

Net-Zero America - oklahoma state report

2021-03-15

These data underlie graphs and tables presented in the Princeton Net-Zero America study:

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Notes

- These data are all data from the study available at https://netzeroamerica.prince-ton.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 statelevel 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.)
- For Pillar 6 (Land sinks), values shown are maximum carbon storage potentials.

Data by category and subcategory

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

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s -		14,173	16,554				
Cumulative 5-yr (million \$2018)							
Sales of cooking units - Electric	30.1	44.4	79.2	86.1	86.5	86.5	86.5
Resistance (%)							
Sales of cooking units - Gas (%)	69.9	55.6	20.8	13.9	13.5	13.5	13.5
Sales of space heating units - Electric	1.94	26.9	77	91.1	92.3	92.3	92.3
Heat Pump (%)							
Sales of space heating units - Electric	2	4.42	4.72	6.04	6.33	6.36	6.38
Resistance (%)							
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	96.1	68.7	18.2	2.83	1.38	1.34	1.33
(%)							
Sales of water heating units - Electric	0.059	10.7	56.4	66.5	67	67	66.9
Heat Pump (%)							
Sales of water heating units - Electric	1.74	8.05	26.9	31.1	31.3	31.3	31.3
Resistance (%)							
Sales of water heating units - Gas Furnace	97.4	79.4	15	0.632	0	0	0
(%)							
Sales of water heating units - Other (%)	0.794	1.77	1.77	1.77	1.78	1.78	1.79

Table 2: E+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.97	3.05	4.83	5.11	4.99	5.22
Cumulative 5-yr (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	122	117	109	103	101	103
Final energy use - Industry (PJ)	310	318	324	323	325	323	330
Final energy use - Residential (PJ)	177	168	153	133	115	105	99.9
Final energy use - Transportation (PJ)	431	405	359	302	250	219	207

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.2	3.89				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	40.4	53.1	92	99.6	100	100	100
Resistance (%)							
Sales of cooking units - Gas (%)	59.6	46.9	8.02	0.404	0	0	0
Sales of space heating units - Electric	8.53	25.2	76.9	88.5	89	88.9	88.8
Heat Pump (%)							
Sales of space heating units - Electric	24.8	26.1	10.9	7.55	7.39	7.53	7.57
Resistance (%)							
Sales of space heating units - Fossil (%)	5.91	8.95	3.48	2.25	2.19	2.17	2.16
Sales of space heating units - Gas (%)	60.7	39.8	8.68	1.75	1.46	1.44	1.43
Sales of water heating units - Electric	0	11.6	61.7	72.9	73.4	73.4	73.4
Heat Pump (%)							
Sales of water heating units - Electric	30.5	39.9	28.2	25.5	25.4	25.4	25.4
Resistance (%)							
Sales of water heating units - Gas Furnace	68.2	47.2	8.93	0.373	0	0	0
(%)							
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.2	1.19	1.2	1.2

Table 5: E+ scenario - PILLAR 1: Efficiency/Electrification - Transportation

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs -		710	1,819	2,948	4,465	4,860	4,634
Cumulative 5-yr (million \$2018)							
Public EV charging plugs - DC Fast (1000	0.326		1.4		6.16		9.97
units)							
Public EV charging plugs - L2 (1000 units)	0.301		33.8		148		240
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	44.5	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 (%)	4.02	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	0.196	1.27	6.33	15.2	19.1	19.9	20
FC (%)							
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

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

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Biomass power plant (billion \$2018)	0	0	0	0	0	0	0
Capital invested - Biomass w/ccu allam power plant (billion \$2018)	0	0	0	0.019	0	0	0
Capital invested - Biomass w/ccu power plant (billion \$2018)	0	0	0	0	0	0	0
Capital invested - Solar PV - Base (billion \$2018)		0	0	0	1.09	4.46	0.979
Capital invested - Solar PV - Constrained (billion \$2018)		1.7	4.96	6.17	5.53	5.51	2.59
Capital invested - Wind - Base (billion \$2018)		0	8.18	17.2	16.7	12	1.18
Capital invested - Wind - Constrained (billion \$2018)		6.51	7.43	13.6	12.3	8.59	0.321
Installed renewables - OffshoreWind - Base land use assumptions (MW)	0	0	0	0	0	0	0
Installed renewables - OffshoreWind - Constrained land use assumptions (MW)	0	0	0	0	0	0	0
Installed renewables - Rooftop PV (MW)	130	228	333	490	714	1,005	1,384
Installed renewables - Solar - Base land use assumptions (MW)	260	260	260	260	1,486	6,806	8,044
Installed renewables - Solar - Constrained land use assumptions (MW)	250	790	4,975	12,747	20,780	27,721	31,164
Installed renewables - Wind - Base land use assumptions (MW)	11,527	11,527	17,669	31,558	45,685	56,368	57,483
Installed renewables - Wind - Constrained land use assumptions (MW)	11,527	11,868	17,422	28,542	40,274	48,054	48,365

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Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	0	0	0	0	0	0
Biomass w/ccu allam power plant (GWh)	0	0	0	19	19	19	19
Biomass w/ccu power plant (GWh)	0	0	0	0	0	0	0
OffshoreWind - Base land use	0	0	0	0	0	0	0
assumptions (GWh)							
OffshoreWind - Constrained land use	0	0	0	0	0	0	0
assumptions (GWh)							
Solar - Base land use assumptions (GWh)	551	551	551	551	2,764	12,560	14,854
Solar - Constrained land use assumptions	531	1,500	9,235	23,604	38,522	51,191	57,598
(GWh)							
Wind - Base land use assumptions (GWh)	48,113	48,113	71,210	122,262	173,218	211,315	215,061
Wind - Constrained land use assumptions	48,113	49,220	69,807	109,923	151,621	178,536	179,576
(GWh)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million \$2018/year)		0	0	192	266	412	531
Conversion capital investment -		0	0	3,342	1,276	2,536	2,177
Cumulative 5-yr (million \$2018)							
Number of facilities - Allam power w ccu	0	0	0	1	1	1	1
(quantity)							
Number of facilities - Beccs hydrogen	0	0	0	4	7	9	12
(quantity)							
Number of facilities - Diesel (quantity)	0	0	0	0	0	0	0
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Power (quantity)	0	0	0	0	0	0	0
Number of facilities - Power ccu	0	0	0	0	0	0	0
(quantity)							
Number of facilities - Pyrolysis (quantity)	0	0	0	0	0	0	0
Number of facilities - Pyrolysis ccu	0	0	0	1	1	1	1
(quantity)							
Number of facilities - Sng (quantity)	0	0	0	0	0	0	0
Number of facilities - Sng ccu (quantity)	0	0	0	0	0	0	0

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)		0	0	11	12.5	16	18.8
Annual - BECCS (MMT)		0	0	4.26	5.9	9.16	11.8
Annual - Cement and lime (MMT)		0	0	6.71	6.64	6.84	7.07
Annual - NGCC (MMT)		0	0	0	0	0	0
Cumulative - All (MMT)		0	0	11	23.5	39.5	58.3
Cumulative - BECCS (MMT)		0	0	4.26	10.2	19.3	31.1
Cumulative - Cement and lime (MMT)		0	0	6.71	13.3	20.2	27.3
Cumulative - NGCC (MMT)		0	0	0	0	0	0

Table 10: E+ scenario - PILLAR 4: CCUS - CO2 pipelines

Item	2020	2025	2030	2035	2040	2045	2050
All (km)		0	774	1,805	2,123	2,851	3,186
Cumulative investment - All (million \$2018)		0	4,032	6,502	6,684	7,204	7,407
Cumulative investment - Spur (million \$2018)		0	0	557	740	1,259	1,462
Cumulative investment - Trunk (million \$2018)		0	4,032	5,944	5,944	5,944	5,944
Spur (km)		0	0	670	988	1,715	2,050
Trunk (km)		0	774	1,136	1,136	1,136	1,136

Table 11: E+ scenario - PILLAR 4: CCUS - CO2 storage

	•						
Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)		0	1.1	1.76	3.61	6.02	7.46
Injection wells (wells)		0	1	4	8	13	16
Resource characterization, appraisal, permitting costs (million \$2020)		103	251	295	295	295	295
Wells and facilities construction costs (million \$2020)		0	35.6	139	247	413	513

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

Table 12: E+ Scenario - PILLAR 6: Land Sink	ks - Agricu. 2020		0000	2025	207.0	207.5	2050
Item Carbon sink potential - Aggressive	2020	2025	2030	2035	2040	2045	2050 -18.2
							-18.2
deployment - Corn-ethanol to energy grasses (1000 tCO2e/y)							
Carbon sink potential - Aggressive							-4,525
deployment - Cropland measures (1000							-4,525
tCO2e/y)							
Carbon sink potential - Aggressive							-262
deployment - Permanent conservation							-202
cover (1000 tC02e/y) Carbon sink potential - Aggressive							-4,806
deployment - Total (1000 tCO2e/y)							-4,806
							10.0
Carbon sink potential - Moderate							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tC02e/y)							0.001
Carbon sink potential - Moderate							-2,381
deployment - Cropland measures (1000							
tCO2e/y)							404
Carbon sink potential - Moderate							-131
deployment - Permanent conservation							
cover (1000 tC02e/y)							
Carbon sink potential - Moderate							-2,530
deployment - Total (1000 tCO2e/y)							
Land impacted for carbon sink -							11.7
Aggressive deployment - Corn-ethanol to							
energy grasses (1000 hectares)							
Land impacted for carbon sink -							4,283
Aggressive deployment - Cropland							
measures (1000 hectares)							
Land impacted for carbon sink -							450
Aggressive deployment - Permanent							
conservation cover (1000 hectares)							
Land impacted for carbon sink -							4,745
Aggressive deployment - Total (1000							
hectares)							
Land impacted for carbon sink - Moderate							11.7
deployment - Corn-ethanol to energy							
grasses (1000 hectares)							
Land impacted for carbon sink - Moderate							2,254
deployment - Cropland measures (1000							
hectares)							
Land impacted for carbon sink - Moderate							225
deployment - Permanent conservation							
cover (1000 hectares)							
Land impacted for carbon sink - Moderate							2,491
deployment - Total (1000 hectares)							•
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Table 13: E+ scenario - PILLAR 6: Land sinks - Forests

Table 13: E+ scenario - PILLAR 6: Land sini		0005	0000	0005	00/0	00/5	0050
Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - High - Accelerate							-952
regeneration (1000 tC02e/y)							
Carbon sink potential - High - All (not							-43,286
counting overlap) (1000 tC02e/y)							
Carbon sink potential - High - Avoid							-1,687
deforestation (1000 tC02e/y)							
Carbon sink potential - High - Extend							-4,643
rotation length (1000 tCO2e/y)							
Carbon sink potential - High - Improve							-646
plantations (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,773
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-9,732
cropland (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-19,153
pasture (1000 tCO2e/y)							
Carbon sink potential - High - Restore							-3,321
productivity (1000 tCO2e/y)							
Carbon sink potential - Low - Accelerate							-477
regeneration (1000 tCO2e/y)							
Carbon sink potential - Low - All (not							-11,380
counting overlap) (1000 tCO2e/y)							,
Carbon sink potential - Low - Avoid							-281
deforestation (1000 tCO2e/y)							
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tC02e/y)							1,1.00
Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y)							027
Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tC02e/y)							071
Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tC02e/y)							-402
Carbon sink potential - Low - Reforest							-4,866
cropland (1000 tC02e/y)							-4,000
Carbon sink potential - Low - Reforest							-1,451
							-1,451
pasture (1000 tC02e/y)							1100
Carbon sink potential - Low - Restore							-1,120
productivity (1000 tC02e/y)							715
Carbon sink potential - Mid - Accelerate							-715
regeneration (1000 tC02e/y)							07.007
Carbon sink potential - Mid - All (not							-27,327
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Mid - Avoid							-984
deforestation (1000 tC02e/y)							
Carbon sink potential - Mid - Extend							-3,213
rotation length (1000 tC02e/y)							
Carbon sink potential - Mid - Improve							-482
plantations (1000 tCO2e/y)							
Carbon sink potential - Mid - Increase							-1,182
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - Mid - Increase							-930
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - Mid - Reforest							-7,299
cropland (1000 tCO2e/y)							
Carbon sink potential - Mid - Reforest							-10,302
pasture (1000 tCO2e/y)							
Carbon sink potential - Mid - Restore							-2,221
productivity (1000 tCO2e/y)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							156
High - Accelerate regeneration (1000							
hectares)							
Land impacted for carbon sink potential -							228
High - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							2,368
High - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							238
High - Improve plantations (1000							
hectares)							
Land impacted for carbon sink potential -							0
High - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							131
High - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							643
High - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							544
High - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,101
High - Restore productivity (1000							1,101
hectares)							
Land impacted for carbon sink potential -	+	+				+	5,409
High - Total impacted (over 30 years)							0,407
(1000 hectares)							
Land impacted for carbon sink potential -							77.9
Low - Accelerate regeneration (1000							11.7
hectares)							
Land impacted for carbon sink potential -	+						214
Low - Avoid deforestation (over 30 years)							214
(1000 hectares)							
Land impacted for carbon sink potential -	+						907
Low - Extend rotation length (1000							901
hectares)							
Land impacted for carbon sink potential -							119
Low - Improve plantations (1000							119
hectares)							
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000							0
•							
hectares)							/00
Land impacted for carbon sink potential -							68.9
Low - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							322
Low - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							94.3
Low - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							666
Low - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							2,470
Low - Total impacted (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							117
Mid - Accelerate regeneration (1000							
hectares)		I			1		

Tahla 12. Fx	econario -	DILLAD 6.	Land sinks -	Enrecte	(continued)
Table 15. Et	SCEIIUI 10 -	PILLAK O.	LUIIU SIIIKS -	. คบา ยอเอา	COHUHUEUT

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							221
Mid - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							1,637
Mid - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							179
Mid - Improve plantations (1000 hectares)							
Land impacted for carbon sink potential -							0
Mid - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000							
hectares)							
Land impacted for carbon sink potential -							483
Mid - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							682
Mid - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,342
Mid - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000							
hectares)							
hectares) Land impacted for carbon sink potential - Mid - Reforest cropland (1000 hectares) Land impacted for carbon sink potential - Mid - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Mid - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Mid - Total impacted (over 30 years) (1000							1,342

Table 14: E+ scenario - IMPACTS - Fossil fuel industries

Item	2020	2025	2030	2035	2040	2045	2050
Natural gas consumption - Annual (tcf)		626	528	423	319	200	139
Natural gas consumption - Cumulative							12,746
(tcf)							
Natural gas production - Annual (tcf)		3,291	3,111	2,709	2,291	1,817	1,411
Oil consumption - Annual (million bbls)		102	87.7	66.7	45.9	29.6	14.7
Oil consumption - Cumulative (million							2,028
bbls)							
Oil production - Annual (million bbls)		260	261	261	206	168	112

Table 15: E+ scenario - IMPACTS - Health

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution - Coal (million 2019\$)		266	0.237	0.229	0.184	0.119	0.002
Monetary damages from air pollution - Natural Gas (million 2019\$)		238	124	55.4	41.2	23.9	12.8
Monetary damages from air pollution - Transportation (million 2019\$)		674	634	485	281	129	50.9
Premature deaths from air pollution - Coal (deaths)		30	0.027	0.026	0.021	0.013	0
Premature deaths from air pollution - Natural Gas (deaths)		26.9	14	6.25	4.66	2.7	1.44
Premature deaths from air pollution - Transportation (deaths)		75.8	71.3	54.5	31.6	14.5	5.72

Table 16: E+ scenario - IMPACTS - Jobs

Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Agriculture (jobs)		27.4	55.6	379	447	560	593
By economic sector - Construction (jobs)		14,781	16,934	21,027	22,801	25,208	21,719
By economic sector - Manufacturing		28,891	31,436	36,802	33,310	27,008	28,975
(jobs)							
By economic sector - Mining (jobs)		35,058	27,735	21,464	14,038	9,029	4,915

Table 16: E+ scenario - IMPACTS - Jobs (continued)

Table 16: E+ scenario - IMPACTS - Jobs (co	intinueaj						
Item	2020	2025	2030	2035	2040	2045	2050
By economic sector - Other (jobs)		778	931	1,480	2,080	2,978	2,723
By economic sector - Pipeline (jobs)		1,798	2,040	1,681	1,137	881	643
By economic sector - Professional (jobs)		13,331	13,581	16,852	18,326	19,829	17,485
By economic sector - Trade (jobs)		12,358	11,762	12,564	12,277	12,543	10,597
By economic sector - Utilities (jobs)		11,521	12,676	16,002	17,481	18,831	17,098
By education level - All sectors -		34,439	34,580	38,498	37,227	36,154	32,760
Associates degree or some college (jobs)							
By education level - All sectors -		29,546	28,272	29,906	27,655	25,933	22,760
Bachelors degree (jobs)							
By education level - All sectors - Doctoral		1,008	953	1,026	991	982	839
degree (jobs)							
By education level - All sectors - High		46,511	46,674	51,743	49,377	47,418	42,852
school diploma or less (jobs)							
By education level - All sectors - Masters		7,039	6,672	7,078	6,647	6,380	5,537
or professional degree (jobs)							
By resource sector - Biomass (jobs)		118	153	1,079	1,345	2,042	2,533
By resource sector - CO2 (jobs)		53.6	3,571	2,476	756	1,295	1,714
By resource sector - Coal (jobs)		679	47.7	0.976	0.751	0.607	0.518
By resource sector - Grid (jobs)		10,694	12,550	21,365	26,557	30,550	28,842
By resource sector - Natural Gas (jobs)		34,455	26,923	20,616	15,610	10,051	5,609
By resource sector - Nuclear (jobs)		0	0.003	0.006	0	0	0
By resource sector - Oil (jobs)		52,247	47,100	42,254	30,570	22,744	13,938
By resource sector - Solar (jobs)		6,432	7,479	10,834	12,680	15,428	17,569
By resource sector - Wind (jobs)		13,865	19,325	29,626	34,379	34,756	34,543
Median wages - Annual - All (\$2019 per		59,948	59,892	59,534	59,523	59,782	59,634
iob)		- , -	- ,-	,	, , ,	, -	, , , ,
On-Site or In-Plant Training - Total jobs - 1		18,548	18,481	20,312	19,425	18,746	16,770
to 4 years (jobs)			.				•
On-Site or In-Plant Training - Total jobs - 4		6,931	6,948	7,660	7,491	7,491	6,518
to 10 years (jobs)		, -	-, -	,	<i>'</i>	,	-,-
On-Site or In-Plant Training - Total jobs -		19,267	18,984	20,837	19,870	19,094	17,214
None (jobs)			·		,	,	•
On-Site or In-Plant Training - Total jobs -		844	870	991	980	972	878
Over 10 years (jobs)							
On-Site or In-Plant Training - Total jobs -		72,954	71,867	78,450	74,131	70,565	63,369
Up to 1 year (jobs)		, -	,	,	, -	,,,,,,,	,
On-the-Job Training - All sectors - 1 to 4		23,643	23,561	25,912	24,855	24,067	21,520
years (jobs)		-,	-,	-,	,	,	,
On-the-Job Training - All sectors - 4 to 10		6,185	6,278	7,041	7,018	7,145	6,251
years (jobs)		-,	-, -	, -	,	, -	-, -
On-the-Job Training - All sectors - None		6,640	6,434	6,939	6,553	6,296	5,605
(jobs)		5,5 15	5, 15 1	7, 2,	2,222	7,210	-,
On-the-Job Training - All sectors - Over 10		1,192	1,191	1,305	1,227	1,151	1,052
years (jobs)		,,	.,	,,,,,,	.,	,,,,,,	.,
On-the-Job Training - All sectors - Up to 1		80,884	79,686	87,054	82,244	78,208	70,320
year (jobs)		33,33	. ,,,,,,	0.,00	0_,	. 5,255	. 0,020
Related work experience - All sectors - 1		44,333	43,558	47,306	44,685	42,664	37,935
to 4 years (jobs)		,000	.5,555	,000	,555	,00 .	0.,700
Related work experience - All sectors - 4		28,132	27,733	30,215	28,703	27,526	24,533
to 10 years (jobs)		20,102	21,100	00,210	20,100	21,020	24,000
Related work experience - All sectors -		16,125	16,057	17,699	16,947	16,394	14,724
None (jobs)		10,120	10,001	11,077	10,771	10,074	17/1 47
Related work experience - All sectors -		8,142	7,971	8,607	8,049	7,545	6,787
Over 10 years (jobs)		0,142	1,711	0,001	0,049	1,040	0,101
Related work experience - All sectors - Up		21,812	21,831	24,423	23,514	22,739	20,769
to 1 year (jobs)		21,012	۷۱٫۵۵۱	24,420	20,014	22,107	20,107
Wage income - All (million \$2019)		7,107	7,017	7,636	7,256	6,987	6,247
vvage income - An (million \$2017)		1,101	1,011	1,030	1,200	0,701	0,241

Table 17: E- scenario - PILLAR 1: Efficiency/Electrification - Commercial

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s -		14,157	16,435				
Cumulative 5-yr (million \$2018)							
Sales of cooking units - Electric	30.1	34.2	39	52	70.1	81.2	85
Resistance (%)							
Sales of cooking units - Gas (%)	69.9	65.8	61	48	29.9	18.8	15
Sales of space heating units - Electric	1.94	17.4	23.1	39.7	65.5	83.2	89.8
Heat Pump (%)							
Sales of space heating units - Electric	2	4.42	4.46	4.63	5.06	5.73	6.18
Resistance (%)							
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	96.1	78.2	72.4	55.7	29.4	11	3.98
(%)							
Sales of water heating units - Electric	0.059	1.96	7.15	22.1	45	59.9	65.1
Heat Pump (%)							
Sales of water heating units - Electric	1.74	4.42	6.55	12.7	22.2	28.4	30.5
Resistance (%)							
Sales of water heating units - Gas Furnace	97.4	91.9	84.5	63.4	31	9.91	2.58
(%)							
Sales of water heating units - Other (%)	0.794	1.77	1.77	1.77	1.78	1.78	1.79

Table 18: E- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.54	2.56	3.09	3.17	4.7	4.96
Cumulative 5-yr (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	122	121	120	117	113	111
Final energy use - Industry (PJ)	310	319	325	326	330	327	334
Final energy use - Residential (PJ)	177	169	164	158	146	131	118
Final energy use - Transportation (PJ)	431	408	374	347	327	302	274

Table 20: E- scenario - PILLAR 1: Efficiency/Electrification - Residential

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.16	3.73				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	40.2	41.8	47.2	61.7	81.7	94.1	98.4
Resistance (%)							
Sales of cooking units - Gas (%)	59.8	58.2	52.8	38.3	18.3	5.9	1.59
Sales of space heating units - Electric	8.53	15.3	21.1	38.1	64.1	81	86.8
Heat Pump (%)							
Sales of space heating units - Electric	24.8	29	27.1	22.1	14.5	9.75	8.07
Resistance (%)							
Sales of space heating units - Fossil (%)	5.91	10	9.47	7.6	4.79	3.01	2.4
Sales of space heating units - Gas (%)	60.7	45.8	42.3	32.2	16.6	6.26	2.7
Sales of water heating units - Electric	0	2	7.69	24.1	49.2	65.6	71.4
Heat Pump (%)							
Sales of water heating units - Electric	30.5	42.2	40.8	37	31.1	27.3	25.9
Resistance (%)							
Sales of water heating units - Gas Furnace	68.2	54.6	50.3	37.7	18.4	5.87	1.53
(%)							
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.21	1.21	1.21	1.2

Table 21: E- scenario - PILLAR 1: Efficiency/Electrification - Transportation

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs -		0	115	241	815	2,564	3,735
Cumulative 5-yr (million \$2018)							
Public EV charging plugs - DC Fast (1000	0.326		0.434		2.29		6.38
units)							
Public EV charging plugs - L2 (1000 units)	0.301		10.4		55		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 (%)	1.68	2.07	2.08	1.66	1.07	0.553	0.236
Vehicle sales - Light-duty - EV (%)	1.74	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 (%)	4.16	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	0.166	0.485	1.37	3.58	7.86	13.2	17
FC (%)							
Vehicle sales - Medium-duty - other (%)	0.253	0.266	0.279	0.286	0.258	0.184	0.102

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - Aggressive							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tC02e/y)							
Carbon sink potential - Aggressive							-4,525
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Aggressive							-262
deployment - Permanent conservation							
cover (1000 tC02e/y)							
Carbon sink potential - Aggressive							-4,806
deployment - Total (1000 tC02e/y)							40.0
Carbon sink potential - Moderate							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tC02e/y)							0.001
Carbon sink potential - Moderate							-2,381
deployment - Cropland measures (1000							
tCO2e/y)							101
Carbon sink potential - Moderate							-131
deployment - Permanent conservation							
cover (1000 tC02e/y)							0.500
Carbon sink potential - Moderate							-2,530
deployment - Total (1000 tC02e/y)							11.7
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to							11.7
energy grasses (1000 hectares)							
Land impacted for carbon sink -							4,283
•							4,283
Aggressive deployment - Cropland							
measures (1000 hectares) Land impacted for carbon sink -							450
•							450
Aggressive deployment - Permanent conservation cover (1000 hectares)							
conservation cover (1000 nectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink -							4,745
Aggressive deployment - Total (1000							
hectares)							
Land impacted for carbon sink - Moderate							11.7
deployment - Corn-ethanol to energy							
grasses (1000 hectares)							
Land impacted for carbon sink - Moderate							2,254
deployment - Cropland measures (1000							
hectares)							
Land impacted for carbon sink - Moderate							225
deployment - Permanent conservation							
cover (1000 hectares)							
Land impacted for carbon sink - Moderate							2,491
deployment - Total (1000 hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - High - Accelerate							-952
regeneration (1000 tCO2e/y)							
Carbon sink potential - High - All (not							-43,286
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - High - Avoid							-1,687
deforestation (1000 tCO2e/y)							
Carbon sink potential - High - Extend							-4,643
rotation length (1000 tCO2e/y)							
Carbon sink potential - High - Improve							-646
plantations (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,773
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-9,732
cropland (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-19,153
pasture (1000 tCO2e/y)							
Carbon sink potential - High - Restore							-3,321
productivity (1000 tCO2e/y)							
Carbon sink potential - Low - Accelerate							-477
regeneration (1000 tCO2e/y)							
Carbon sink potential - Low - All (not							-11,380
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Low - Avoid							-281
deforestation (1000 tCO2e/y)							
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tCO2e/y)							
Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - Low - Reforest							-4,866
cropland (1000 tCO2e/y)							-
Carbon sink potential - Low - Reforest							-1,451
pasture (1000 tC02e/y)							, -
Carbon sink potential - Low - Restore							-1,120
productivity (1000 tCO2e/y)							.,.20
Carbon sink potential - Mid - Accelerate							-715
regeneration (1000 tCO2e/y)							. 10

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

Item Carbon sink potential - Mid - All (not	2020	2025	2030	2035	2040	2045	2050 -27,327
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Mid - Avoid deforestation (1000 tCO2e/y)							-984
Carbon sink potential - Mid - Extend rotation length (1000 tCO2e/y)							-3,213
Carbon sink potential - Mid - Improve plantations (1000 tCO2e/y)							-482
Carbon sink potential - Mid - Increase retention of HWP (1000 tCO2e/y)							-1,182
Carbon sink potential - Mid - Increase trees outside forests (1000 tC02e/y)							-930
Carbon sink potential - Mid - Reforest cropland (1000 tCO2e/y)							-7,299
Carbon sink potential - Mid - Reforest pasture (1000 tCO2e/y)							-10,302
Carbon sink potential - Mid - Restore productivity (1000 tC02e/y)							-2,221
Land impacted for carbon sink potential - High - Accelerate regeneration (1000 hectares)							156
Land impacted for carbon sink potential - High - Avoid deforestation (over 30 years) (1000 hectares)							228
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)							2,368
Land impacted for carbon sink potential - High - Improve plantations (1000 hectares)							238
Land impacted for carbon sink potential - High - Increase retention of HWP (1000 hectares)							0
Land impacted for carbon sink potential - High - Increase trees outside forests (1000 hectares)							131
Land impacted for carbon sink potential - High - Reforest cropland (1000 hectares)							643
Land impacted for carbon sink potential - High - Reforest pasture (1000 hectares)							544
Land impacted for carbon sink potential - High - Restore productivity (1000 hectares)							1,101
Land impacted for carbon sink potential - High - Total impacted (over 30 years) (1000 hectares)							5,409
Land impacted for carbon sink potential - Low - Accelerate regeneration (1000 hectares)							77.9
Land impacted for carbon sink potential - Low - Avoid deforestation (over 30 years) (1000 hectares)							214
Land impacted for carbon sink potential - Low - Extend rotation length (1000 hectares)							907
Land impacted for carbon sink potential - Low - Improve plantations (1000 hectares)							119
Land impacted for carbon sink potential - Low - Increase retention of HWP (1000 hectares)							0

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

Low - Increase trees outside forests [1000 hectares] Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares) Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) [1000 hectares] Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) [1000 hectares] Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) [1000 hectares] Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Item	2020	2025	2030	2035	2040	2045	2050
Compacted for carbon sink potential -	Land impacted for carbon sink potential -							68.9
Land impacted for carbon sink potential - Low - Reforest cropland (1000 hectares) Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Low - Increase trees outside forests							
Low - Reforest cropland (1000 hectares) Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	(1000 hectares)							
Land impacted for carbon sink potential - Low - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							322
Low - Reforest pasture (1000 hectares) Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Low - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential - Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							94.3
Low - Restore productivity (1000 hectares) Land impacted for carbon sink potential - 2,470 Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Low - Reforest pasture (1000 hectares)							
hectares) Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							666
Land impacted for carbon sink potential - Low - Total impacted (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Low - Restore productivity (1000							
Low - Total impacted (over 30 years) [1000 hectares] Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) [1000 hectares] Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	hectares)							
(1000 hectares) Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							2,470
Land impacted for carbon sink potential - Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Low - Total impacted (over 30 years)							
Mid - Accelerate regeneration (1000 hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	(1000 hectares)							
hectares) Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							117
Land impacted for carbon sink potential - Mid - Avoid deforestation (over 30 years) [1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Mid - Accelerate regeneration (1000							
Mid - Avoid deforestation (over 30 years) (1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	hectares)							
(1000 hectares) Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)								221
Land impacted for carbon sink potential - Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Mid - Avoid deforestation (over 30 years)							
Mid - Extend rotation length (1000 hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	(1000 hectares)							
hectares) Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	Land impacted for carbon sink potential -							1,637
Land impacted for carbon sink potential - Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)								
Mid - Improve plantations (1000 hectares) Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)	•							
Land impacted for carbon sink potential - Mid - Increase retention of HWP (1000 hectares)								179
Mid - Increase retention of HWP (1000 hectares)								
hectares)	Land impacted for carbon sink potential -							0
	Mid - Increase retention of HWP (1000							
Land impacted for earhon sink notential -	•							
•	Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000	Mid - Increase trees outside forests (1000							
hectares)	•							
								483
Mid - Reforest cropland (1000 hectares)								
								682
Mid - Reforest pasture (1000 hectares)								
								1,342
Mid - Restore productivity (1000	Mid - Restore productivity (1000							
hectares)								
Land impacted for carbon sink potential - 4,761	Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000	Mid - Total impacted (over 30 years) (1000							
hectares)	hectares)							

Table 24: E- scenario - IMPACTS - Health

2020	2025	2030	2035	2040	2045	2050
	266	0.237	0.229	0.184	0.119	0.002
	237	105	51.4	27	9.67	7.79
	685	696	682	619	496	343
	30	0.027	0.026	0.021	0.013	0
	26.7	11.9	5.81	3.05	1.09	0.88
	77	78.2	76.7	69.6	55.8	38.5
	2020	266 237 685 30 26.7	266 0.237 237 105 685 696 30 0.027 26.7 11.9	266 0.237 0.229 237 105 51.4 685 696 682 30 0.027 0.026 26.7 11.9 5.81	266 0.237 0.229 0.184 237 105 51.4 27 685 696 682 619 30 0.027 0.026 0.021 26.7 11.9 5.81 3.05	266 0.237 0.229 0.184 0.119 237 105 51.4 27 9.67 685 696 682 619 496 30 0.027 0.026 0.021 0.013 26.7 11.9 5.81 3.05 1.09

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

,,	.,					
2020	2025	2030	2035	2040	2045	2050
	14,173	16,554				
30.1	44.4	79.2	86.1	86.5	86.5	86.5
69.9	55.6	20.8	13.9	13.5	13.5	13.5
1.94	26.9	77	91.1	92.3	92.3	92.3
2	4.42	4.72	6.04	6.33	6.36	6.38
0	0	0	0	0	0	0
96.1	68.7	18.2	2.83	1.38	1.34	1.33
0.059	10.7	56.4	66.5	67	67	66.9
1.74	8.05	26.9	31.1	31.3	31.3	31.3
97.4	79.4	15	0.632	0	0	0
0.794	1.77	1.77	1.77	1.78	1.78	1.79
	69.9 1.94 2 0 96.1 0.059 1.74	14,173 30.1 44.4 69.9 55.6 1.94 26.9 2 4.42 0 0 96.1 68.7 0.059 10.7 1.74 8.05 97.4 79.4	14,173 16,554 30.1 44.4 79.2 69.9 55.6 20.8 1.94 26.9 77 2 4.42 4.72 0 0 0 96.1 68.7 18.2 0.059 10.7 56.4 1.74 8.05 26.9 97.4 79.4 15	14,173 16,554 30.1 44.4 79.2 86.1 69.9 55.6 20.8 13.9 1.94 26.9 77 91.1 2 4.42 4.72 6.04 0 0 0 0 96.1 68.7 18.2 2.83 0.059 10.7 56.4 66.5 1.74 8.05 26.9 31.1 97.4 79.4 15 0.632	30.1 44.4 79.2 86.1 86.5 69.9 55.6 20.8 13.9 13.5 1.94 26.9 77 91.1 92.3 2 4.42 4.72 6.04 6.33 0 0 0 0 0 96.1 68.7 18.2 2.83 1.38 0.059 10.7 56.4 66.5 67 1.74 8.05 26.9 31.1 31.3 97.4 79.4 15 0.632 0	30.1 44.4 79.2 86.1 86.5 86.5 69.9 55.6 20.8 13.9 13.5 13.5 1.94 26.9 77 91.1 92.3 92.3 2 4.42 4.72 6.04 6.33 6.36 0 0 0 0 0 96.1 68.7 18.2 2.83 1.38 1.34 0.059 10.7 56.4 66.5 67 67 1.74 8.05 26.9 31.1 31.3 31.3 97.4 79.4 15 0.632 0 0

Table 26: E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.97	3.05	4.83	5.11	4.99	5.22
Cumulative 5-yr (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	122	117	109	103	101	103
Final energy use - Industry (PJ)	310	318	324	323	325	323	330
Final energy use - Residential (PJ)	177	168	153	133	115	105	99.9
Final energy use - Transportation (PJ)	431	405	359	302	250	219	207

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.2	3.89				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	40.4	53.1	92	99.6	100	100	100
Resistance (%)							
Sales of cooking units - Gas (%)	59.6	46.9	8.02	0.404	0	0	0
Sales of space heating units - Electric	8.53	25.2	76.9	88.5	89	88.9	88.8
Heat Pump (%)							
Sales of space heating units - Electric	24.8	26.1	10.9	7.55	7.39	7.53	7.57
Resistance (%)							
Sales of space heating units - Fossil (%)	5.91	8.95	3.48	2.25	2.19	2.17	2.16
Sales of space heating units - Gas (%)	60.7	39.8	8.68	1.75	1.46	1.44	1.43
Sales of water heating units - Electric	0	11.6	61.7	72.9	73.4	73.4	73.4
Heat Pump (%)							
Sales of water heating units - Electric	30.5	39.9	28.2	25.5	25.4	25.4	25.4
Resistance (%)							
Sales of water heating units - Gas Furnace	68.2	47.2	8.93	0.373	0	0	0
(%)							
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.2	1.19	1.2	1.2

Table 29: E+RE+ scenario - PILLAR 1: Efficiency/Electrification - Transportation

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs -		710	1,819	2,948	4,465	4,860	4,634
Cumulative 5-yr (million \$2018)							
Public EV charging plugs - DC Fast (1000	0.326		1.4		6.16		9.97
units)							
Public EV charging plugs - L2 (1000 units)	0.301		33.8		148		240
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	44.5	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 (%)	4.02	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	0.196	1.27	6.33	15.2	19.1	19.9	20
FC (%)							
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

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

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Solar PV - Base (billion		0	0	0.381	4.53	11.1	7.93
\$2018)							
Capital invested - Wind - Base (billion		3.94	9.8	31.2	29.9	33.3	33.7
\$2018)							
Installed renewables - OffshoreWind -	0	0	0	0	0	0	0
Base land use assumptions (MW)							
Installed renewables - OffshoreWind -	0	0	0	0	0	0	0
Constrained land use assumptions (MW)							
Installed renewables - Solar - Base land	260	260	260	665	5,772	18,992	29,015
use assumptions (MW)							
Installed renewables - Solar -	520	7,090	26,391	39,463	68,280	125,547	158,037
Constrained land use assumptions (MW)							
Installed renewables - Wind - Base land	11,527	14,207	21,569	46,677	71,962	101,680	133,508
use assumptions (MW)							
Installed renewables - Wind - Constrained	23,055	28,566	42,074	82,082	121,892	169,561	199,486
land use assumptions (MW)							

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

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use	0	0	0	0	0	0	0
assumptions (GWh)							
OffshoreWind - Constrained land use	0	0	0	0	0	0	0
assumptions (GWh)							
Solar - Base land use assumptions (GWh)	551	551	551	1,289	10,675	34,995	53,523
Solar - Constrained land use assumptions	1,102	13,197	49,056	73,202	125,988	229,674	288,320
(GWh)							
Wind - Base land use assumptions (GWh)	48,113	58,260	85,647	176,825	266,347	369,711	477,993
Wind - Constrained land use assumptions	96,225	116,526	165,926	308,604	444,515	600,153	693,679
(GWh)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - Aggressive							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tC02e/y)							
Carbon sink potential - Aggressive							-4,525
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Aggressive							-262
deployment - Permanent conservation							
cover (1000 tC02e/y)							
Carbon sink potential - Aggressive							-4,806
deployment - Total (1000 tC02e/y)							
Carbon sink potential - Moderate							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tC02e/y)							
Carbon sink potential - Moderate							-2,381
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Moderate							-131
deployment - Permanent conservation							
cover (1000 tCO2e/y)							
Carbon sink potential - Moderate							-2,530
deployment - Total (1000 tCO2e/y)							
Land impacted for carbon sink -							11.7
Aggressive deployment - Corn-ethanol to							
energy grasses (1000 hectares)							
Land impacted for carbon sink -							4,283
Aggressive deployment - Cropland							
measures (1000 hectares)							
Land impacted for carbon sink -							450
Aggressive deployment - Permanent							
conservation cover (1000 hectares)							
Land impacted for carbon sink -							4,745
Aggressive deployment - Total (1000							
hectares)							
Land impacted for carbon sink - Moderate							11.7
deployment - Corn-ethanol to energy							
grasses (1000 hectares)							
Land impacted for carbon sink - Moderate							2,254
deployment - Cropland measures (1000							
hectares)							
Land impacted for carbon sink - Moderate							225
deployment - Permanent conservation							
cover (1000 hectares)							
Land impacted for carbon sink - Moderate							2,491
deployment - Total (1000 hectares)							

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

2020	2025	2030	2035	2040	2045	2050
						-952
						-43,286
						-1,687
						-4,643
						-646
						-1,773
	2020	2020 2025	2020 2025 2030	2020 2025 2030 2035	2020 2025 2030 2035 2040	2020 2025 2030 2035 2040 2045

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest cropland (1000 tCO2e/y)							-9,732
Carbon sink potential - High - Reforest pasture (1000 tCO2e/y)							-19,153
Carbon sink potential - High - Restore productivity (1000 tCO2e/y)							-3,321
Carbon sink potential - Low - Accelerate regeneration (1000 tC02e/y)							-477
Carbon sink potential - Low - All (not counting overlap) (1000 tC02e/y)							-11,380
Carbon sink potential - Low - Avoid deforestation (1000 tCO2e/y)							-281
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tC02e/y) Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y) Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tCO2e/y) Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tC02e/y) Carbon sink potential - Low - Reforest							-4,866
cropland (1000 tCO2e/y) Carbon sink potential - Low - Reforest							-1,451
pasture (1000 tCO2e/y) Carbon sink potential - Low - Restore							-1,120
productivity (1000 tCO2e/y) Carbon sink potential - Mid - Accelerate							-715
regeneration (1000 tC02e/y) Carbon sink potential - Mid - All (not							-27,327
counting overlap) (1000 tCO2e/y) Carbon sink potential - Mid - Avoid							-984
deforestation (1000 tCO2e/y) Carbon sink potential - Mid - Extend							-3,213
rotation length (1000 tCO2e/y) Carbon sink potential - Mid - Improve							-482
plantations (1000 tCO2e/y) Carbon sink potential - Mid - Increase							-1,182
retention of HWP (1000 tC02e/y) Carbon sink potential - Mid - Increase							-930
trees outside forests (1000 tC02e/y) Carbon sink potential - Mid - Reforest							-7,299
cropland (1000 tCO2e/y) Carbon sink potential - Mid - Reforest							-10,302
pasture (1000 tCO2e/y) Carbon sink potential - Mid - Restore							-2,221
productivity (1000 tCO2e/y) Land impacted for carbon sink potential -							156
High - Accelerate regeneration (1000 hectares)							
Land impacted for carbon sink potential -							228
High - Avoid deforestation (over 30 years) [1000 hectares]							
Land impacted for carbon sink potential - High - Extend rotation length (1000 hectares)							2,368
Land impacted for carbon sink potential - High - Improve plantations (1000							238
hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential - High - Increase retention of HWP (1000							0
hectares)							
Land impacted for carbon sink potential -							131
High - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							643
High - Reforest cropland (1000 hectares) Land impacted for carbon sink potential -							544
High - Reforest pasture (1000 hectares)							544
Land impacted for carbon sink potential -							1,101
High - Restore productivity (1000							1,101
hectares)							
Land impacted for carbon sink potential -							5,409
High - Total impacted (over 30 years)							•
(1000 hectares)							
Land impacted for carbon sink potential -							77.9
Low - Accelerate regeneration (1000							
hectares)							
Land impacted for carbon sink potential -							214
Low - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							907
Low - Extend rotation length (1000							
hectares)							110
Land impacted for carbon sink potential - Low - Improve plantations (1000							119
hectares)							
Land impacted for carbon sink potential -							0
Low - Increase retention of HWP (1000							J
hectares)							
Land impacted for carbon sink potential -							68.9
Low - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							322
Low - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							94.3
Low - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							666
Low - Restore productivity (1000							
hectares)							0.770
Land impacted for carbon sink potential -							2,470
Low - Total impacted (over 30 years) (1000 hectares)							
Land impacted for carbon sink potential -							117
Mid - Accelerate regeneration (1000							1117
hectares)							
Land impacted for carbon sink potential -							221
Mid - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							1,637
Mid - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							179
Mid - Improve plantations (1000 hectares)							
Land impacted for carbon sink potential -							0
Mid - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000							
hectares)							

Table 33: E+RE+	. cronaria -	DTII AD A.	I and cinke -	Forests	(continued)
14018 33. E+KE+	· SCEHUITO -	PILLAR O.	LUIIU SIIIKS -	FULESTS	COMUNICEUR

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							483
Mid - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							682
Mid - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,342
Mid - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000							
hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution -		266	0.237	0.229	0.184	0.119	0.002
Coal (million 2019\$)							
Monetary damages from air pollution -		225	120	35.1	23.8	10.3	6.76
Natural Gas (million 2019\$)							
Monetary damages from air pollution -		674	634	485	281	129	50.9
Transportation (million 2019\$)							
Premature deaths from air pollution -		30	0.027	0.026	0.021	0.013	0
Coal (deaths)							
Premature deaths from air pollution -		25.4	13.6	3.96	2.69	1.16	0.763
Natural Gas (deaths)							
Premature deaths from air pollution -		75.8	71.3	54.5	31.6	14.5	5.72
Transportation (deaths)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s -		14,173	16,554				
Cumulative 5-yr (million \$2018)							
Sales of cooking units - Electric	30.1	44.4	79.2	86.1	86.5	86.5	86.5
Resistance (%)							
Sales of cooking units - Gas (%)	69.9	55.6	20.8	13.9	13.5	13.5	13.5
Sales of space heating units - Electric	1.94	26.9	77	91.1	92.3	92.3	92.3
Heat Pump (%)							
Sales of space heating units - Electric	2	4.42	4.72	6.04	6.33	6.36	6.38
Resistance (%)							
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	96.1	68.7	18.2	2.83	1.38	1.34	1.33
(%)							
Sales of water heating units - Electric	0.059	10.7	56.4	66.5	67	67	66.9
Heat Pump (%)							
Sales of water heating units - Electric	1.74	8.05	26.9	31.1	31.3	31.3	31.3
Resistance (%)							
Sales of water heating units - Gas Furnace	97.4	79.4	15	0.632	0	0	0
(%)							
Sales of water heating units - Other (%)	0.794	1.77	1.77	1.77	1.78	1.78	1.79

Table 36: E+RE- scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.97	3.05	4.83	5.11	4.99	5.22
Cumulative 5-yr (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	122	117	109	103	101	103

Table 37: E+RE- scenario - PILLAR 1: Efficiency/Electrification - Overview (continued)

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Industry (PJ)	310	318	324	323	325	323	330
Final energy use - Residential (PJ)	177	168	153	133	115	105	99.9
Final energy use - Transportation (PJ)	431	405	359	302	250	219	207

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.2	3.89				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	40.4	53.1	92	99.6	100	100	100
Resistance (%)							
Sales of cooking units - Gas (%)	59.6	46.9	8.02	0.404	0	0	0
Sales of space heating units - Electric	8.53	25.2	76.9	88.5	89	88.9	88.8
Heat Pump (%)							
Sales of space heating units - Electric	24.8	26.1	10.9	7.55	7.39	7.53	7.57
Resistance (%)							
Sales of space heating units - Fossil (%)	5.91	8.95	3.48	2.25	2.19	2.17	2.16
Sales of space heating units - Gas (%)	60.7	39.8	8.68	1.75	1.46	1.44	1.43
Sales of water heating units - Electric	0	11.6	61.7	72.9	73.4	73.4	73.4
Heat Pump (%)							
Sales of water heating units - Electric	30.5	39.9	28.2	25.5	25.4	25.4	25.4
Resistance (%)							
Sales of water heating units - Gas Furnace	68.2	47.2	8.93	0.373	0	0	0
(%)							
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.2	1.19	1.2	1.2

Table 39: E+RE- scenario - PILLAR 1: Efficiency/Electrification - Transportation

Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs -		710	1,819	2,948	4,465	4,860	4,634
Cumulative 5-yr (million \$2018)							
Public EV charging plugs - DC Fast (1000	0.326		1.4		6.16		9.97
units)							
Public EV charging plugs - L2 (1000 units)	0.301		33.8		148		240
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	44.5	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 (%)	4.02	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	0.196	1.27	6.33	15.2	19.1	19.9	20
FC (%)							
Vehicle sales - Medium-duty - other (%)	0.253	0.255	0.205	0.083	0.019	0.004	0

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

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Solar PV - Base (billion \$2018)		0	0	0	0.659	2.65	1.08
Capital invested - Solar PV - Constrained (billion \$2018)		4.95	7.13	4.83	5.6	7.78	5.84
Capital invested - Wind - Base (billion \$2018)		0	0	7.96	10.5	4.98	0
Capital invested - Wind - Constrained (billion \$2018)		0	0.453	7.19	8.53	3.71	0.089
Installed renewables - OffshoreWind - Base land use assumptions (MW)	0	0	0	0	0	0	0
Installed renewables - OffshoreWind - Constrained land use assumptions (MW)	0	0	0	0	0	0	0
Installed renewables - Solar - Base land use assumptions (MW)	260	260	260	260	1,003	4,164	5,530
Installed renewables - Solar - Constrained land use assumptions (MW)	260	4,592	11,567	16,697	23,008	32,290	39,670
Installed renewables - Wind - Base land use assumptions (MW)	11,527	11,527	11,527	17,941	26,841	31,280	31,280
Installed renewables - Wind - Constrained land use assumptions (MW)	11,527	11,527	11,868	17,664	24,882	28,195	28,278

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

Item	2020	2025	2030	2035	2040	2045	2050
OffshoreWind - Base land use	0	0	0	0	0	0	0
assumptions (GWh)							
OffshoreWind - Constrained land use	0	0	0	0	0	0	0
assumptions (GWh)							
Solar - Base land use assumptions (GWh)	551	551	551	551	1,884	7,748	10,295
Solar - Constrained land use assumptions	551	8,560	21,637	31,206	42,932	59,833	73,465
(GWh)							
Wind - Base land use assumptions (GWh)	48,113	48,113	48,113	72,219	105,046	121,255	121,255
Wind - Constrained land use assumptions	48,113	48,113	49,220	70,691	96,785	108,692	108,979
(GWh)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - Aggressive							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tCO2e/y)							
Carbon sink potential - Aggressive							-4,525
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Aggressive							-262
deployment - Permanent conservation							
cover (1000 tCO2e/y)							
Carbon sink potential - Aggressive							-4,806
deployment - Total (1000 tCO2e/y)							
Carbon sink potential - Moderate							-18.2
deployment - Corn-ethanol to energy							
grasses (1000 tCO2e/y)							
Carbon sink potential - Moderate							-2,381
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Moderate							-131
deployment - Permanent conservation							
cover (1000 tCO2e/y)							
Carbon sink potential - Moderate							-2,530
deployment - Total (1000 tCO2e/y)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink -							11.7
Aggressive deployment - Corn-ethanol to							
energy grasses (1000 hectares)							
Land impacted for carbon sink -							4,283
Aggressive deployment - Cropland							
measures (1000 hectares)							
Land impacted for carbon sink -							450
Aggressive deployment - Permanent							
conservation cover (1000 hectares)							
Land impacted for carbon sink -							4,745
Aggressive deployment - Total (1000							
hectares)							
Land impacted for carbon sink - Moderate							11.7
deployment - Corn-ethanol to energy							
grasses (1000 hectares)							
Land impacted for carbon sink - Moderate							2,254
deployment - Cropland measures (1000							
hectares)							
Land impacted for carbon sink - Moderate							225
deployment - Permanent conservation							
cover (1000 hectares)							
Land impacted for carbon sink - Moderate							2,491
deployment - Total (1000 hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - High - Accelerate							-952
regeneration (1000 tCO2e/y)							
Carbon sink potential - High - All (not							-43,286
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - High - Avoid							-1,687
deforestation (1000 tCO2e/y)							
Carbon sink potential - High - Extend							-4,643
rotation length (1000 tCO2e/y)							
Carbon sink potential - High - Improve							-646
plantations (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,773
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-9,732
cropland (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-19,153
pasture (1000 tCO2e/y)							
Carbon sink potential - High - Restore							-3,321
productivity (1000 tCO2e/y)							
Carbon sink potential - Low - Accelerate							-477
regeneration (1000 tCO2e/y)							
Carbon sink potential - Low - All (not							-11,380
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Low - Avoid							-281
deforestation (1000 tCO2e/y)							
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tCO2e/y)							
Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tCO2e/y)							

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

Item	2020	2025	2030	2035	2040	2045	205
Carbon sink potential - Low - Reforest							-4,86
cropland (1000 tCO2e/y)							
Carbon sink potential - Low - Reforest							-1,45
pasture (1000 tC02e/y)							
Carbon sink potential - Low - Restore							-1,12
productivity (1000 tCO2e/y)							
Carbon sink potential - Mid - Accelerate							-71
regeneration (1000 tCO2e/y)							
Carbon sink potential - Mid - All (not							-27,32
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Mid - Avoid							-98
deforestation (1000 tCO2e/y)							
Carbon sink potential - Mid - Extend							-3,21
rotation length (1000 tCO2e/y)							
Carbon sink potential - Mid - Improve							-48
plantations (1000 tCO2e/y)							
Carbon sink potential - Mid - Increase							-1,18
retention of HWP (1000 tCO2e/y)							•
Carbon sink potential - Mid - Increase							-93
rees outside forests (1000 tC02e/y)							
Carbon sink potential - Mid - Reforest							-7,29
cropland (1000 tCO2e/y)							1,2,
Carbon sink potential - Mid - Reforest						+	-10,30
pasture (1000 tC02e/y)							-10,50
Carbon sink potential - Mid - Restore							-2,2
productivity (1000 tCO2e/y)							-2,2
Land impacted for carbon sink potential -							15
							15
High - Accelerate regeneration (1000							
hectares)							0.0
Land impacted for carbon sink potential -							22
High - Avoid deforestation (over 30 years)							
(1000 hectares)							0.04
Land impacted for carbon sink potential -							2,36
High - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							23
High - Improve plantations (1000							
hectares)							
Land impacted for carbon sink potential -							
High - Increase retention of HWP (1000							
nectares)							
Land impacted for carbon sink potential -							1
High - Increase trees outside forests							
1000 hectares)							
and impacted for carbon sink potential -							64
ligh - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -						+	54
High - Reforest pasture (1000 hectares)							
and impacted for carbon sink potential -							1,1
High - Restore productivity (1000							','
nectares)							
and impacted for carbon sink potential -				+			5,40
							5,40
High - Total impacted (over 30 years)							
1000 hectares)							
and impacted for carbon sink potential -							7
ow - Accelerate regeneration (1000							
nectares)							
and impacted for carbon sink potential -							2
.ow - Avoid deforestation (over 30 years)							
1000 hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							907
Low - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							119
Low - Improve plantations (1000							
hectares)							
Land impacted for carbon sink potential -							0
Low - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							68.9
Low - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							322
Low - Reforest cropland (1000 hectares)							022
Land impacted for carbon sink potential -							94.3
Low - Reforest pasture (1000 hectares)							74.0
Land impacted for carbon sink potential -							666
Low - Restore productivity (1000							000
hectares)							
							0 /70
Land impacted for carbon sink potential -							2,470
Low - Total impacted (over 30 years)							
(1000 hectares)							44-
Land impacted for carbon sink potential -							117
Mid - Accelerate regeneration (1000							
hectares)							
Land impacted for carbon sink potential -							221
Mid - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							1,637
Mid - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							179
Mid - Improve plantations (1000 hectares)							
Land impacted for carbon sink potential -							0
Mid - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000							
hectares)							
Land impacted for carbon sink potential -							483
Mid - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							682
Mid - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,342
Mid - Restore productivity (1000							,
hectares)							
Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000							7,101
hectares)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution -		266	0.237	0.229	0.184	0.119	0.002
Coal (million 2019\$)							
Monetary damages from air pollution -		251	114	114	78.9	32.4	14.4
Natural Gas (million 2019\$)							
Monetary damages from air pollution -		674	634	485	281	129	50.9
Transportation (million 2019\$)							
Premature deaths from air pollution -		30	0.027	0.026	0.021	0.013	0
Coal (deaths)							

Table 44: E+RE- scenario - IMPACTS - Health (continued)

Item	2020	2025	2030	2035	2040	2045	2050
Premature deaths from air pollution -		28.4	12.9	12.8	8.91	3.66	1.62
Natural Gas (deaths)							
Premature deaths from air pollution -		75.8	71.3	54.5	31.6	14.5	5.72
Transportation (deaths)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s -		14,157	16,435				
Cumulative 5-yr (million \$2018)							
Sales of cooking units - Electric	30.1	34.2	39	52	70.1	81.2	85
Resistance (%)							
Sales of cooking units - Gas (%)	69.9	65.8	61	48	29.9	18.8	15
Sales of space heating units - Electric	1.94	17.4	23.1	39.7	65.5	83.2	89.8
Heat Pump (%)							
Sales of space heating units - Electric	2	4.42	4.46	4.63	5.06	5.73	6.18
Resistance (%)							
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	96.1	78.2	72.4	55.7	29.4	11	3.98
(%)							
Sales of water heating units - Electric	0.059	1.96	7.15	22.1	45	59.9	65.1
Heat Pump (%)							
Sales of water heating units - Electric	1.74	4.42	6.55	12.7	22.2	28.4	30.5
Resistance (%)							
Sales of water heating units - Gas Furnace	97.4	91.9	84.5	63.4	31	9.91	2.58
(%)							
Sales of water heating units - Other (%)	0.794	1.77	1.77	1.77	1.78	1.78	1.79

Table 46: E-B+ scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.54	2.56	3.09	3.17	4.7	4.96
Cumulative 5-yr (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	122	121	120	117	113	111
Final energy use - Industry (PJ)	310	319	325	326	330	327	334
Final energy use - Residential (PJ)	177	169	164	158	146	131	118
Final energy use - Transportation (PJ)	431	408	374	347	327	302	274

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

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.16	3.73				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	40.2	41.8	47.2	61.7	81.7	94.1	98.4
Resistance (%)							
Sales of cooking units - Gas (%)	59.8	58.2	52.8	38.3	18.3	5.9	1.59
Sales of space heating units - Electric	8.53	15.3	21.1	38.1	64.1	81	86.8
Heat Pump (%)							
Sales of space heating units - Electric	24.8	29	27.1	22.1	14.5	9.75	8.07
Resistance (%)							
Sales of space heating units - Fossil (%)	5.91	10	9.47	7.6	4.79	3.01	2.4
Sales of space heating units - Gas (%)	60.7	45.8	42.3	32.2	16.6	6.26	2.7
Sales of water heating units - Electric	0	2	7.69	24.1	49.2	65.6	71.4
Heat Pump (%)							
Sales of water heating units - Electric	30.5	42.2	40.8	37	31.1	27.3	25.9
Resistance (%)							

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

	-	•	•	-			
Item	2020	2025	2030	2035	2040	2045	2050
Sales of water heating units - Gas Furnace (%)	68.2	54.6	50.3	37.7	18.4	5.87	1.53
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.21	1.21	1.21	1.2

Table 49: E-B+ scenario - PILLAR 1: Efficiency/Electrification - Transportation

•••	, .		•				
Item	2020	2025	2030	2035	2040	2045	2050
Light-duty vehicle capital costs -		0	115	241	815	2,564	3,735
Cumulative 5-yr (million \$2018)							
Public EV charging plugs - DC Fast (1000	0.326		0.434		2.29		6.38
units)							
Public EV charging plugs - L2 (1000 units)	0.301		10.4		55		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 (%)	1.68	2.07	2.08	1.66	1.07	0.553	0.236
Vehicle sales - Light-duty - EV (%)	1.74	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 (%)	4.16	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	0.166	0.485	1.37	3.58	7.86	13.2	17
FC (%)							
Vehicle sales - Medium-duty - other (%)	0.253	0.266	0.279	0.286	0.258	0.184	0.102

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

Item	2020	2025	2030	2035	2040	2045	2050
Capital invested - Biomass power plant	0	0	0	0	0	0	0
(billion \$2018)							
Capital invested - Biomass w/ccu allam	0	0	0	0.034	0	0	0
power plant (billion \$2018)							
Capital invested - Biomass w/ccu power	0	0	2.6	1.6	12.5	21.2	5.44
plant (billion \$2018)							

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass power plant (GWh)	0	0	0	0	0	0	0
Biomass w/ccu allam power plant (GWh)	0	0	0	34.2	34.2	34.2	34.2
Biomass w/ccu power plant (GWh)	0	0	2,913	4,709	18,789	42,612	48,723

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

Item	2020	2025	2030	2035	2040	2045	2050
Biomass purchases (million \$2018/year)		0	188	2,532	4,349	6,838	7,232
Conversion capital investment -		0	2,381	25,955	21,506	29,942	4,994
Cumulative 5-yr (million \$2018)							
Number of facilities - Allam power w ccu	0	0	0	1	1	1	1
(quantity)							

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Table 52: E-B+ scenario -	PILLAR 3: Clean fuels -	Bioeneray Icontinued I

Item	2020	2025	2030	2035	2040	2045	2050
Number of facilities - Beccs hydrogen	0	0	0	27	39	51	51
(quantity)							
Number of facilities - Diesel (quantity)	0	0	0	0	0	0	0
Number of facilities - Diesel ccu (quantity)	0	0	0	1	1	1	1
Number of facilities - Power (quantity)	0	0	0	0	0	0	0
Number of facilities - Power ccu	0	0	2	3	14	34	39
(quantity)							
Number of facilities - Pyrolysis (quantity)	0	0	0	0	0	0	0
Number of facilities - Pyrolysis ccu	0	0	0	1	2	2	2
(quantity)							
Number of facilities - Sng (quantity)	0	0	0	0	0	0	0
Number of facilities - Sng ccu (quantity)	0	0	1	1	1	1	1

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

Item	2020	2025	2030	2035	2040	2045	2050
Annual - All (MMT)		0	2.89	42.8	69.5	107	113
Annual - BECCS (MMT)		0	2.89	36.1	62.8	99.9	106
Annual - Cement and lime (MMT)		0	0	6.71	6.64	6.84	7.07
Annual - NGCC (MMT)		0	0	0	0	0	0
Cumulative - All (MMT)		0	2.89	45.7	115	222	335
Cumulative - BECCS (MMT)		0	2.89	39	102	202	307
Cumulative - Cement and lime (MMT)		0	0	6.71	13.3	20.2	27.3
Cumulative - NGCC (MMT)		0	0	0	0	0	0

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

Item	2020	2025	2030	2035	2040	2045	2050
All (km)		0	865	2,722	4,312	5,904	6,156
Cumulative investment - All (million \$2018)		0	4,390	8,116	11,940	14,166	14,563
Cumulative investment - Spur (million \$2018)		0	69.1	1,512	2,637	4,863	5,259
Cumulative investment - Trunk (million \$2018)		0	4,321	6,605	9,304	9,304	9,304
Spur (km)		0	90.7	1,586	2,740	4,332	4,584
Trunk (km)		0	774	1,136	1,572	1,572	1,572

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

Item	2020	2025	2030	2035	2040	2045	2050
CO2 storage (MMT)		0	0.92	4.28	9.51	12.8	13.4
Injection wells (wells)		0	2	9	16	26	33
Resource characterization, appraisal, permitting costs (million \$2020)		103	294	380	380	380	380
Wells and facilities construction costs (million \$2020)		0	70.4	274	489	817	1,014

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

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - Aggressive							-560
deployment - Corn-ethanol to energy							
grasses (1000 tCO2e/y)							
Carbon sink potential - Aggressive							-4,205
deployment - Cropland measures (1000							
tCO2e/y)							
Carbon sink potential - Aggressive							0
deployment - Cropland to woody energy							
crops (1000 tCO2e/y)							

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

Item Carbon sink potential - Aggressive	2020	2025	2030	2035	2040	2045	2050 0
deployment - Pasture to energy crops							U
(1000 tC02e/y) Carbon sink potential - Aggressive							-231
deployment - Permanent conservation cover (1000 tC02e/y)							-231
Carbon sink potential - Aggressive deployment - Total (1000 tCO2e/y)							-4,996
Carbon sink potential - Moderate deployment - Corn-ethanol to energy							-560
grasses (1000 tCO2e/y)							
Carbon sink potential - Moderate deployment - Cropland measures (1000 tCO2e/y)							-2,212
Carbon sink potential - Moderate deployment - Cropland to woody energy crops (1000 tC02e/y)							0
Carbon sink potential - Moderate deployment - Pasture to energy crops (1000 tCO2e/y)							0
Carbon sink potential - Moderate deployment - Permanent conservation cover (1000 tCO2e/y)							-116
Carbon sink potential - Moderate deployment - Total (1000 tCO2e/y)							-2,887
Land impacted for carbon sink - Aggressive deployment - Corn-ethanol to energy grasses (1000 hectares)							496
Land impacted for carbon sink - Aggressive deployment - Cropland measures (1000 hectares)							9,423
Land impacted for carbon sink - Aggressive deployment - Cropland to woody energy crops (1000 hectares)							183
Land impacted for carbon sink - Aggressive deployment - Pasture to energy crops (1000 hectares)							2,300
Land impacted for carbon sink - Aggressive deployment - Permanent conservation cover (1000 hectares)							399
Land impacted for carbon sink - Aggressive deployment - Total (1000 hectares)							12,800
Land impacted for carbon sink - Moderate deployment - Corn-ethanol to energy grasses (1000 hectares)							496
Land impacted for carbon sink - Moderate deployment - Cropland measures (1000 hectares)							2,008
Land impacted for carbon sink - Moderate deployment - Cropland to woody energy crops (1000 hectares)							183
Land impacted for carbon sink - Moderate deployment - Pasture to energy crops (1000 hectares)							2,300
Land impacted for carbon sink - Moderate deployment - Permanent conservation cover (1000 hectares)							199
Land impacted for carbon sink - Moderate deployment - Total (1000 hectares)							5,186

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

Iable 57: E-B+ scenario - PILLAR 6: Land 8 Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - High - Accelerate	2020	2025	2030	2035	2040	2045	-952
regeneration (1000 tCO2e/y)							-702
Carbon sink potential - High - All (not							-43,286
							-43,286
counting overlap) (1000 tC02e/y)							1 / 07
Carbon sink potential - High - Avoid							-1,687
deforestation (1000 tCO2e/y)							
Carbon sink potential - High - Extend							-4,643
rotation length (1000 tCO2e/y)							
Carbon sink potential - High - Improve							-646
plantations (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,773
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-9,732
cropland (1000 tCO2e/y)							•
Carbon sink potential - High - Reforest				+			-19,153
pasture (1000 tCO2e/y)							,
Carbon sink potential - High - Restore							-3,321
productivity (1000 tCO2e/y)							0,021
Carbon sink potential - Low - Accelerate							-477
							-411
regeneration (1000 tCO2e/y)							11 000
Carbon sink potential - Low - All (not							-11,380
counting overlap) (1000 tC02e/y)							
Carbon sink potential - Low - Avoid							-281
deforestation (1000 tCO2e/y)							
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tCO2e/y)							
Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - Low - Reforest							-4,866
cropland (1000 tCO2e/y)							4,000
Carbon sink potential - Low - Reforest				+			-1,451
pasture (1000 tC02e/y)							-1,431
Carbon sink potential - Low - Restore							-1,120
•							-1,120
productivity (1000 tC02e/y)							745
Carbon sink potential - Mid - Accelerate							-715
regeneration (1000 tCO2e/y)							
Carbon sink potential - Mid - All (not							-27,327
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Mid - Avoid							-984
deforestation (1000 tCO2e/y)							
Carbon sink potential - Mid - Extend							-3,213
rotation length (1000 tCO2e/y)							
Carbon sink potential - Mid - Improve							-482
plantations (1000 tCO2e/y)							
Carbon sink potential - Mid - Increase			+				-1,182
retention of HWP (1000 tCO2e/y)							1,102
Carbon sink potential - Mid - Increase		+		+			-930
							-730
trees outside forests (1000 tC02e/y)							7,000
Carbon sink potential - Mid - Reforest							-7,299
cropland (1000 tCO2e/y)							40.000
Carbon sink potential - Mid - Reforest							-10,302
pasture (1000 tCO2e/y)							
Carbon sink potential - Mid - Restore	T	Т		T		T	-2,221
productivity (1000 tCO2e/y)							
	l .		-		1		

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

2020	2025	2030	2035	2040	2045	2050
						156
						228
						0.070
						2,368
						238
						230
						0
						U
						131
						131
						643
						043
						544
						544
						1,101
						1,101
						5,409
						5,409
						77.9
						11.9
						214
						214
						907
						907
						119
						117
						0
						U
						68.9
						00.7
						322
						522
						94.3
						74.0
						666
ļ						000
						2,470
						۷,410
					+	117
						111
	1	1	l l	ı		
	2020	2020 2025	2020 2025 2030	2020 2025 2030 2035	2020 2025 2030 2035 2040	2020 2025 2030 2035 2040 2045

<u>Table 57: E-B+ scenario - PILLAR 6: Land sinks - Forests (continued)</u>

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							221
Mid - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							1,637
Mid - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							179
Mid - Improve plantations (1000 hectares)							
Land impacted for carbon sink potential -							0
Mid - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000							
hectares)							
Land impacted for carbon sink potential -							483
Mid - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							682
Mid - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,342
Mid - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000							
hectares)							

Table 58: E-B+ scenario - IMPACTS - Health

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution -		266	0.237	0.229	0.184	0.119	0.002
Coal (million 2019\$)							
Monetary damages from air pollution -		229	98.6	66.6	42.2	17.9	9.91
Natural Gas (million 2019\$)							
Monetary damages from air pollution -		685	696	682	619	496	343
Transportation (million 2019\$)							
Premature deaths from air pollution -		30	0.027	0.026	0.021	0.013	0
Coal (deaths)							
Premature deaths from air pollution -		25.8	11.1	7.52	4.76	2.02	1.12
Natural Gas (deaths)							
Premature deaths from air pollution -		77	78.2	76.7	69.6	55.8	38.5
Transportation (deaths)							

Table 59: REF scenario - PILLAR 1: Efficiency/Electrification - Commercial

Item	2020	2025	2030	2035	2040	2045	2050
Commercial HVAC investment in 2020s -		13,857	14,543				
Cumulative 5-yr (million \$2018)							
Sales of cooking units - Electric	30.1	32.3	32.3	32.3	32.3	32.3	32.3
Resistance (%)							
Sales of cooking units - Gas (%)	69.9	67.7	67.7	67.7	67.7	67.7	67.7
Sales of space heating units - Electric	1.94	29.6	70.8	79.1	79.5	79.5	79.5
Heat Pump (%)							
Sales of space heating units - Electric	2	6.3	12.1	15.9	18.7	19.1	19.2
Resistance (%)							
Sales of space heating units - Fossil (%)	0	0	0	0	0	0	0
Sales of space heating units - Gas Furnace	96.1	64.1	17.1	5.05	1.83	1.38	1.33
(%)							
Sales of water heating units - Electric	0.059	0.129	0.128	0.129	0.129	0.127	0.127
Heat Pump (%)							
Sales of water heating units - Electric	1.74	3.67	3.65	3.65	3.67	3.67	3.68
Resistance (%)							

Table 59: REF scenario - PILLAR 1: Efficiency/Electrification - Commercial (continued)

•••			•	•			
Item	2020	2025	2030	2035	2040	2045	2050
Sales of water heating units - Gas Furnace (%)	97.4	94.4	94.5	94.5	94.4	94.4	94.4
Sales of water heating units - Other (%)	0.794	1.77	1.77	1.77	1.78	1.78	1.79

Table 60: REF scenario - PILLAR 1: Efficiency/Electrification - Electricity demand

Item	2020	2025	2030	2035	2040	2045	2050
Electricity distribution capital invested -		2.84	2.89	4.38	4.61	4.42	4.6
Cumulative 5-yr (billion \$2018)							

Table 61: REF scenario - PILLAR 1: Efficiency/Electrification - Overview

Item	2020	2025	2030	2035	2040	2045	2050
Final energy use - Commercial (PJ)	121	123	124	125	127	132	141
Final energy use - Industry (PJ)	310	325	335	340	350	358	369
Final energy use - Residential (PJ)	177	167	164	162	163	166	169
Final energy use - Transportation (PJ)	431	408	377	358	359	370	385

Table 62: REF scenario - PILLAR 1: Efficiency/Electrification - Residential

Item	2020	2025	2030	2035	2040	2045	2050
Residential HVAC investment in 2020s vs.		3.09	3.21				
REF - Cumulative 5-yr (billion \$2018)							
Sales of cooking units - Electric	39.7	39.7	39.7	39.7	39.7	39.7	39.7
Resistance (%)							
Sales of cooking units - Gas (%)	60.3	60.3	60.3	60.3	60.3	60.3	60.3
Sales of space heating units - Electric	5.79	35.1	36.6	38.9	40.5	42.1	44.4
Heat Pump (%)							
Sales of space heating units - Electric	25.8	23.1	22.7	22.1	21.2	19.8	17.5
Resistance (%)							
Sales of space heating units - Fossil (%)	6.03	6.01	6.08	6.04	5.95	5.95	5.96
Sales of space heating units - Gas (%)	62.3	35.7	34.6	33	32.4	32.1	32.2
Sales of water heating units - Electric	0	0	0	0	0	0	0
Heat Pump (%)							
Sales of water heating units - Electric	30.5	42.6	42.5	42.6	42.5	42.5	42.4
Resistance (%)							
Sales of water heating units - Gas Furnace	68.2	56.1	56.2	56.2	56.3	56.3	56.4
(%)							
Sales of water heating units - Other (%)	1.38	1.21	1.22	1.22	1.22	1.22	1.22

Table 63: 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	78.3
Vehicle sales - Light-duty - hybrid (%)	4.04	4.91	6.02	6.6	7.2	7.83	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

Table 63: REF scenario - PILLAR 1: Efficiency/Electrification - Transportation (continued)

Item	2020	2025	2030	2035	2040	2045	2050
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 64: REF scenario - PILLAR 6: Land sinks - Forests

Thom	2020		2020	2025	2040	207.5	2050
Item Carbon sink potential - High - Accelerate	2020	2025	2030	2035	2040	2045	-952
							-902
regeneration (1000 tC02e/y)							/ 0 00/
Carbon sink potential - High - All (not							-43,286
counting overlap) (1000 tC02e/y)							1 / 07
Carbon sink potential - High - Avoid							-1,687
deforestation (1000 tC02e/y)							
Carbon sink potential - High - Extend							-4,643
rotation length (1000 tC02e/y)							
Carbon sink potential - High - Improve							-646
plantations (1000 tCO2e/y)							4 770
Carbon sink potential - High - Increase							-1,773
retention of HWP (1000 tCO2e/y)							4.070
Carbon sink potential - High - Increase							-1,378
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-9,732
cropland (1000 tCO2e/y)							
Carbon sink potential - High - Reforest							-19,153
pasture (1000 tCO2e/y)							
Carbon sink potential - High - Restore							-3,321
productivity (1000 tCO2e/y)							
Carbon sink potential - Low - Accelerate							-477
regeneration (1000 tCO2e/y)							
Carbon sink potential - Low - All (not							-11,380
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Low - Avoid							-281
deforestation (1000 tCO2e/y)							
Carbon sink potential - Low - Extend							-1,783
rotation length (1000 tCO2e/y)							
Carbon sink potential - Low - Improve							-329
plantations (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-591
retention of HWP (1000 tCO2e/y)							
Carbon sink potential - Low - Increase							-482
trees outside forests (1000 tCO2e/y)							
Carbon sink potential - Low - Reforest							-4,866
cropland (1000 tCO2e/y)							
Carbon sink potential - Low - Reforest							-1,451
pasture (1000 tCO2e/y)							
Carbon sink potential - Low - Restore							-1,120
productivity (1000 tCO2e/y)							
Carbon sink potential - Mid - Accelerate							-715
regeneration (1000 tCO2e/y)							
Carbon sink potential - Mid - All (not							-27,327
counting overlap) (1000 tCO2e/y)							
Carbon sink potential - Mid - Avoid							-984
deforestation (1000 tC02e/y)							
Carbon sink potential - Mid - Extend							-3,213
rotation length (1000 tCO2e/y)							
Carbon sink potential - Mid - Improve							-482
plantations (1000 tCO2e/y)							-
Carbon sink potential - Mid - Increase							-1,182
retention of HWP (1000 tCO2e/y)							,

Table 64: REF scenario - PILLAR 6: Land sinks - Forests (continued)

Item	2020	2025	2030	2035	2040	2045	2050
Carbon sink potential - Mid - Increase							-930
trees outside forests (1000 tC02e/y)							7,000
Carbon sink potential - Mid - Reforest							-7,299
cropland (1000 tC02e/y)							10.000
Carbon sink potential - Mid - Reforest							-10,302
pasture (1000 tC02e/y)							0.001
Carbon sink potential - Mid - Restore							-2,221
productivity (1000 tCO2e/y) Land impacted for carbon sink potential -							156
							156
High - Accelerate regeneration (1000							
hectares)							000
Land impacted for carbon sink potential -							228
High - Avoid deforestation (over 30 years)							
(1000 hectares)							0.040
Land impacted for carbon sink potential -							2,368
High - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							238
High - Improve plantations (1000							
hectares)							
Land impacted for carbon sink potential -							0
High - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							131
High - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							643
High - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							544
High - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,101
High - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							5,409
High - Total impacted (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							77.9
Low - Accelerate regeneration (1000							
hectares)							
Land impacted for carbon sink potential -							214
Low - Avoid deforestation (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							907
Low - Extend rotation length (1000							
hectares)							
Land impacted for carbon sink potential -							119
Low - Improve plantations (1000							
hectares)							
Land impacted for carbon sink potential -							0
Low - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							68.9
Low - Increase trees outside forests							
(1000 hectares)							
Land impacted for carbon sink potential -							322
Low - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							94.3
Low - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -		-					666
Low - Restore productivity (1000							
hectares)		[

Table 64: REF scenario - PILLAR 6: Land sinks - Forests (continued)

Item	2020	2025	2030	2035	2040	2045	2050
Land impacted for carbon sink potential -							2,470
Low - Total impacted (over 30 years)							
(1000 hectares)							
Land impacted for carbon sink potential -							117
Mid - Accelerate regeneration (1000							
hectares)							001
Land impacted for carbon sink potential -							221
Mid - Avoid deforestation (over 30 years) (1000 hectares)							
Land impacted for carbon sink potential -							1,637
Mid - Extend rotation length (1000							1,031
hectares)							
Land impacted for carbon sink potential -							179
Mid - Improve plantations (1000 hectares)							11.7
Land impacted for carbon sink potential -							0
Mid - Increase retention of HWP (1000							
hectares)							
Land impacted for carbon sink potential -							99.9
Mid - Increase trees outside forests (1000							
hectares)							
Land impacted for carbon sink potential -							483
Mid - Reforest cropland (1000 hectares)							
Land impacted for carbon sink potential -							682
Mid - Reforest pasture (1000 hectares)							
Land impacted for carbon sink potential -							1,342
Mid - Restore productivity (1000							
hectares)							
Land impacted for carbon sink potential -							4,761
Mid - Total impacted (over 30 years) (1000							
hectares)							

Table 65: REF scenario - PILLAR 6: Land sinks - Forests - REF only

Item	2020	2025	2030	2035	2040	2045	2050
Business-as-usual carbon sink - Natural uptake (Mt CO2e/y)	-3.92		-9.16				-7.43
Business-as-usual carbon sink - Retained in Hardwood Products (Mt CO2e/y)	-0.482		-0.805				-0.847
Business-as-usual carbon sink - Total (Mt CO2e/y)	-4.4		-9.97				-8.27

Table 66: REF scenario - IMPACTS - Health

Item	2020	2025	2030	2035	2040	2045	2050
Monetary damages from air pollution -		1,113	545	307	245	215	200
Coal (million 2019\$)							
Monetary damages from air pollution -		242	213	229	166	153	128
Natural Gas (million 2019\$)							
Monetary damages from air pollution -		685	706	728	753	779	805
Transportation (million 2019\$)							
Premature deaths from air pollution -		126	61.6	34.7	27.6	24.2	22.6
Coal (deaths)							
Premature deaths from air pollution -		27.4	24	25.8	18.7	17.3	14.5
Natural Gas (deaths)							
Premature deaths from air pollution -		77	79.4	81.8	84.7	87.6	90.5
Transportation (deaths)							