64.9	68.2	76.9	89	96.4	99
Sales of cooking units - Gas (%)	36	35.1	31.8	23.1	11	3.56	0.957
Sales of space heating units - Electric Heat Pump (%)	6.91	7.36	12	26	51.8	76	88
Sales of space heating units - Electric Resistance (%)	6.17	9.22	8.85	8.12	6.41	4.13	2.94
Sales of space heating units - Fossil (%)	32.4	46.7	43.8	34.6	19.9	9.61	5.55
Sales of space heating units - Gas (%)	54.5	36.7	35.3	31.3	21.9	10.3	3.54
Sales of water heating units - Electric Heat Pump (%)	0	0.459	1.73	5.83	15.1	26.1	32.4
Sales of water heating units - Electric Resistance (%)	30.5	48.3	49	51.2	55.6	60.5	63.2
Sales of water heating units - Gas Furnace (%)	60	44.6	43.2	38.4	27	12.6	4.1
Sales of water heating units - Other (%)	9.47	6.6	6.08	4.62	2.32	0.811	0.288

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	161	327	1,113	3,470	5,067
Public EV charging plugs - DC Fast (1000 units)	0.317	0	0.499	0	2.34	0	6.43
Public EV charging plugs - L2 (1000 units)	2.26	0	12	0	56.3	0	154
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 (%)	1.41	1.85	2.03	1.61	1.02	0.519	0.223
Vehicle sales - Light-duty - EV (%)	2.06	5.07	12.6	27.1	49.7	72.9	87.9
Vehicle sales - Light-duty - gasoline (%)	91.2	86.7	78.4	65.1	44.7	23.9	10.6
Vehicle sales - Light-duty - hybrid (%)	5.1	5.88	6.54	5.88	4.34	2.52	1.21
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.376	0.317	0.239	0.168	0.092	0.043
Vehicle sales - Light-duty - other (%)	0.097	0.1	0.09	0.078	0.056	0.03	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)	253	241	235	230	223	216	207
Final energy use - Industry (PJ)	81.4	79.4	79.8	80.8	82.8	83.9	85.2
Final energy use - Residential (PJ)	286	270	259	248	231	207	181
Final energy use - Transportation (PJ)	501	471	433	400	373	341	304

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	13,315	14,553	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	40.7	44.7	56.5	72.7	82.9	86.4
Sales of cooking units - Gas (%)	63.1	59.3	55.3	43.5	27.3	17.1	13.6
Sales of space heating units - Electric Heat Pump (%)	4.31	7.58	10.8	20.7	40.6	61.6	72.9
Sales of space heating units - Electric Resistance (%)	2.07	2.47	3.76	7.71	14.2	19.1	21
Sales of space heating units - Fossil (%)	23.7	34.5	32.4	24.4	11.9	3.8	0.998
Sales of space heating units - Gas Furnace (%)	69.9	55.4	53.1	47.2	33.3	15.5	5.06
Sales of water heating units - Electric Heat Pump (%)	2.04	2.9	4.29	8.99	20.1	34	42
Sales of water heating units - Electric Resistance (%)	10.2	11.8	12.9	17.6	28.1	41.1	48.8
Sales of water heating units - Gas Furnace (%)	84.8	81.2	79	70.2	49.4	23.1	7.53
Sales of water heating units - Other (%)	2.99	4.09	3.78	3.24	2.41	1.82	1.65

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	1.91	1.91	3.04	3.17	5.62	6.03

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	-105
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-3.29
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-109
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	-55
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-1.64
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-56.7
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	63.5
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	5.98
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	69.5
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	33.2
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	2.99
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	36.2

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	1,417

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	191
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	669
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	142
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	184
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	146

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	382
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	689
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	1,095

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	561	0.602	0.601	0.571	0.347	0.018
Monetary damages from air pollution - Natural Gas (million 2019$)	0	283	123	47.3	19.9	5.96	9.81
Monetary damages from air pollution - Transportation (million 2019$)	0	2,064	2,069	1,991	1,771	1,392	941
Premature deaths from air pollution - Coal (deaths)	0	62.9	0.068	0.067	0.064	0.039	0.002
Premature deaths from air pollution - Natural Gas (deaths)	0	32	13.9	5.34	2.25	0.674	1.11
Premature deaths from air pollution - Transportation (deaths)	0	232	233	224	199	157	106

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	5.62	6.19	0	0	0	0
Sales of cooking units - Electric Resistance (%)	64.1	71.7	95.2	99.8	100	100	100
Sales of cooking units - Gas (%)	35.9	28.3	4.84	0.243	0	0	0
Sales of space heating units - Electric Heat Pump (%)	6.91	13.1	53.5	87.8	93.1	93.4	93.4

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 (%)	6.17	9.15	7.14	3.07	2.34	2.27	2.46
Sales of space heating units - Fossil (%)	32.4	41.6	13.8	4.85	4.07	4.05	3.91
Sales of space heating units - Gas (%)	54.5	36.2	25.6	4.29	0.5	0.264	0.249
Sales of water heating units - Electric Heat Pump (%)	0	1.22	12.2	31.8	35.2	35.4	35.4
Sales of water heating units - Electric Resistance (%)	30.5	48.9	54.7	62.9	64.4	64.5	64.5
Sales of water heating units - Gas Furnace (%)	60	44.2	31.9	5.09	0.3	0	0
Sales of water heating units - Other (%)	9.47	5.72	1.16	0.145	0.102	0.103	0.103

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	962	2,495	3,997	6,074	6,591	6,294
Public EV charging plugs - DC Fast (1000 units)	0.317	0	1.49	0	6.24	0	10
Public EV charging plugs - L2 (1000 units)	2.26	0	35.7	0	150	0	241
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 (%)	1.4	1.68	1.2	0.382	0.072	0.013	0
Vehicle sales - Light-duty - EV (%)	4.41	16.7	48.7	82.7	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.1	76.3	46.4	15.6	3.17	0.586	0
Vehicle sales - Light-duty - hybrid (%)	4.9	4.89	3.38	1.24	0.304	0.067	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.331	0.191	0.059	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.095	0.091	0.058	0.02	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)	253	241	230	215	199	188	181
Final energy use - Industry (PJ)	81.4	79.3	79.4	79.4	80.6	81.8	83.4
Final energy use - Residential (PJ)	286	269	250	218	185	159	144
Final energy use - Transportation (PJ)	500	466	414	349	289	250	231

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	13,317	14,546	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	49.9	81.2	87.4	87.7	87.7	87.7
Sales of cooking units - Gas (%)	63.1	50.1	18.8	12.6	12.3	12.3	12.3
Sales of space heating units - Electric Heat Pump (%)	4.31	10.7	38.6	72.2	77.8	78.1	78.1
Sales of space heating units - Electric Resistance (%)	2.07	4.58	16.4	21.3	21.9	21.9	21.9
Sales of space heating units - Fossil (%)	23.7	29.9	5.74	0.244	0	0	0
Sales of space heating units - Gas Furnace (%)	69.9	54.9	39.2	6.26	0.372	0	0
Sales of water heating units - Electric Heat Pump (%)	2.04	3.48	15.8	41.1	45.6	46	45.9
Sales of water heating units - Electric Resistance (%)	10.2	12.4	23.9	48	52.3	52.5	52.5
Sales of water heating units - Gas Furnace (%)	84.8	80.4	58.4	9.31	0.551	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 (%)	2.99	3.76	1.89	1.58	1.56	1.56	1.58

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	2.59	2.67	6.63	7.17	6.63	7.04

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	1.72	8.25	26	18.5	2.74	0
Capital invested - Solar PV - Base (billion $2018)	0	0	2.48	4.94	8.24	2.04	0
Capital invested - Wind - Base (billion $2018)	0	0.105	1.71	0.488	0.32	0	0.218

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

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use assumptions (GWh)	282	2,446	12,876	48,252	39,559	8,011	0
OffshoreWind - Constrained land use assumptions (GWh)	0	0	13,165	51,357	9,619	0	15,928
Solar - Base land use assumptions (GWh)	744	0	3,665	7,767	13,819	3,589	0
Solar - Constrained land use assumptions (GWh)	744	0	3,484	4,682	7,810	3,047	0
Wind - Base land use assumptions (GWh)	502	153	2,604	775	538	0	405
Wind - Constrained land use assumptions (GWh)	502	153	2,904	423	307	298	890

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	-105
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-3.29
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-109
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	-55
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-1.64
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-56.7
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	63.5
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	5.98
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	69.5
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	33.2

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	2.99
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	36.2

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	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	1,417
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	191
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	669
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	142

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	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	184
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	146
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	382
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	689
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0

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	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	1,095

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	561	0.602	0.601	0.571	0.347	0.018
Monetary damages from air pollution - Natural Gas (million 2019$)	0	273	137	76.8	69.4	24	12.3
Monetary damages from air pollution - Transportation (million 2019$)	0	2,027	1,872	1,408	804	356	128
Premature deaths from air pollution - Coal (deaths)	0	62.9	0.068	0.067	0.064	0.039	0.002
Premature deaths from air pollution - Natural Gas (deaths)	0	30.8	15.5	8.67	7.84	2.71	1.39
Premature deaths from air pollution - Transportation (deaths)	0	228	211	158	90.4	40	14.3

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	5.62	6.19	0	0	0	0
Sales of cooking units - Electric Resistance (%)	64.1	71.7	95.2	99.8	100	100	100
Sales of cooking units - Gas (%)	35.9	28.3	4.84	0.243	0	0	0
Sales of space heating units - Electric Heat Pump (%)	6.91	13.1	53.5	87.8	93.1	93.4	93.4
Sales of space heating units - Electric Resistance (%)	6.17	9.15	7.14	3.07	2.34	2.27	2.46
Sales of space heating units - Fossil (%)	32.4	41.6	13.8	4.85	4.07	4.05	3.91
Sales of space heating units - Gas (%)	54.5	36.2	25.6	4.29	0.5	0.264	0.249
Sales of water heating units - Electric Heat Pump (%)	0	1.22	12.2	31.8	35.2	35.4	35.4
Sales of water heating units - Electric Resistance (%)	30.5	48.9	54.7	62.9	64.4	64.5	64.5
Sales of water heating units - Gas Furnace (%)	60	44.2	31.9	5.09	0.3	0	0
Sales of water heating units - Other (%)	9.47	5.72	1.16	0.145	0.102	0.103	0.103

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	962	2,495	3,997	6,074	6,591	6,294
Public EV charging plugs - DC Fast (1000 units)	0.317	0	1.49	0	6.24	0	10
Public EV charging plugs - L2 (1000 units)	2.26	0	35.7	0	150	0	241
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 (%)	1.4	1.68	1.2	0.382	0.072	0.013	0
Vehicle sales - Light-duty - EV (%)	4.41	16.7	48.7	82.7	96.4	99.3	100
Vehicle sales - Light-duty - gasoline (%)	89.1	76.3	46.4	15.6	3.17	0.586	0
Vehicle sales - Light-duty - hybrid (%)	4.9	4.89	3.38	1.24	0.304	0.067	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.331	0.191	0.059	0.012	0.002	0
Vehicle sales - Light-duty - other (%)	0.095	0.091	0.058	0.02	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)	253	241	230	215	199	188	181
Final energy use - Industry (PJ)	81.4	79.3	79.4	79.4	80.6	81.8	83.4
Final energy use - Residential (PJ)	286	269	250	218	185	159	144
Final energy use - Transportation (PJ)	500	466	414	349	289	250	231

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	13,317	14,546	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	49.9	81.2	87.4	87.7	87.7	87.7
Sales of cooking units - Gas (%)	63.1	50.1	18.8	12.6	12.3	12.3	12.3
Sales of space heating units - Electric Heat Pump (%)	4.31	10.7	38.6	72.2	77.8	78.1	78.1
Sales of space heating units - Electric Resistance (%)	2.07	4.58	16.4	21.3	21.9	21.9	21.9
Sales of space heating units - Fossil (%)	23.7	29.9	5.74	0.244	0	0	0
Sales of space heating units - Gas Furnace (%)	69.9	54.9	39.2	6.26	0.372	0	0
Sales of water heating units - Electric Heat Pump (%)	2.04	3.48	15.8	41.1	45.6	46	45.9
Sales of water heating units - Electric Resistance (%)	10.2	12.4	23.9	48	52.3	52.5	52.5
Sales of water heating units - Gas Furnace (%)	84.8	80.4	58.4	9.31	0.551	0	0
Sales of water heating units - Other (%)	2.99	3.76	1.89	1.58	1.56	1.56	1.58

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	2.59	2.67	6.63	7.17	6.63	7.04

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	6.33	5.44	6.44	2.81	1.2	1.44
Capital invested - Offshore Wind - Constrained (billion $2018)	0	3.86	6.35	7.03	2.97	1.19	1.97
Capital invested - Solar PV - Base (billion $2018)	0	0.489	1.5	0.551	0.859	0.368	1.16
Capital invested - Solar PV - Constrained (billion $2018)	0	0	0	0	0	1.24	1.34
Capital invested - Wind - Base (billion $2018)	0	0.105	0.866	0	0	0	0.67
Capital invested - Wind - Constrained (billion $2018)	0	0.105	0.871	0	0	0.229	0.615

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

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use assumptions (GWh)	282	9,053	8,495	11,802	6,088	3,355	4,787
OffshoreWind - Constrained land use assumptions (GWh)	0	5,479	9,974	12,718	6,101	3,213	6,664
Solar - Base land use assumptions (GWh)	744	646	2,193	878	1,444	659	2,197
Solar - Constrained land use assumptions (GWh)	2,577	0	0	0	0	2,187	2,508

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)	502	153	1,336	0	0	0	1,268
Wind - Constrained land use assumptions (GWh)	502	153	1,345	0	0	407	1,152

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	-105
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-3.29
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-109
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	-55
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-1.64
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-56.7
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	63.5
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	5.98
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	69.5
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	33.2
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	2.99
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	36.2

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	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0

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	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	1,417
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	191
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	669
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	142
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	184

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	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	146
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	382
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	689
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	1,095

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	561	0.602	0.601	0.571	0.347	0.018
Monetary damages from air pollution - Natural Gas (million 2019$)	0	286	161	172	129	66.4	15.4
Monetary damages from air pollution - Transportation (million 2019$)	0	2,027	1,872	1,408	804	356	128
Premature deaths from air pollution - Coal (deaths)	0	62.9	0.068	0.067	0.064	0.039	0.002
Premature deaths from air pollution - Natural Gas (deaths)	0	32.3	18.1	19.4	14.5	7.5	1.74
Premature deaths from air pollution - Transportation (deaths)	0	228	211	158	90.4	40	14.3

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	5.63	6.47	0	0	0	0
Sales of cooking units - Electric Resistance (%)	64	64.9	68.2	76.9	89	96.4	99
Sales of cooking units - Gas (%)	36	35.1	31.8	23.1	11	3.56	0.957
Sales of space heating units - Electric Heat Pump (%)	6.91	7.36	12	26	51.8	76	88
Sales of space heating units - Electric Resistance (%)	6.17	9.22	8.85	8.12	6.41	4.13	2.94
Sales of space heating units - Fossil (%)	32.4	46.7	43.8	34.6	19.9	9.61	5.55
Sales of space heating units - Gas (%)	54.5	36.7	35.3	31.3	21.9	10.3	3.54
Sales of water heating units - Electric Heat Pump (%)	0	0.459	1.73	5.83	15.1	26.1	32.4
Sales of water heating units - Electric Resistance (%)	30.5	48.3	49	51.2	55.6	60.5	63.2
Sales of water heating units - Gas Furnace (%)	60	44.6	43.2	38.4	27	12.6	4.1
Sales of water heating units - Other (%)	9.47	6.6	6.08	4.62	2.32	0.811	0.288

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	161	327	1,113	3,470	5,067
Public EV charging plugs - DC Fast (1000 units)	0.317	0	0.499	0	2.34	0	6.43
Public EV charging plugs - L2 (1000 units)	2.26	0	12	0	56.3	0	154
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 (%)	1.41	1.85	2.03	1.61	1.02	0.519	0.223
Vehicle sales - Light-duty - EV (%)	2.06	5.07	12.6	27.1	49.7	72.9	87.9
Vehicle sales - Light-duty - gasoline (%)	91.2	86.7	78.4	65.1	44.7	23.9	10.6
Vehicle sales - Light-duty - hybrid (%)	5.1	5.88	6.54	5.88	4.34	2.52	1.21
Vehicle sales - Light-duty - hydrogen FC (%)	0.112	0.376	0.317	0.239	0.168	0.092	0.043
Vehicle sales - Light-duty - other (%)	0.097	0.1	0.09	0.078	0.056	0.03	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)	253	241	235	230	223	216	207
Final energy use - Industry (PJ)	81.4	79.4	79.8	80.8	82.8	83.9	85.2
Final energy use - Residential (PJ)	286	270	259	248	231	207	181
Final energy use - Transportation (PJ)	501	471	433	400	373	341	304

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	13,315	14,553	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	40.7	44.7	56.5	72.7	82.9	86.4
Sales of cooking units - Gas (%)	63.1	59.3	55.3	43.5	27.3	17.1	13.6
Sales of space heating units - Electric Heat Pump (%)	4.31	7.58	10.8	20.7	40.6	61.6	72.9
Sales of space heating units - Electric Resistance (%)	2.07	2.47	3.76	7.71	14.2	19.1	21
Sales of space heating units - Fossil (%)	23.7	34.5	32.4	24.4	11.9	3.8	0.998

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 (%)	69.9	55.4	53.1	47.2	33.3	15.5	5.06
Sales of water heating units - Electric Heat Pump (%)	2.04	2.9	4.29	8.99	20.1	34	42
Sales of water heating units - Electric Resistance (%)	10.2	11.8	12.9	17.6	28.1	41.1	48.8
Sales of water heating units - Gas Furnace (%)	84.8	81.2	79	70.2	49.4	23.1	7.53
Sales of water heating units - Other (%)	2.99	4.09	3.78	3.24	2.41	1.82	1.65

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	1.91	1.91	3.04	3.17	5.62	6.03

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	0.403	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.006	0	0	0
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	0.006	0	0	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	0	792	792	792	792	792
Biomass w/ccu allam power plant (GWh)	0	0	0	5.53	5.81	6.24	6.24
Biomass w/ccu power plant (GWh)	0	0	7.09	7.09	7.22	7.57	7.57

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	48.1	52	54.9	56.1	376
Conversion capital investment - Cumulative 5-yr (million $2018)	0	0	456	66.9	44.2	19.3	4,630
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	2
Number of facilities - Diesel (quantity)	0	0	0	1	1	1	1
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Power (quantity)	0	0	1	1	1	1	1
Number of facilities - Power ccu (quantity)	0	0	1	1	1	1	1
Number of facilities - Pyrolysis (quantity)	0	0	0	1	1	1	3
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Sng (quantity)	0	0	1	1	1	1	1
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	0.02	0.03	0.03	2.76
Annual - BECCS (MMT)	0	0	0.01	0.02	0.02	0.02	2.75
Annual - Cement and lime (MMT)	0	0	0	0	0	0	0
Annual - NGCC (MMT)	0	0	0	0	0	0	0.01
Cumulative - All (MMT)	0	0	0.01	0.03	0.06	0.09	2.85
Cumulative - BECCS (MMT)	0	0	0.01	0.03	0.05	0.07	2.82
Cumulative - Cement and lime (MMT)	0	0	0	0	0	0	0
Cumulative - NGCC (MMT)	0	0	0	0	0	0	0.01

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	171	314	314	314	393
Cumulative investment - All (million $2018)	0	0	264	339	339	339	407
Cumulative investment - Spur (million $2018)	0	0	19.1	94.2	94.2	94.2	162
Cumulative investment - Trunk (million $2018)	0	0	245	245	245	245	245
Spur (km)	0	0	36.2	179	179	179	257
Trunk (km)	0	0	135	135	135	135	135

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	-105
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	-3.29
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-109
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	-55
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	-1.64
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-56.7
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	157
Land impacted for carbon sink - Aggressive deployment - Cropland to woody energy crops (1000 hectares)	0	0	0
Land impacted for carbon sink - Aggressive deployment - Pasture to energy crops (1000 hectares)	0	0	1.5
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	5.98
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	164
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	33.2
Land impacted for carbon sink - Moderate deployment - Cropland to woody energy crops (1000 hectares)	0	0	0
Land impacted for carbon sink - Moderate deployment - Pasture to energy crops (1000 hectares)	0	0	1.5
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	2.99
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	37.7

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	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	1,417
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	191
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	669

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	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	142
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	184
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	146
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	382
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	689

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	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	1,095

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	5.48	5.7	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.6	63.6	63.6	63.6	63.6	63.6	63.6
Sales of cooking units - Gas (%)	36.4	36.4	36.4	36.4	36.4	36.4	36.4
Sales of space heating units - Electric Heat Pump (%)	6.66	9.84	10.2	10.6	10.9	11.2	11.6
Sales of space heating units - Electric Resistance (%)	6.21	8.92	8.73	8.57	8.52	8.08	7.76
Sales of space heating units - Fossil (%)	32.5	40.9	22.6	9.73	8.85	8.82	8.8
Sales of space heating units - Gas (%)	54.6	40.4	58.5	71.1	71.7	71.9	71.8
Sales of water heating units - Electric Heat Pump (%)	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance (%)	30.5	48.1	48.1	48.2	48.2	48.2	48.2
Sales of water heating units - Gas Furnace (%)	60	45.1	45.1	45	45	45	45
Sales of water heating units - Other (%)	9.47	6.78	6.78	6.83	6.83	6.84	6.85

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 (%)	1.4	1.84	2.16	2.01	1.81	1.68	1.6
Vehicle sales - Light-duty - EV (%)	4.05	6.23	7.05	8.7	10.6	12.1	13.3
Vehicle sales - Light-duty - gasoline (%)	89.4	85.7	83.4	81.3	79.2	77.3	75.8
Vehicle sales - Light-duty - hybrid (%)	4.92	5.75	7	7.55	8.08	8.59	8.94
Vehicle sales - Light-duty - hydrogen FC (%)	0.11	0.372	0.337	0.298	0.293	0.293	0.303
Vehicle sales - Light-duty - other (%)	0.095	0.099	0.095	0.096	0.095	0.094	0.096
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)	253	246	249	250	251	258	269
Final energy use - Industry (PJ)	81.4	81.9	84.8	88.8	94.4	99.2	104
Final energy use - Residential (PJ)	286	272	264	261	258	256	255

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Transportation (PJ)	501	474	444	426	429	442	458

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	13,153	13,534	0	0	0	0
Sales of cooking units - Electric Resistance (%)	36.9	39	38.6	38.5	38.3	38.5	38.4
Sales of cooking units - Gas (%)	63.1	61	61.4	61.5	61.7	61.5	61.6
Sales of space heating units - Electric Heat Pump (%)	4.31	12.9	41	64	67.7	68.1	68.2
Sales of space heating units - Electric Resistance (%)	2.07	2.89	7.66	20	30.1	31.7	31.8
Sales of space heating units - Fossil (%)	23.7	33.3	23.6	9.31	1.33	0.106	0
Sales of space heating units - Gas Furnace (%)	69.9	50.9	27.8	6.73	0.854	0.047	0
Sales of water heating units - Electric Heat Pump (%)	2.04	2.38	2.35	2.36	2.34	2.36	2.35
Sales of water heating units - Electric Resistance (%)	10.2	11.3	11.1	11.3	11.2	11.1	11.1
Sales of water heating units - Gas Furnace (%)	84.8	82.1	82.5	82.3	82.3	82.6	82.5
Sales of water heating units - Other (%)	2.99	4.16	4.05	4.05	4.14	3.96	4.03

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	1.9	1.89	4.44	4.74	4.91	5.2

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

Item	2020	2025	2030	2050
Business-as-usual carbon sink - Natural uptake (Mt CO2e/y)	-4.85	0	-2.63	-2.35
Business-as-usual carbon sink - Retained in Hardwood Products (Mt CO2e/y)	-0.141	0	-0.253	-0.263
Business-as-usual carbon sink - Total (Mt CO2e/y)	-4.99	0	-2.89	-2.62
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	0	36.4
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	0	4,728
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	0	1,146
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	0	1,955
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	0	518
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	0	210
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	0	307
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	0	555
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	0	18.3
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	0	1,417
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	0	191

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	751
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	0	173
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	0	73.7
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	0	23.3
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	0	187
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	0	27.4
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	0	3,072
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	0	669
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	0	1,353
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	0	345
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	0	142
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0	0
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	0	165
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	0	371
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	0	5.96
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	155
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	0	997
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0	0
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	20
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	0	8.73
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	0	184
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	0	1,371
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	0	2.98
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	146
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	0	382

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	0
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	10.5
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	0	1.51
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	0	111
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	0	654
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	0	4.47
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	150
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	0	689
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0	0
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	15.3
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0	0
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	0	10.9
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	0	224
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	0	1,095

Table 64: *REF scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	1,570	986	915	891	873	772
Monetary damages from air pollution - Natural Gas (million 2019$)	0	223	162	211	251	229	208
Monetary damages from air pollution - Transportation (million 2019$)	0	2,059	2,091	2,116	2,147	2,176	2,204
Premature deaths from air pollution - Coal (deaths)	0	176	111	103	100	98	86.7
Premature deaths from air pollution - Natural Gas (deaths)	0	25.2	18.3	23.8	28.4	25.8	23.5
Premature deaths from air pollution - Transportation (deaths)	0	232	235	238	242	245	248