Net-Zero America - texas 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	22.2	28.7	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.8	71.5	95.1	99.8	100	100	100
Sales of cooking units - Gas (%)	36.2	28.5	4.87	0.245	0	0	0
Sales of space heating units - Electric Heat Pump (%)	14.3	29.1	74.6	84.7	85.2	85	85
Sales of space heating units - Electric Resistance (%)	43.4	42.6	17.9	12.3	12.1	12.4	12.4
Sales of space heating units - Fossil (%)	3.05	4.67	2.39	1.88	1.84	1.81	1.8
Sales of space heating units - Gas (%)	39.3	23.7	5.17	1.03	0.847	0.825	0.821
Sales of water heating units - Electric Heat Pump (%)	0	11.9	63.1	74.6	75.1	75.1	75.1
Sales of water heating units - Electric Resistance (%)	53.8	58.4	30.1	23.6	23.3	23.4	23.4
Sales of water heating units - Gas Furnace (%)	44.2	28	5.25	0.218	0	0	0
Sales of water heating units - Other (%)	2.01	1.61	1.59	1.56	1.56	1.57	1.57

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	4,242	10,921	17,620	26,721	29,049	27,715
Public EV charging plugs - DC Fast (1000 units)	0.675	0	7.03	0	30.3	0	48.9
Public EV charging plugs - L2 (1000 units)	3.14	0	169	0	728	0	1,176
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 (%)	1.67	1.92	1.31	0.419	0.077	0.013	0
Vehicle sales - Light-duty - EV (%)	3.51	13.9	44.6	81	96.2	99.3	100
Vehicle sales - Light-duty - gasoline (%)	90.6	79.4	50.8	17.3	3.39	0.593	0
Vehicle sales - Light-duty - hybrid (%)	4.03	4.25	3.08	1.16	0.279	0.06	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.111	0.347	0.213	0.067	0.013	0.002	0
Vehicle sales - Light-duty - other (%)	0.107	0.103	0.069	0.024	0.005	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)	700	703	680	646	618	611	621
Final energy use - Industry (PJ)	3,891	4,374	4,672	4,814	4,969	5,063	5,241
Final energy use - Residential (PJ)	833	805	759	696	642	616	611
Final energy use - Transportation (PJ)	2,702	2,603	2,334	2,008	1,714	1,533	1,453

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	92,591	107,907	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	44.4	79.2	86.1	86.5	86.4	86.5
Sales of cooking units - Gas (%)	69.9	55.6	20.8	13.9	13.5	13.6	13.5
Sales of space heating units - Electric Heat Pump (%)	6.39	26.3	76.9	91.1	92.2	92.2	92.2
Sales of space heating units - Electric Resistance (%)	5.23	4.51	4.79	6.09	6.39	6.41	6.42
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0

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

Item	2020	2025	2030	2035	2040	2045	2050
Sales of space heating units - Gas Furnace (%)	88.4	69.2	18.3	2.84	1.39	1.35	1.34
Sales of water heating units - Electric Heat Pump (%)	0.154	10.7	56.3	66.5	66.9	66.9	66.9
Sales of water heating units - Electric Resistance (%)	4.33	8.13	26.9	31.1	31.3	31.3	31.3
Sales of water heating units - Gas Furnace (%)	93.4	79.3	15	0.631	0	0	0
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	22.7	23.6	38.5	41	31.3	32.4

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	0.002	0.136	0	0.009	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.027	0.002	0.015	0.031
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	6.41	0	0	0.016	0.258
Capital invested - Offshore Wind - Base (billion $2018)	0	0.216	0.126	0.189	0	0.05	10.9
Capital invested - Solar PV - Base (billion $2018)	0	22.9	24.1	28.4	28.6	26.9	31.8
Capital invested - Solar PV - Constrained (billion $2018)	0	51.1	28.6	29.6	27.3	30.1	37.5
Capital invested - Wind - Base (billion $2018)	0	16.8	30.2	28.5	42.1	28.2	20.3
Capital invested - Wind - Constrained (billion $2018)	0	29	40.5	35.5	44	29.7	19.1

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	4.22	271	271	290	290	290
Biomass w/ccu allam power plant (GWh)	0	0	0	26.8	28.5	43.7	74.8
Biomass w/ccu power plant (GWh)	0	0	7,189	7,189	7,189	7,207	7,496
OffshoreWind - Base land use assumptions (GWh)	0	301	207	363	0	132	32,639
OffshoreWind - Constrained land use assumptions (GWh)	0	301	207	363	0	132	32,639
Solar - Base land use assumptions (GWh)	18,855	41,613	48,496	59,936	62,162	61,057	77,377
Solar - Constrained land use assumptions (GWh)	18,650	65,657	51,738	55,542	47,618	70,295	84,236
Wind - Base land use assumptions (GWh)	149,083	43,206	82,409	81,669	125,911	88,015	64,463
Wind - Constrained land use assumptions (GWh)	149,083	46,850	100,219	87,220	121,296	85,587	58,258

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	0.873	298	662	997	1,394	1,420
Conversion capital investment - Cumulative 5-yr (million $2018)	0	2.44	6,027	6,686	6,128	7,284	551
Number of facilities - Allam power w ccu (quantity)	0	0	0	1	3	5	5
Number of facilities - Beccs hydrogen (quantity)	0	0	0	6	13	25	25
Number of facilities - Diesel (quantity)	0	0	0	1	1	1	1
Number of facilities - Diesel ccu (quantity)	0	0	0	1	3	5	5
Number of facilities - Power (quantity)	0	1	1	1	1	1	1
Number of facilities - Power ccu (quantity)	0	0	5	6	6	7	8
Number of facilities - Pyrolysis (quantity)	0	0	0	1	1	1	1
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	1	3	5	5
Number of facilities - Sng (quantity)	0	1	1	1	1	1	1
Number of facilities - Sng ccu (quantity)	0	0	1	1	1	2	2

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)	0	0	10.6	27.5	42.6	56.2	64.6
Annual - BECCS (MMT)	0	0	7.12	15.6	23.2	32.6	33.2
Annual - Cement and lime (MMT)	0	0	3.24	3.35	6.64	6.84	14.1
Annual - NGCC (MMT)	0	0	0.22	8.53	12.8	16.8	17.3
Cumulative - All (MMT)	0	0	10.6	38.1	80.7	137	202
Cumulative - BECCS (MMT)	0	0	7.12	22.8	46	78.6	112
Cumulative - Cement and lime (MMT)	0	0	3.24	6.59	13.2	20.1	34.2
Cumulative - NGCC (MMT)	0	0	0.22	8.75	21.5	38.3	55.6

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

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	28.5	93.4	169	270	363
Injection wells (wells)	0	0	24	97	174	290	362
Resource characterization, appraisal, permitting costs (million $2020)	0	157	2,677	4,202	4,202	4,202	4,202
Wells and facilities construction costs (million $2020)	0	0	751	2,927	5,217	8,723	10,830

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

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	708	2,025	3,726	5,225	7,057	7,808
Cumulative investment - All (million $2018)	0	3,706	9,870	10,931	12,050	13,213	13,770
Cumulative investment - Spur (million $2018)	0	0	430	1,491	2,610	3,772	4,329
Cumulative investment - Trunk (million $2018)	0	3,706	9,440	9,440	9,440	9,440	9,440
Spur (km)	0	0	496	2,197	3,696	5,528	6,279
Trunk (km)	0	708	1,529	1,529	1,529	1,529	1,529

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

Item	2020	2025	2050
Carbon sink potential - Aggressive deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-322
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-13,586
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-615
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-14,523
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-322
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-7,102
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-307
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-7,732
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	10,684
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	999
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	11,891
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208

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

Item	2020	2025	2050
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	5,592
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	499
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	6,299

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	1,334
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	19,303
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	8,752

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

Item	2020	2025	2050
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	2,756
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	1,461
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	483
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	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	195
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	727
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	296

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

Item	2020	2025	2050
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	1,914
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	19,461

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	988	0.887	0.842	0.639	0.413	0.005
Monetary damages from air pollution - Natural Gas (million 2019$)	0	694	395	227	217	100	67.3
Monetary damages from air pollution - Transportation (million 2019$)	0	4,679	4,521	3,556	2,127	1,004	411
Premature deaths from air pollution - Coal (deaths)	0	111	0.1	0.095	0.072	0.046	0.001
Premature deaths from air pollution - Natural Gas (deaths)	0	78.4	44.6	25.6	24.5	11.3	7.6
Premature deaths from air pollution - Transportation (deaths)	0	526	508	400	239	113	46.3

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

Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Agriculture (jobs)	786	805	1,170	2,053	2,137	2,072	1,701
By economic sector - Construction (jobs)	80,469	107,942	117,928	130,598	138,595	135,804	145,957
By economic sector - Manufacturing (jobs)	110,205	163,272	180,479	212,582	194,247	156,863	174,857
By economic sector - Mining (jobs)	207,601	181,192	144,017	111,632	73,299	47,779	26,498
By economic sector - Other (jobs)	4,012	7,622	9,713	12,617	15,740	17,519	22,655
By economic sector - Pipeline (jobs)	11,156	12,107	11,629	10,239	8,242	6,545	4,759
By economic sector - Professional (jobs)	64,584	75,788	78,333	84,285	86,860	85,368	89,186
By economic sector - Trade (jobs)	81,349	83,703	79,607	77,534	70,472	64,162	62,495
By economic sector - Utilities (jobs)	56,835	72,051	75,760	87,133	100,671	101,761	114,477
By education level - All sectors - Associates degree or some college (jobs)	174,884	204,885	205,870	218,044	210,831	190,858	202,337
By education level - All sectors - Bachelors degree (jobs)	155,529	169,699	163,481	165,004	151,219	132,957	133,928
By education level - All sectors - Doctoral degree (jobs)	5,296	5,661	5,417	5,379	5,017	4,571	4,534
By education level - All sectors - High school diploma or less (jobs)	244,339	284,454	285,799	302,112	287,887	257,915	269,991
By education level - All sectors - Masters or professional degree (jobs)	36,951	39,783	38,069	38,136	35,310	31,571	31,794
By resource sector - Biomass (jobs)	2,107	2,156	2,906	5,447	6,199	7,587	7,372
By resource sector - CO2 (jobs)	0	3,800	7,363	3,775	4,355	6,081	7,013
By resource sector - Coal (jobs)	9,406	3,731	443	64.5	54.3	47.5	41.4
By resource sector - Grid (jobs)	58,786	82,876	100,180	136,224	165,283	173,846	206,972
By resource sector - Natural Gas (jobs)	171,362	164,883	131,138	100,627	78,324	52,576	31,906
By resource sector - Nuclear (jobs)	2,636	2,594	2,000	700	0.008	0.018	0.032
By resource sector - Oil (jobs)	318,034	307,881	278,453	250,309	183,956	139,185	88,861
By resource sector - Solar (jobs)	24,907	66,025	81,149	110,182	122,306	119,492	162,552
By resource sector - Wind (jobs)	29,759	70,537	95,001	121,345	129,787	119,058	137,867
Median wages - Annual - All ($2019 per job)	64,389	63,652	63,502	63,087	62,901	63,276	62,820
On-Site or In-Plant Training - Total jobs - 1 to 4 years (jobs)	95,054	109,769	109,481	114,761	109,942	99,109	103,725
On-Site or In-Plant Training - Total jobs - 4 to 10 years (jobs)	36,021	41,363	41,216	42,797	41,938	38,793	40,284
On-Site or In-Plant Training - Total jobs - None (jobs)	100,145	114,378	113,240	118,086	111,827	100,043	104,590

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

Item	2020	2025	2030	2035	2040	2045	2050
On-Site or In-Plant Training - Total jobs - Over 10 years (jobs)	4,179	5,054	5,180	5,575	5,524	5,090	5,419
On-Site or In-Plant Training - Total jobs - Up to 1 year (jobs)	381,598	433,917	429,518	447,455	421,034	374,838	388,566
On-the-Job Training - All sectors - 1 to 4 years (jobs)	120,668	139,437	139,013	145,665	140,053	126,600	132,758
On-the-Job Training - All sectors - 4 to 10 years (jobs)	32,022	37,383	37,627	39,515	39,476	36,995	38,968
On-the-Job Training - All sectors - None (jobs)	35,908	39,972	39,016	40,005	37,395	33,349	34,469
On-the-Job Training - All sectors - Over 10 years (jobs)	5,986	7,063	7,083	7,466	7,016	6,170	6,493
On-the-Job Training - All sectors - Up to 1 year (jobs)	422,413	480,628	475,896	496,024	466,324	414,758	429,896
Related work experience - All sectors - 1 to 4 years (jobs)	231,172	261,265	257,699	266,945	251,418	224,522	231,544
Related work experience - All sectors - 4 to 10 years (jobs)	145,257	165,133	163,134	169,255	160,387	143,725	148,979
Related work experience - All sectors - None (jobs)	84,471	97,291	97,030	101,785	97,282	87,653	91,620
Related work experience - All sectors - Over 10 years (jobs)	41,462	47,094	46,377	48,088	44,945	39,659	41,088
Related work experience - All sectors - Up to 1 year (jobs)	114,636	133,699	134,395	142,601	136,233	122,313	129,351
Wage income - All (million $2019)	39,729	44,843	44,367	45,972	43,422	39,100	40,371

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

Item	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption - Annual (tcf)	3,381	3,431	2,892	2,320	1,746	1,099	762
Natural gas consumption - Cumulative (tcf)	0	0	0	0	0	0	69,865
Natural gas production - Annual (tcf)	7,529	8,345	7,888	6,870	5,809	4,607	3,578
Oil consumption - Annual (million bbls)	969	953	866	729	597	492	401
Oil consumption - Cumulative (million bbls)	0	0	0	0	0	0	22,296
Oil production - Annual (million bbls)	2,664	2,881	2,891	2,887	2,287	1,859	1,237

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	21.9	27.1	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.7	64.6	68	76.7	88.9	96.4	99
Sales of cooking units - Gas (%)	36.3	35.4	32	23.3	11.1	3.58	0.964
Sales of space heating units - Electric Heat Pump (%)	14.3	20.3	25.5	40.5	63.3	78.1	83.3
Sales of space heating units - Electric Resistance (%)	43.4	47.3	44.3	36.1	23.8	16	13.2
Sales of space heating units - Fossil (%)	3.05	5.12	4.92	4.14	2.95	2.18	1.92
Sales of space heating units - Gas (%)	39.3	27.2	25.2	19.3	9.88	3.69	1.58
Sales of water heating units - Electric Heat Pump (%)	0	2.05	7.87	24.6	50.4	67.2	73
Sales of water heating units - Electric Resistance (%)	53.8	63.9	60.9	51.6	37.2	27.8	24.5
Sales of water heating units - Gas Furnace (%)	44.2	32.4	29.6	22.2	10.9	3.45	0.893
Sales of water heating units - Other (%)	2.01	1.61	1.6	1.59	1.6	1.58	1.57

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	695	1,441	4,884	15,313	22,329
Public EV charging plugs - DC Fast (1000 units)	0.675	0	2.24	0	11.3	0	31.3
Public EV charging plugs - L2 (1000 units)	3.14	0	54	0	272	0	753
Vehicle sales - Heavy-duty - diesel (%)	97.4	96	91.3	79.8	58.2	32.1	13.7

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

Item	2020	2025	2030	2035	2040	2045	2050
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 (%)	1.68	2.07	2.08	1.66	1.07	0.553	0.236
Vehicle sales - Light-duty - EV (%)	1.75	4.37	11.2	24.8	47.2	71.3	87.3
Vehicle sales - Light-duty - gasoline (%)	92.2	88.1	80.6	68	47.5	25.7	11.3
Vehicle sales - Light-duty - hybrid (%)	4.17	5	5.65	5.2	3.96	2.37	1.16
Vehicle sales - Light-duty - hydrogen FC (%)	0.113	0.384	0.333	0.257	0.184	0.103	0.048
Vehicle sales - Light-duty - other (%)	0.108	0.112	0.102	0.09	0.065	0.036	0.016
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)	700	704	700	693	678	663	655
Final energy use - Industry (PJ)	3,891	4,375	4,678	4,836	5,002	5,094	5,266
Final energy use - Residential (PJ)	833	808	795	778	738	694	660
Final energy use - Transportation (PJ)	2,704	2,621	2,420	2,258	2,136	1,994	1,823

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	92,535	107,526	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	34.2	39	52	70.1	81.2	85
Sales of cooking units - Gas (%)	69.9	65.8	61	48	29.9	18.8	15
Sales of space heating units - Electric Heat Pump (%)	6.39	16.7	22.6	39.2	65.2	83.1	89.8
Sales of space heating units - Electric Resistance (%)	5.23	4.51	4.54	4.7	5.13	5.79	6.22
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	88.4	78.8	72.9	56.1	29.7	11.1	4.01
Sales of water heating units - Electric Heat Pump (%)	0.154	1.96	7.14	22.1	44.9	59.9	65.1
Sales of water heating units - Electric Resistance (%)	4.33	4.5	6.61	12.8	22.2	28.4	30.5
Sales of water heating units - Gas Furnace (%)	93.4	91.7	84.4	63.3	31	9.9	2.58
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	19.1	19.6	24.1	25.1	33.9	35.8

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	-322
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-13,586
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-615
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-14,523

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

Item	2020	2025	2050
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-322
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-7,102
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-307
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-7,732
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	10,684
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	999
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	11,891
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	5,592
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	499
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	6,299

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

Item	2020	2025	2050
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	1,334

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

Item	2020	2025	2050
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	19,303
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	8,752
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	2,756
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	1,461
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	483
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0

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

Item	2020	2025	2050
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	195
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	727
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	296
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	1,914
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	19,461

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	988	0.887	0.842	0.639	0.413	0.005
Monetary damages from air pollution - Natural Gas (million 2019$)	0	704	318	160	92.6	41.1	29.1
Monetary damages from air pollution - Transportation (million 2019$)	0	4,756	4,973	5,004	4,655	3,823	2,700
Premature deaths from air pollution - Coal (deaths)	0	111	0.1	0.095	0.072	0.046	0.001
Premature deaths from air pollution - Natural Gas (deaths)	0	79.5	35.9	18.1	10.5	4.65	3.29
Premature deaths from air pollution - Transportation (deaths)	0	535	559	563	524	430	304

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	22.2	28.7	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.8	71.5	95.1	99.8	100	100	100
Sales of cooking units - Gas (%)	36.2	28.5	4.87	0.245	0	0	0
Sales of space heating units - Electric Heat Pump (%)	14.3	29.1	74.6	84.7	85.2	85	85
Sales of space heating units - Electric Resistance (%)	43.4	42.6	17.9	12.3	12.1	12.4	12.4
Sales of space heating units - Fossil (%)	3.05	4.67	2.39	1.88	1.84	1.81	1.8
Sales of space heating units - Gas (%)	39.3	23.7	5.17	1.03	0.847	0.825	0.821
Sales of water heating units - Electric Heat Pump (%)	0	11.9	63.1	74.6	75.1	75.1	75.1

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

Item	2020	2025	2030	2035	2040	2045	2050
Sales of water heating units - Electric Resistance (%)	53.8	58.4	30.1	23.6	23.3	23.4	23.4
Sales of water heating units - Gas Furnace (%)	44.2	28	5.25	0.218	0	0	0
Sales of water heating units - Other (%)	2.01	1.61	1.59	1.56	1.56	1.57	1.57

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	4,242	10,921	17,620	26,721	29,049	27,715
Public EV charging plugs - DC Fast (1000 units)	0.675	0	7.03	0	30.3	0	48.9
Public EV charging plugs - L2 (1000 units)	3.14	0	169	0	728	0	1,176
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 (%)	1.67	1.92	1.31	0.419	0.077	0.013	0
Vehicle sales - Light-duty - EV (%)	3.51	13.9	44.6	81	96.2	99.3	100
Vehicle sales - Light-duty - gasoline (%)	90.6	79.4	50.8	17.3	3.39	0.593	0
Vehicle sales - Light-duty - hybrid (%)	4.03	4.25	3.08	1.16	0.279	0.06	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.111	0.347	0.213	0.067	0.013	0.002	0
Vehicle sales - Light-duty - other (%)	0.107	0.103	0.069	0.024	0.005	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)	700	703	680	646	618	611	621
Final energy use - Industry (PJ)	3,891	4,374	4,672	4,814	4,969	5,063	5,241
Final energy use - Residential (PJ)	833	805	759	696	642	616	611
Final energy use - Transportation (PJ)	2,702	2,603	2,334	2,008	1,714	1,533	1,453

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	92,591	107,907	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	44.4	79.2	86.1	86.5	86.4	86.5
Sales of cooking units - Gas (%)	69.9	55.6	20.8	13.9	13.5	13.6	13.5
Sales of space heating units - Electric Heat Pump (%)	6.39	26.3	76.9	91.1	92.2	92.2	92.2
Sales of space heating units - Electric Resistance (%)	5.23	4.51	4.79	6.09	6.39	6.41	6.42
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	88.4	69.2	18.3	2.84	1.39	1.35	1.34
Sales of water heating units - Electric Heat Pump (%)	0.154	10.7	56.3	66.5	66.9	66.9	66.9
Sales of water heating units - Electric Resistance (%)	4.33	8.13	26.9	31.1	31.3	31.3	31.3
Sales of water heating units - Gas Furnace (%)	93.4	79.3	15	0.631	0	0	0
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	22.7	23.6	38.5	41	31.3	32.4

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	0.216	0.126	0.189	0.189	0.118	17.7
Capital invested - Solar PV - Base (billion $2018)	0	30.6	23.9	42.6	49.1	80.1	76.1
Capital invested - Wind - Base (billion $2018)	0	25.2	32.7	52.6	81.2	76.8	87.8

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	301	207	363	426	312	50,780
OffshoreWind - Constrained land use assumptions (GWh)	0	0	0	0	0	0	33,643
Solar - Base land use assumptions (GWh)	18,855	55,538	47,627	89,396	106,229	185,223	183,996
Solar - Constrained land use assumptions (GWh)	18,855	56,535	63,703	93,864	88,307	133,866	186,338
Wind - Base land use assumptions (GWh)	149,083	64,417	88,169	150,800	236,995	230,289	274,747
Wind - Constrained land use assumptions (GWh)	149,083	70,062	104,414	156,669	233,786	251,260	359,935

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	-322
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-13,586
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-615
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-14,523
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-322
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-7,102
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-307
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-7,732
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	10,684
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	999
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	11,891
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	5,592
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	499
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	6,299

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	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	1,334
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	19,303
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	8,752
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	2,756
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	1,461

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

Item	2020	2025	2050
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	483
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	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	195
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	727
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	296
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	1,914
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	19,461

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	988	0.887	0.842	0.639	0.413	0.005
Monetary damages from air pollution - Natural Gas (million 2019$)	0	613	355	150	121	53.4	28.9
Monetary damages from air pollution - Transportation (million 2019$)	0	4,679	4,521	3,556	2,127	1,004	411
Premature deaths from air pollution - Coal (deaths)	0	111	0.1	0.095	0.072	0.046	0.001
Premature deaths from air pollution - Natural Gas (deaths)	0	69.2	40.1	16.9	13.6	6.04	3.26
Premature deaths from air pollution - Transportation (deaths)	0	526	508	400	239	113	46.3

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	22.2	28.7	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.8	71.5	95.1	99.8	100	100	100
Sales of cooking units - Gas (%)	36.2	28.5	4.87	0.245	0	0	0
Sales of space heating units - Electric Heat Pump (%)	14.3	29.1	74.6	84.7	85.2	85	85
Sales of space heating units - Electric Resistance (%)	43.4	42.6	17.9	12.3	12.1	12.4	12.4
Sales of space heating units - Fossil (%)	3.05	4.67	2.39	1.88	1.84	1.81	1.8
Sales of space heating units - Gas (%)	39.3	23.7	5.17	1.03	0.847	0.825	0.821
Sales of water heating units - Electric Heat Pump (%)	0	11.9	63.1	74.6	75.1	75.1	75.1
Sales of water heating units - Electric Resistance (%)	53.8	58.4	30.1	23.6	23.3	23.4	23.4
Sales of water heating units - Gas Furnace (%)	44.2	28	5.25	0.218	0	0	0
Sales of water heating units - Other (%)	2.01	1.61	1.59	1.56	1.56	1.57	1.57

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	4,242	10,921	17,620	26,721	29,049	27,715
Public EV charging plugs - DC Fast (1000 units)	0.675	0	7.03	0	30.3	0	48.9
Public EV charging plugs - L2 (1000 units)	3.14	0	169	0	728	0	1,176
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 (%)	1.67	1.92	1.31	0.419	0.077	0.013	0
Vehicle sales - Light-duty - EV (%)	3.51	13.9	44.6	81	96.2	99.3	100
Vehicle sales - Light-duty - gasoline (%)	90.6	79.4	50.8	17.3	3.39	0.593	0
Vehicle sales - Light-duty - hybrid (%)	4.03	4.25	3.08	1.16	0.279	0.06	0
Vehicle sales - Light-duty - hydrogen FC (%)	0.111	0.347	0.213	0.067	0.013	0.002	0
Vehicle sales - Light-duty - other (%)	0.107	0.103	0.069	0.024	0.005	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 37: *E+RE- scenario - PILLAR 1: Efficiency/Electrification - Overview*

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	700	703	680	646	618	611	621
Final energy use - Industry (PJ)	3,891	4,374	4,672	4,814	4,969	5,063	5,241
Final energy use - Residential (PJ)	833	805	759	696	642	616	611
Final energy use - Transportation (PJ)	2,702	2,603	2,334	2,008	1,714	1,533	1,453

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	92,591	107,907	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	44.4	79.2	86.1	86.5	86.4	86.5
Sales of cooking units - Gas (%)	69.9	55.6	20.8	13.9	13.5	13.6	13.5
Sales of space heating units - Electric Heat Pump (%)	6.39	26.3	76.9	91.1	92.2	92.2	92.2
Sales of space heating units - Electric Resistance (%)	5.23	4.51	4.79	6.09	6.39	6.41	6.42
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	88.4	69.2	18.3	2.84	1.39	1.35	1.34
Sales of water heating units - Electric Heat Pump (%)	0.154	10.7	56.3	66.5	66.9	66.9	66.9
Sales of water heating units - Electric Resistance (%)	4.33	8.13	26.9	31.1	31.3	31.3	31.3
Sales of water heating units - Gas Furnace (%)	93.4	79.3	15	0.631	0	0	0
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	22.7	23.6	38.5	41	31.3	32.4

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

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Offshore Wind - Base (billion $2018)	0	0.216	0	0.107	0	0	0
Capital invested - Solar PV - Base (billion $2018)	0	25.2	19.9	3.81	7.97	14.7	23.2
Capital invested - Solar PV - Constrained (billion $2018)	0	36.4	32.8	7.97	7.44	14.1	19.2
Capital invested - Wind - Base (billion $2018)	0	7.11	9.23	4.77	17.5	10.8	8.55
Capital invested - Wind - Constrained (billion $2018)	0	7.22	11.1	14.8	20.9	11.9	7.61

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	301	0	207	0	0	0
Solar - Base land use assumptions (GWh)	18,855	45,886	40,034	8,178	17,730	34,481	57,831
Solar - Constrained land use assumptions (GWh)	18,855	62,188	59,904	16,074	16,081	31,683	44,374
Wind - Base land use assumptions (GWh)	149,083	18,554	25,990	13,640	53,363	34,189	27,924
Wind - Constrained land use assumptions (GWh)	149,083	18,748	29,230	30,921	58,226	36,200	24,141

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	-322
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-13,586
Carbon sink potential - Aggressive deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-615
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-14,523

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

Item	2020	2025	2050
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-322
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-7,102
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)	0	0	-307
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-7,732
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	10,684
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	999
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	11,891
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	208
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	5,592
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)	0	0	499
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	6,299

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	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	1,334

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

Item	2020	2025	2050
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	19,303
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	8,752
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	2,756
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	1,461
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	483
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)	0	0	0

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

Item	2020	2025	2050
Land impacted for carbon sink potential - Low - Increase trees outside forests (1000 hectares)	0	0	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	195
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	727
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	296
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	1,914
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	19,461

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	988	0.887	0.842	0.639	0.413	0.005
Monetary damages from air pollution - Natural Gas (million 2019$)	0	673	506	376	318	145	80.2
Monetary damages from air pollution - Transportation (million 2019$)	0	4,679	4,521	3,556	2,127	1,004	411
Premature deaths from air pollution - Coal (deaths)	0	111	0.1	0.095	0.072	0.046	0.001
Premature deaths from air pollution - Natural Gas (deaths)	0	76	57.1	42.4	35.9	16.3	9.06
Premature deaths from air pollution - Transportation (deaths)	0	526	508	400	239	113	46.3

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	21.9	27.1	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.7	64.6	68	76.7	88.9	96.4	99
Sales of cooking units - Gas (%)	36.3	35.4	32	23.3	11.1	3.58	0.964
Sales of space heating units - Electric Heat Pump (%)	14.3	20.3	25.5	40.5	63.3	78.1	83.3
Sales of space heating units - Electric Resistance (%)	43.4	47.3	44.3	36.1	23.8	16	13.2
Sales of space heating units - Fossil (%)	3.05	5.12	4.92	4.14	2.95	2.18	1.92
Sales of space heating units - Gas (%)	39.3	27.2	25.2	19.3	9.88	3.69	1.58
Sales of water heating units - Electric Heat Pump (%)	0	2.05	7.87	24.6	50.4	67.2	73

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

Item	2020	2025	2030	2035	2040	2045	2050
Sales of water heating units - Electric Resistance (%)	53.8	63.9	60.9	51.6	37.2	27.8	24.5
Sales of water heating units - Gas Furnace (%)	44.2	32.4	29.6	22.2	10.9	3.45	0.893
Sales of water heating units - Other (%)	2.01	1.61	1.6	1.59	1.6	1.58	1.57

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	695	1,441	4,884	15,313	22,329
Public EV charging plugs - DC Fast (1000 units)	0.675	0	2.24	0	11.3	0	31.3
Public EV charging plugs - L2 (1000 units)	3.14	0	54	0	272	0	753
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 (%)	1.68	2.07	2.08	1.66	1.07	0.553	0.236
Vehicle sales - Light-duty - EV (%)	1.75	4.37	11.2	24.8	47.2	71.3	87.3
Vehicle sales - Light-duty - gasoline (%)	92.2	88.1	80.6	68	47.5	25.7	11.3
Vehicle sales - Light-duty - hybrid (%)	4.17	5	5.65	5.2	3.96	2.37	1.16
Vehicle sales - Light-duty - hydrogen FC (%)	0.113	0.384	0.333	0.257	0.184	0.103	0.048
Vehicle sales - Light-duty - other (%)	0.108	0.112	0.102	0.09	0.065	0.036	0.016
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)	700	704	700	693	678	663	655
Final energy use - Industry (PJ)	3,891	4,375	4,678	4,836	5,002	5,094	5,266
Final energy use - Residential (PJ)	833	808	795	778	738	694	660
Final energy use - Transportation (PJ)	2,704	2,621	2,420	2,258	2,136	1,994	1,823

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	92,535	107,526	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	34.2	39	52	70.1	81.2	85
Sales of cooking units - Gas (%)	69.9	65.8	61	48	29.9	18.8	15
Sales of space heating units - Electric Heat Pump (%)	6.39	16.7	22.6	39.2	65.2	83.1	89.8
Sales of space heating units - Electric Resistance (%)	5.23	4.51	4.54	4.7	5.13	5.79	6.22
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	88.4	78.8	72.9	56.1	29.7	11.1	4.01
Sales of water heating units - Electric Heat Pump (%)	0.154	1.96	7.14	22.1	44.9	59.9	65.1
Sales of water heating units - Electric Resistance (%)	4.33	4.5	6.61	12.8	22.2	28.4	30.5
Sales of water heating units - Gas Furnace (%)	93.4	91.7	84.4	63.3	31	9.9	2.58
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	19.1	19.6	24.1	25.1	33.9	35.8

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	0.003	0.009	0	0.014	0	0
Capital invested - Biomass w/ccu allam power plant (billion $2018)	0	0	0	0.038	0.015	0.013	0.05
Capital invested - Biomass w/ccu power plant (billion $2018)	0	0	15.1	11.6	27.2	1	9.41

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	5	22.5	22.5	51.8	51.8	51.8
Biomass w/ccu allam power plant (GWh)	0	0	0	38.2	53.4	66.8	116
Biomass w/ccu power plant (GWh)	0	0	16,905	29,918	60,456	61,582	72,147

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million $2018/year)	0	3.03	1,085	5,343	7,752	9,088	10,150
Conversion capital investment - Cumulative 5-yr (million $2018)	0	2.92	13,826	48,977	30,237	15,040	13,128
Number of facilities - Allam power w ccu (quantity)	0	0	0	1	3	4	5
Number of facilities - Beccs hydrogen (quantity)	0	0	0	44	50	65	70
Number of facilities - Diesel (quantity)	0	0	0	1	2	2	2
Number of facilities - Diesel ccu (quantity)	0	0	0	1	3	4	4
Number of facilities - Power (quantity)	0	1	1	1	2	2	2
Number of facilities - Power ccu (quantity)	0	0	14	24	48	49	58
Number of facilities - Pyrolysis (quantity)	0	0	0	1	2	2	2
Number of facilities - Pyrolysis ccu (quantity)	0	0	0	0	1	2	3
Number of facilities - Sng (quantity)	0	1	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	20	82.3	123	145	171
Annual - BECCS (MMT)	0	0	16.7	78.8	116	135	151
Annual - Cement and lime (MMT)	0	0	3.24	3.35	6.64	6.84	14.1
Annual - NGCC (MMT)	0	0	0.01	0.15	0.12	2.93	6.25
Cumulative - All (MMT)	0	0	20	102	225	370	541
Cumulative - BECCS (MMT)	0	0	16.7	95.6	211	346	497
Cumulative - Cement and lime (MMT)	0	0	3.24	6.59	13.2	20.1	34.2
Cumulative - NGCC (MMT)	0	0	0.01	0.16	0.28	3.21	9.46

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

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)	0	0	39.7	179	356	492	519
Injection wells (wells)	0	0	38	148	264	442	549
Resource characterization, appraisal, permitting costs (million $2020)	0	157	4,112	6,534	6,534	6,534	6,534
Wells and facilities construction costs (million $2020)	0	0	1,143	4,456	7,942	13,279	16,486

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

Item	2020	2025	2030	2035	2040	2045	2050
All (km)	0	708	2,386	5,232	7,401	9,393	10,975
Cumulative investment - All (million $2018)	0	3,706	10,471	16,421	20,544	22,345	24,019
Cumulative investment - Spur (million $2018)	0	0	773	3,345	5,344	7,146	8,819
Cumulative investment - Trunk (million $2018)	0	3,706	9,698	13,077	15,200	15,200	15,200
Spur (km)	0	0	857	3,162	5,051	7,043	8,625
Trunk (km)	0	708	1,529	2,070	2,350	2,350	2,350

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	-1,972
Carbon sink potential - Aggressive deployment - Cropland measures (1000 tCO2e/y)	0	0	-12,539
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	-543
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)	0	0	-15,055
Carbon sink potential - Moderate deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)	0	0	-1,972
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)	0	0	-6,549
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	-271
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)	0	0	-8,793
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	1,265
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)	0	0	23,841
Land impacted for carbon sink - Aggressive deployment - Cropland to woody energy crops (1000 hectares)	0	0	203
Land impacted for carbon sink - Aggressive deployment - Pasture to energy crops (1000 hectares)	0	0	5,475
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)	0	0	885
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)	0	0	31,668
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)	0	0	1,265
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)	0	0	5,049
Land impacted for carbon sink - Moderate deployment - Cropland to woody energy crops (1000 hectares)	0	0	203
Land impacted for carbon sink - Moderate deployment - Pasture to energy crops (1000 hectares)	0	0	5,475

Table 56: *E-B+ 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	442
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)	0	0	12,434

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	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	1,334
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	19,303
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	8,752
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	2,756

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

Item	2020	2025	2050
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	1,461
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	483
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	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	195
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	727
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	296
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	1,914

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

Item	2020	2025	2050
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	19,461

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	21.4	22.1	0	0	0	0
Sales of cooking units - Electric Resistance (%)	63.4	63.4	63.4	63.4	63.4	63.4	63.4
Sales of cooking units - Gas (%)	36.6	36.6	36.6	36.6	36.6	36.6	36.6
Sales of space heating units - Electric Heat Pump (%)	11.8	38.1	39.3	41.3	43.1	45.6	49.3
Sales of space heating units - Electric Resistance (%)	44.8	37.5	36.8	35.9	34.6	32.3	28.5
Sales of space heating units - Fossil (%)	3.12	3.34	3.39	3.37	3.32	3.31	3.33
Sales of space heating units - Gas (%)	40.4	21.1	20.5	19.5	19	18.8	18.9
Sales of water heating units - Electric Heat Pump (%)	0	0	0	0	0	0	0
Sales of water heating units - Electric Resistance (%)	53.8	65.1	65.3	65.3	65.2	65.2	65.2
Sales of water heating units - Gas Furnace (%)	44.2	33.3	33.1	33.1	33.2	33.2	33.2
Sales of water heating units - Other (%)	2.01	1.61	1.6	1.6	1.61	1.61	1.61

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 (%)	1.68	2.07	2.21	2.05	1.85	1.73	1.64
Vehicle sales - Light-duty - EV (%)	3.16	5.08	5.81	7.12	8.7	10.2	11.3
Vehicle sales - Light-duty - gasoline (%)	90.9	87.5	85.5	83.8	81.8	79.9	78.2
Vehicle sales - Light-duty - hybrid (%)	4.04	4.91	6.03	6.6	7.2	7.84	8.37
Vehicle sales - Light-duty - hydrogen FC (%)	0.111	0.381	0.353	0.315	0.314	0.315	0.326
Vehicle sales - Light-duty - other (%)	0.108	0.111	0.108	0.109	0.108	0.107	0.11
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)	699	714	723	730	744	773	820
Final energy use - Industry (PJ)	3,891	4,400	4,708	4,872	5,055	5,192	5,374
Final energy use - Residential (PJ)	833	811	817	837	865	900	933
Final energy use - Transportation (PJ)	2,703	2,633	2,461	2,363	2,377	2,448	2,536

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	90,575	95,067	0	0	0	0
Sales of cooking units - Electric Resistance (%)	30.1	32.3	32.2	32.3	32.3	32.2	32.3

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

Item	2020	2025	2030	2035	2040	2045	2050
Sales of cooking units - Gas (%)	69.9	67.7	67.8	67.7	67.7	67.8	67.7
Sales of space heating units - Electric Heat Pump (%)	6.39	29	70.5	79	79.5	79.5	79.5
Sales of space heating units - Electric Resistance (%)	5.23	6.36	12.1	15.9	18.7	19.1	19.1
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace (%)	88.4	64.7	17.4	5.08	1.83	1.39	1.34
Sales of water heating units - Electric Heat Pump (%)	0.154	0.132	0.129	0.132	0.131	0.13	0.129
Sales of water heating units - Electric Resistance (%)	4.33	3.75	3.72	3.73	3.75	3.74	3.75
Sales of water heating units - Gas Furnace (%)	93.4	94.3	94.3	94.3	94.3	94.3	94.3
Sales of water heating units - Other (%)	2.08	1.83	1.82	1.82	1.83	1.83	1.83

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	24.3	25.5	38.5	41	32.8	34.1

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

Item	2020	2025	2030	2050
Business-as-usual carbon sink - Natural uptake (Mt CO2e/y)	-14.2	0	-31.5	-25.5
Business-as-usual carbon sink - Retained in Hardwood Products (Mt CO2e/y)	-3.57	0	-5.96	-6.27
Business-as-usual carbon sink - Total (Mt CO2e/y)	-17.8	0	-37.5	-31.8
Carbon sink potential - High - Accelerate regeneration (1000 tCO2e/y)	0	0	0	8,931
Carbon sink potential - High - All (not counting overlap) (1000 tCO2e/y)	0	0	0	148,038
Carbon sink potential - High - Avoid deforestation (1000 tCO2e/y)	0	0	0	6,717
Carbon sink potential - High - Extend rotation length (1000 tCO2e/y)	0	0	0	15,037
Carbon sink potential - High - Improve plantations (1000 tCO2e/y)	0	0	0	2,622
Carbon sink potential - High - Increase retention of HWP (1000 tCO2e/y)	0	0	0	13,128
Carbon sink potential - High - Increase trees outside forests (1000 tCO2e/y)	0	0	0	4,082
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)	0	0	0	38,605
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)	0	0	0	39,514
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)	0	0	0	19,401
Carbon sink potential - Low - Accelerate regeneration (1000 tCO2e/y)	0	0	0	4,475
Carbon sink potential - Low - All (not counting overlap) (1000 tCO2e/y)	0	0	0	47,345
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)	0	0	0	1,120
Carbon sink potential - Low - Extend rotation length (1000 tCO2e/y)	0	0	0	5,776
Carbon sink potential - Low - Improve plantations (1000 tCO2e/y)	0	0	0	1,334
Carbon sink potential - Low - Increase retention of HWP (1000 tCO2e/y)	0	0	0	4,376
Carbon sink potential - Low - Increase trees outside forests (1000 tCO2e/y)	0	0	0	1,429
Carbon sink potential - Low - Reforest cropland (1000 tCO2e/y)	0	0	0	19,303

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

Item	2020	2025	2030	2050
Carbon sink potential - Low - Reforest pasture (1000 tCO2e/y)	0	0	0	2,993
Carbon sink potential - Low - Restore productivity (1000 tCO2e/y)	0	0	0	6,540
Carbon sink potential - Mid - Accelerate regeneration (1000 tCO2e/y)	0	0	0	6,703
Carbon sink potential - Mid - All (not counting overlap) (1000 tCO2e/y)	0	0	0	97,668
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)	0	0	0	3,918
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)	0	0	0	10,406
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)	0	0	0	1,955
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)	0	0	0	8,752
Carbon sink potential - Mid - Increase trees outside forests (1000 tCO2e/y)	0	0	0	2,756
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)	0	0	0	28,954
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)	0	0	0	21,254
Carbon sink potential - Mid - Restore productivity (1000 tCO2e/y)	0	0	0	12,970
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)	0	0	0	1,461
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	909
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)	0	0	0	7,668
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)	0	0	0	966
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	388
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)	0	0	0	2,552
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)	0	0	0	1,123
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)	0	0	0	6,431
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)	0	0	0	21,498
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)	0	0	0	731
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	854
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)	0	0	0	2,938
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)	0	0	0	483
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	204
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares)	0	0	0	1,276
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares)	0	0	0	195

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

Item	2020	2025	2030	2050
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares)	0	0	0	3,891
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares)	0	0	0	10,571
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares)	0	0	0	1,096
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares)	0	0	0	882
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares)	0	0	0	5,303
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares)	0	0	0	727
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	296
Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares)	0	0	0	1,914
Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares)	0	0	0	1,407
Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares)	0	0	0	7,837
Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000 hectares)	0	0	0	19,461

Table 64: *REF scenario - IMPACTS - Health*

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019$)	0	5,230	1,950	1,119	880	790	702
Monetary damages from air pollution - Natural Gas (million 2019$)	0	823	961	1,063	869	731	812
Monetary damages from air pollution - Transportation (million 2019$)	0	4,751	5,037	5,328	5,647	5,969	6,300
Premature deaths from air pollution - Coal (deaths)	0	587	219	126	98.7	88.7	78.8
Premature deaths from air pollution - Natural Gas (deaths)	0	93	109	120	98.2	82.6	91.8
Premature deaths from air pollution - Transportation (deaths)	0	534	566	599	635	671	709