Impact of Energy Efficiency Measures on Greenhouse Gas Emission Reduction

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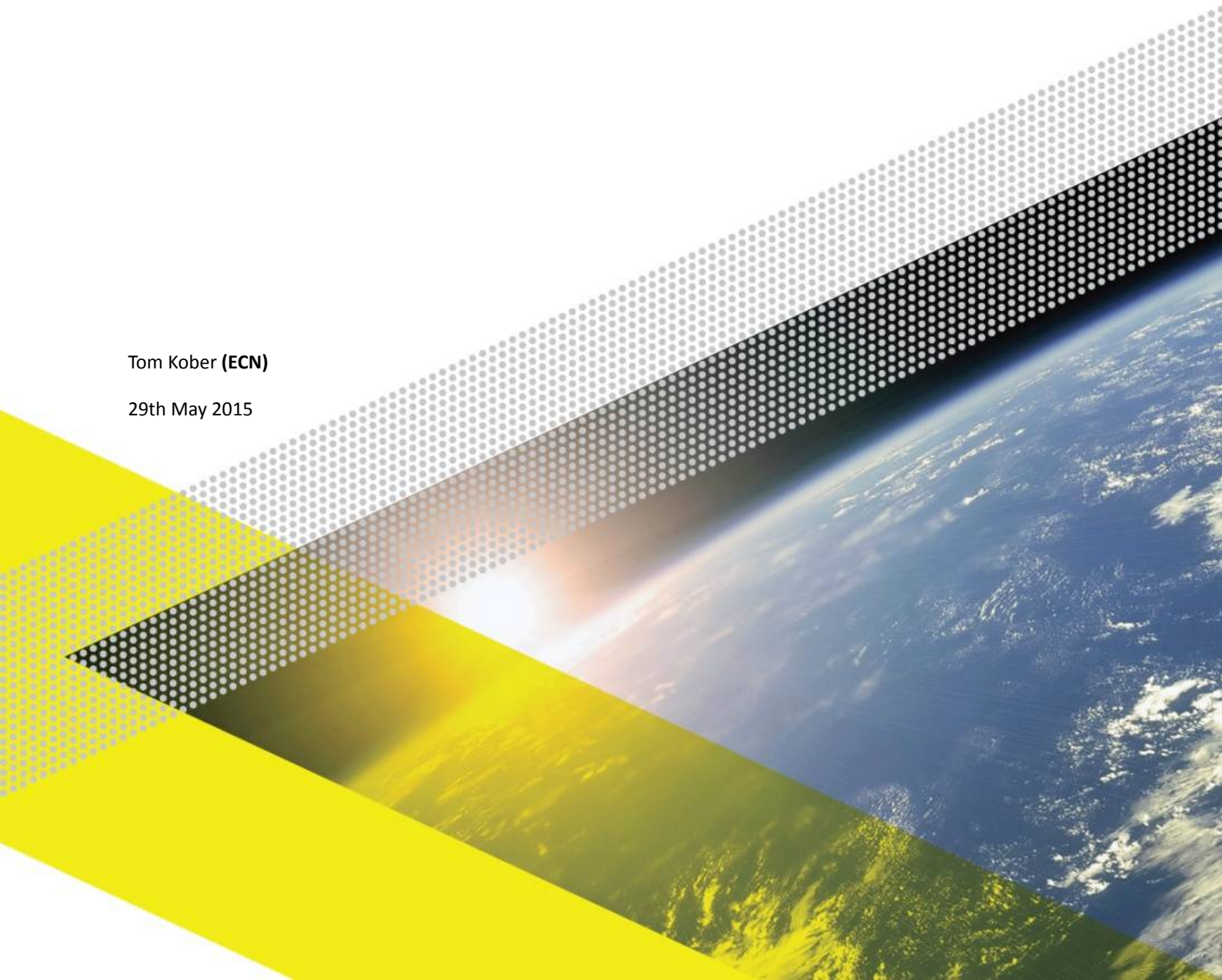

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Abstract

Mitigating climate change requires a shift from traditional carbon-intensive energy transformation towards a low-carbon energy structure. One option to reduce greenhouse gas emissions is to provide energy services at reduced fossil fuel intensity by using technology with improved energy conversion efficiency and by implementing energy saving measures. From today's perspective, limited knowledge exists about the role that energy efficiency improvement can play under climate change control policy in the future. There is a growing demand among interest groups for quantitative assessment of energy efficiency effects. This study aims to address that need with a dedicated analysis of climate policy induced greenhouse gas emission reductions resulting of energy efficiency improvements. To this end, a model-based approach has been applied using the global energy system model TIAM-ECN for a multiple scenario analysis in which three carbon tax scenarios are assessed against a business as usual scenario. A general finding is, that there exist energy efficiency measures, in particular in the power sector with significant power plant replacements over the next two decades and also in the energy demand sectors where fuel costs are higher than in the supply sector, which allow for net cost savings as a result of fuel savings and thus reduced fuel expenditures even in the absence of carbon tax policy. The resulting global greenhouse gas emission reduction accumulates to roughly 3 $GtCO_2e$ by 2030 compared to the future development of the energy economy at an emission intensity stagnated at 2010 level. Hence, climate policy enables supplementary incentives for unlocking further potential to improve energy efficiency. If climate policy is introduced via carbon taxes ranging from 40 to 100 $ per tonne of CO_2e in 2030, and kept at these levels afterwards, energy efficiency measures are responsible for 15 to 25 % of the total global greenhouse gas emission reductions related to energy and non-energy use until 2050. These results reveal that energy efficiency measures have a higher impact in the short to medium term (2020/2030) than in the long run (2050), which is partly caused by the good energy efficiency improvement opportunities that fast developing economies offer in the near future. Compared to the business as usual development, by 2030 improvements in energy efficiency could offset 2 $GtCO_2e$ at carbon price of 40 $ per tonne of CO_2e and up to 3 $GtCO_2e$ under a 100 $ carbon tax regime. Until 2030 the global greenhouse gas emission reduction potential based on energy efficiency is largest in the electricity sector, in the industry and in the transport sector. Energy efficiency measures in the two industry branches of iron & steel and non-metallic minerals, i.e. cement production, as well as road transport result in the highest response to carbon tax policy. The largest reductions in greenhouse gas emission by improving energy efficiency are realised in China, India, the USA and Europe. Independent of the carbon tax regimes analysed here by 2030, China is responsible for roughly 40 % of the global GHG emission reductions through energy efficiency improvements.

1

Introduction

Mitigating climate change requires to abate greenhouse gas (GHG) emissions which is associated with a shift from traditional carbon-intensive energy transformation towards a low-carbon energy structure. One option to reduce GHG emissions is to provide energy services at reduced fossil fuel intensity by using technology with improved energy conversion efficiency and by conducting energy saving measures.[1] Today, limited knowledge exists about the role enhancements of energy efficiency can play under climate change control policy in future.

This study, which is funded by the UNEP DTU Partnership within the project *KEBMIN-EE_for _GAP2014*, provides an analysis on climate policy induced GHG emission reductions resulting from improvements of energy efficiency on a global level and for G20 member countries in particular. For this analysis a model-based approach has been chosen by using three global energy models, namely the energy system model TIAM-ECN (ECN), the energy system model POLES (ENERDATA) and the energy-econometric model E3ME (Cambridge Econometric).

This report is the final deliverable of ECN's contribution to the project of UNEP DTU Partnership *KEBMIN-EE_for_GAP2014*. The report describes the approach (chapter 2), including key characteristics of the global energy system model TIAM-ECN, the model's main assumptions (chapter 3) and the harmonisation with the other project partners involved (Cambridge Econometrics and ENERDATA). Moreover, this report highlights the main results (chapter 4) and provides result tables for the world and selected G20 member countries in the data annexes A to D.

1 In this report the term *energy efficiency* refers to energy technology's conversion efficiency but also to the energy intensity of useful energy demand.

2

Approach

2.1 TIAM-ECN energy system model

For the purpose of this project we apply TIAM-ECN which is the TIMES[2] Integrated Assessment Model of the Energy research Centre of the Netherlands, used for long-term energy systems and climate policy analysis. It has a global scope with a world energy system disaggregated in 20 distinct regions (see table 1 on page 10) with 10 of the G20 member states being represented as a separate regions in the model.

TIAM-ECN is a linear optimisation model, based on energy system cost minimisation with perfect foresight until 2100. It simulates the development of the global energy economy over time from resource extraction to consumption of final energy to satisfy demand for useful energy. The objective function is represented by the total discounted aggregate energy system costs summed over all time periods and across all regions. The main cost components included in the objective function are the investment costs and fixed plus variable operation and maintenance costs for energy conversion technologies and emission reduction measures. Since TIAM-ECN is based on a partial equilibrium approach with demands for energy services that respond to changes in their respective prices through end-use price elasticities, savings of energy demand and corresponding cost variations are accounted for in the objective function as well. TIAM-ECN is operated with a comprehensive technology database that includes many possible fuel transformation and energy supply pathways and encompasses technologies based on fossil, nuclear and renewable energy resources. Both currently applied technologies and future advanced technologies, such as ultra-supercritical fossil-fuelled power plants, hydrogen technologies and options for carbon dioxide capture and storage (CCS) in power plants and industrial applications, are available in the model's technology portfolio. With regard to climate change mitigation measures, the model covers reduction options for the three main greenhouse gas emissions, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), for both energy and non-energy related emission sources. More detailed model descriptions and further examples of the application of TIAM-ECN can be found in [9, 12, 8, 7], as well as the references therein.

As energy system model, TIAM-ECN allows to analyse greenhouse gas reduction path-

2 TIMES is the acronym for The Integrated MARKAL-EFOM System, a model generator inspired by two bottom-up energy system models: the MARket Allocation model (MARKAL) and Energy Flow Optimization Model (EFOM).

Table 1: Model regions in TIAM-ECN

Model regions representing G20 member states	Model regions being not a G20 member state
Argentina	Africa
Australia (incl. New Zealand)	Chile
Brazil	Colombia
Canada	Eastern Europe
China	Middle Easte
India	Other Developing Asia
Japan	Other Latin America
Mexico	Reforming Economies
South Korea	Venezuela
USA	Western Europe

ways over the whole energy supply chain up to end-use energy demand. Thereby horizontal and vertical interdependencies and substitution effects of the energy supply are incorporated. For instance, the net contributions of hydrogen applications in the transport sector as climate change mitigation measure depend significantly on the availability of hydrogen production technology, which has an impact on the supply costs of hydrogen for the transport sector. Besides this integrated system approach, TIAM-ECN features peculiarities of energy extraction, conversion and demand, like available fossil and renewable resources, potentials of storage of CO_2 and region specific demand developments. The region and sector-specific demands for end-use energy or industrial products are driven by socio-economic parameters which are described in section 3.1.

2.2 Energy efficiency measures in the model

The model structure of TIAM-ECN includes several measures and technologies to reduce energy intensity of fuel transformation of both energy supply and energy demand, including different types of power plants, various transport technologies, different industrial applications and energy appliances for the residential and commercial sectors. Due to the bottom-up model approach, energy efficiency measures are represented as separate processes in the model with different fuel conversion efficiencies and corresponding costs.

Energy efficiency measures for road transport are parameterised according to IEA [4], and are displayed in the tables 2 and 3. For cars with internal combustion engines operated with gasoline or diesel we assume a maximum improvement of fuel transformation efficiency of 46 % which can be deployed at 3344 US$[3] for gasoline engines and 3966 US$ for diesel engines compared to the standard car technology. Heavy duty trucks operated with diesel can reach a reduction of the fuel consumption of up to 42 % at additional costs of 38504 US$ compered to the standard truck technology. In order to reflect different levels of fuel conversion efficiency measures to reduce fuel consuption are clustered for the corresponding car and truck technologies. As a results the model contains five steps for energy efficiency improvements for gasoline cars and diesel trucks and six steps for diesel cars.

For the residential and commercial sector TIAM-ECN distinguishes among different types of end-use energy, such as room heat, heat for warm water production, cooking, cooling and energy for other end-use applications (divided into electric and non-electric appliances). To satisfy end-use demand the model can choose between different tech-

3 In this report monetary values refer to $US\$_{2005}$ unless stated otherwise.

Technology	Reduction of fuel consumption compared to standard technology	Additional invest costs compared to standard technology
Gasoline cars		
Advanced car with improvements up to 25 US$ per %-point of efficiency improvement, including low rolling resistance tyres, low friction design and material, improvement of aerodynamics	8 %	168 US$
Advanced car with improvements up to 35 US$ per %-point of efficiency improvement, including additionally lightweight components and variable valve actuation and lift	20 %	619 US$
Advanced car with improvements up to 50 US$ per %-point of efficiency improvement, including additionally start and stop technology and direct injection	33 %	1350 US$
Advanced car with improvements up to 100 US$ per %-point of efficiency improvement, including additionally starter-alternator, lightweight steel components, auxiliary systems improvements and dual clutch transmission	44 %	2765 US$
Advanced car with improvements up to 170 US$ per %-point of efficiency improvement, including additionally lightweight aluminium	46 %	3344 US$
Diesel cars		
Advanced car with improvements up to 25 US$ per %-point of efficiency improvement, including low rolling resistance tyres, low friction design and material, improvement of aerodynamics	8 %	168 US$
Advanced car with improvements up to 35 US$ per %-point of efficiency improvement, including additionally lightweight components	10 %	225 US$
Advanced car with improvements up to 50 US$ per %-point of efficiency improvement, including additionally start and stop technology and advanced combustion technology	19 %	632 US$
Advanced car with improvements up to 75 US$ per %-point of efficiency improvement, including additionally variable valve actuation and lift	34 %	1972 US$
Advanced car with improvements up to 100 US$ per %-point of efficiency improvement, including additionally starter-alternator, lightweight steel components, auxiliary systems improvements and dual clutch transmission	44 %	3387 US$
Advanced car with improvements up to 170 US$ per %-point of efficiency improvement, including additionally lightweight aluminium	46 %	3966 US$

Table 2: Assumptions on energy efficiency measures for car technologies

nologies (e.g. boilers, heat pumps, electric heaters, etc.), including different levels of energy intensity and different fuels. Also considered in the model is a reduction in end-use demand, modelled via demand elasticities, which can result from energy efficiency measures, such as improved insulation for the reduction of room heat demand.

In TIAM-ECN, the industry sector consists of seven sub-sectors, namely iron & steel, chemicals, non-metallic minerals, non-ferrous metals, pulp and paper, other industries, and energy consumption for non-energy use (mainly feedstocks for chemical industry). The model's technology database contains both standard technologies to cover the industrial demand but also advanced technologies with higher fuel conversion efficiencies and CCS. The model also allows a shift between fuels in the industry sub-sectors within given ranges, whereat the technical feasibility to produce the corresponding final industry good is taken into consideration.

Table 3: Assumptions on energy efficiency measures for diesel trucks

Technology	Reduction of fuel consumption compared to standard technology	Additional invest costs compared to standard technology
Diesel trucks (heavy duty)		
Advanced truck with improvements up to 100 US$ per %-point of efficiency improvement, including eco roll freewheel function and driver support systems	6 %	350 US$
Advanced truck with improvements up to 200 US$ per %-point of efficiency improvement, including additionally controllable air compressor, low rolling resistance tyres, variable valve actuation, sequential turbo/downsizing, speed control (injection) and vehicle platooning	18 %	2628 US$
Advanced truck with improvements up to 550 US$ per %-point of efficiency improvement, including additionally acceleration control, smart alternator, battery sensor, electric accessory drive, neumatic booster – air hybrid, active aerodynamics and single wide tyres	29 %	7359 US$
Advanced truck with improvements up to 1050 US$ per %-point of efficiency improvement, including additionally aerodynamic fairings, predictive cruise control, leightweight materials and automated manual transmission	38 %	18354 US$
Advanced truck with improvements up to 4500 US$ per %-point of efficiency improvement, including additionally aerodynamic trailers, turbo-compound and bottoming cycles/waste heat recovery	42 %	38504 US$

2.3 Scenario definition

In this project four scenarios have been analysed, which consist of a business as usual (BAU) scenario and three carbon tax scenarios, reaching 40, 70 and 100 US$/t$CO_2$e in 2030 (table 4). For 2020 the carbon tax is assumed to be one third of the tax in 2030 and for the periods past 2030 the tax is assumed to remain at the level of 2030. The carbon tax is applied to all GHG emissions, independent of their origin (combustion, land-use, industrial processes). Apart from the carbon tax no further climate change mitigation policies or support schemes for low-carbon technologies are assumed for the future. For electricity generation from renewable energy at least a production level of the year 2010 for future periods is anticipated, which also applies to the BAU scenario.The development of CO_2 emissions from land-use and land-use change and forestry (LULUCF), as assumed in this study, follows a declining trend also under absence of climate policy measures due to the benefits related to conservation of natural area and biodiversity.

Table 4: Carbon taxes applied in the three climate policy scenarios (units in US$/t$CO_2$e)

Scenario	2010	2020	2030	2040	2050
carbon tax 40 US$ (ct40)	0	13	40	40	40
carbon tax 70 US$ (ct70)	0	23	70	70	70
carbon tax 100 US$ (ct100)	0	33	100	100	100

3

Model input data

This chapter provides an overview of the main model assumptions underlying this analysis. Key parameters, such as global GDP development, population, power plant parameters and assumptions of biomass availability, have been harmonised with POLES model (ENERDATA). With E3ME model (Cambridge Econometrics) energy system data from TIAM-ECN is syncronised via a data interface tool, including regional and sector-specific data on fuel consumption, GHG emissions, investments and prices of major fuels and emission certificates. Hence, harmonisation of model data between E3ME and TIAM-ECN is accomplished via a soft link covering the structural changes of the regions' energy systems and their implications regarding costs and GHG emissions.

3.1 Socio-economic development

On a global level a quadrupling of growth domestic product (GDP) from 67 tln US$ in 2010 to 295 tln US$ in 2050 and a further increase to 853 tln US$ in 2100 is assumed (table 5).[4] The world population is expected to grow rapidly in the first half of the century and to reach 9 bln persons in 2050, and to remain at this level until the end of the century (table 7). This population development mimics the medium fertility projections of the United Nations [11], and is characterised by the strong population growth in three of the main economies, namely Africa to 2.1 bln persons in 2050, India to 1.7 bln persons in 2050 and Other Asia to 1.4 bln persons in 2050.[5] China's population is supposed to peak around 2025 with 1.4 bln persons and to decline afterwards down to 0.9 bln persons in 2100. The underlying population development of most of the countries of the Organisation for Economic Cooperation and Development (OECD) is rather stable with a total average increase of 0.1%/yr. for the period 2010 to 2100. In comparison to population growth, the increase of the number of households is more pronounced, as a result of changing living patterns towards smaller household sizes. The total number of households amounts to almost 4 bln in 2050 and 4.4 bln in 2100 (table 9).

4 GDP in this report is expressed in terms of purchasing power parity (PPP), if not indicated otherwise.

5 The latter do not include India, China, South Korea, Japan and Central Asian countries (formerly part of the Soviet Union).

Table 5: Assumption on the development of the GDP (based on [5, 13, 6])

billion US$$_{2005}$$	2010	2020	2030	2040	2050
Africa	2759	4988	7454	10515	14832
Argentina	580	819	1155	1522	2006
Australia	888	1125	1372	1639	1960
Brazil	1970	2501	3622	5486	8310
Canada	1202	1554	1932	2378	2927
Chile	248	378	523	703	944
China	9417	21058	41851	68041	96910
Colombia	393	599	828	1113	1496
Eastern Europe	1791	2519	3336	4143	5145
India	3763	7901	14016	22400	35798
Japan	3897	4750	5678	6720	7954
Mexico	1411	2029	2754	3630	4784
Middle East	3382	6114	9137	12889	18181
Other Developing Asia	3706	6211	8762	12722	18473
Other Latin America	938	1429	1978	2658	3572
Reforming Economies	2952	4412	6105	7739	9810
South Korea	1321	1674	2041	2440	2916
USA	13085	16913	21025	25882	31861
Venezuela	316	481	666	895	1203
Western Europe	12736	15526	18558	21965	25998
World	66755	102981	152792	215480	295082

Table 6: Average annual GDP growth

%/yr	2005 –2010	2010 –2020	2020 –2030	2030 –2040	2040 –2050
Africa	5.2	6.1	4.1	3.5	3.5
Argentina	6.8	3.5	3.5	2.8	2.8
Australia	2.8	2.4	2.0	1.8	1.8
Brazil	4.6	2.4	3.8	4.2	4.2
Canada	1.2	2.6	2.2	2.1	2.1
Chile	3.5	4.3	3.3	3.0	3.0
China	10.9	8.4	7.1	5.0	3.6
Colombia	4.6	4.3	3.3	3.0	3.0
Eastern Europe	3.2	3.5	2.9	2.2	2.2
India	8.3	7.7	5.9	4.8	4.8
Japan	0.2	2.0	1.8	1.7	1.7
Mexico	1.7	3.7	3.1	2.8	2.8
Middle East	3.4	6.1	4.1	3.5	3.5
Other Developing Asia	5.4	5.3	3.5	3.8	3.8
Other Latin America	4.2	4.3	3.3	3.0	3.0
Reforming Economies	3.9	4.1	3.3	2.4	2.4
South Korea	3.7	2.4	2.0	1.8	1.8
USA	0.8	2.6	2.2	2.1	2.1
Venezuela	3.7	4.3	3.3	3.0	3.0
Western Europe	0.8	2.0	1.8	1.7	1.7
World	3.4	4.4	4.0	3.5	3.2

million inhabitants	2010	2020	2030	2040	2050
Africa	1031	1312	1634	1999	2393
Argentina	40	44	47	49	51
Australia	27	30	34	37	40
Brazil	195	211	223	229	231
Canada	34	38	41	43	45
Chile	17	19	20	21	21
China	1367	1440	1461	1444	1393
Colombia	46	52	57	61	63
Eastern Europe	120	119	116	110	105
India	1206	1353	1476	1566	1620
Japan	127	125	121	115	108
Mexico	118	132	144	152	156
Middle East	289	341	386	424	455
Other Developing Asia	1059	1193	1309	1395	1449
Other Latin America	150	170	189	205	217
Reforming Economies	287	289	285	279	273
South Korea	48	51	52	52	51
USA	312	338	363	383	401
Venezuela	29	33	37	40	42
Western Europe	412	424	431	435	436
World	6916	7717	8425	9039	9551

Table 7: Assumption on the development of the population (based on UNDP medium fertility projection [11])

%/yr	2005 –2010	2010 –2020	2020 –2030	2030 –2040	2040 –2050
Africa	2.5	2.4	2.2	2.0	1.8
Argentina	0.8	0.8	0.7	0.5	0.3
Australia	1.7	1.2	1.0	0.9	0.8
Brazil	1.0	0.8	0.5	0.3	0.1
Canada	1.2	1.0	0.8	0.6	0.5
Chile	1.0	0.8	0.6	0.4	0.1
China	0.6	0.5	0.1	-0.1	-0.4
Colombia	1.6	1.2	0.9	0.6	0.4
Eastern Europe	0.0	-0.1	-0.3	-0.4	-0.5
India	1.4	1.2	0.9	0.6	0.3
Japan	0.0	-0.2	-0.4	-0.5	-0.6
Mexico	1.2	1.1	0.9	0.6	0.3
Middle East	2.3	1.7	1.2	1.0	0.7
Other Developing Asia	1.4	1.2	0.9	0.6	0.4
Other Latin America	1.4	1.3	1.1	0.8	0.6
Reforming Economies	0.2	0.1	-0.1	-0.2	-0.2
South Korea	0.6	0.5	0.3	0.0	-0.2
USA	1.0	0.8	0.7	0.6	0.5
Venezuela	1.7	1.4	1.1	0.8	0.5
Western Europe	0.6	0.3	0.2	0.1	0.0
World	1.2	1.1	0.9	0.7	0.6

Table 8: Average annual population growth

Table 9: Assumption on the development of the number of households

million households	2010	2020	2030	2040	2050
Africa	233	344	511	698	945
Argentina	12	15	19	23	28
Australia	10	13	16	17	19
Brazil	57	65	68	74	73
Canada	14	17	20	22	23
Chile	5	6	8	10	12
China	386	472	571	628	683
Colombia	12	15	18	21	21
Eastern Europe	42	45	49	51	54
India	272	355	462	547	640
Japan	67	70	71	70	68
Mexico	29	38	48	57	67
Middle East	59	80	106	131	160
Other Developing Asia	217	284	372	443	520
Other Latin America	46	60	77	91	105
Reforming Economies	82	91	99	106	115
South Korea	11	14	17	19	21
USA	119	141	167	181	194
Venezuela	8	10	12	14	14
Western Europe	189	214	241	247	252
World	1871	2347	2952	3448	4015

Table 10: Average annual growth of the number of households

%/yr	2005 –2010	2010 –2020	2020 –2030	2030 –2040	2040 –2050
Africa	5.2	4.0	4.0	3.2	3.1
Argentina	6.8	2.1	2.1	2.1	2.1
Australia	2.8	2.1	2.0	1.1	1.0
Brazil	4.6	1.2	0.5	0.8	-0.1
Canada	1.2	1.8	1.7	0.7	0.6
Chile	3.5	2.1	2.1	2.0	1.9
China	10.9	2.0	1.9	0.9	0.8
Colombia	4.6	2.1	1.8	1.4	0.3
Eastern Europe	3.2	0.8	0.8	0.5	0.5
India	8.3	2.7	2.7	1.7	1.6
Japan	0.2	0.4	0.2	-0.2	-0.2
Mexico	1.7	2.5	2.4	1.7	1.6
Middle East	3.4	3.1	2.9	2.1	2.0
Other Developing Asia	5.4	2.7	2.7	1.8	1.6
Other Latin America	4.2	2.6	2.6	1.6	1.5
Reforming Economies	3.9	1.0	0.9	0.7	0.8
South Korea	3.7	2.0	2.1	1.1	1.0
USA	0.8	1.7	1.7	0.8	0.7
Venezuela	3.7	2.3	2.0	1.6	0.5
Western Europe	0.8	1.2	1.2	0.3	0.2
World	3.4	2.3	2.3	1.6	1.5

3.2 Technology development

The parameters of key electricity generation technologies are displayed for renewable energy in table 11 and for fossil and nuclear energy in table 12. The parameters are based on IEA [4] and own assessments, and comprise economic parameters, such as investment cost, cost for operation and maintenance (O+M), and technical parameters, such as net efficiency and lifetime, as well as the technology's levelised costs of electricity generation (LCOE). The parameters given in the tables correspond to average European circumstances and deviate for other model regions, because technology paramters in TIAM-ECN are attributed region-specific.

Table 11: Parameters of selected power plant technologies based on renewable energy

Technology parameter	2010	2020	2030	2050
Hydro power impoundment (medium)				
Invest costs (US$$_{2005}$/kW)	3500	3410	3330	3150
Fixed O+M costs (US$$_{2005}$/kW)	35	34	33	32
Variable O+M costs (US$$_{2005}$/kW)	0.3	0.3	0.3	0.3
Net efficiency (%)	100	100	100	100
Lifetime (years)	80	80	80	80
Average annual availability (hours)	2600	2600	2600	2600
LCOE (US$$_{2005}$/MWh)	150	146	143	135
Solar photovoltaic				
Invest costs (US$$_{2005}$/kW)	3180	1960	1610	1260
Fixed O+M costs (US$$_{2005}$/kW)	10	10	10	10
Variable O+M costs (US$$_{2005}$/kW)	0.0	0.0	0.0	0.0
Net efficiency (%)	100	100	100	100
Lifetime (years)	20	20	20	20
Average annual availability (hours)	1600	1600	1600	1600
LCOE (US$$_{2005}$/MWh)	240	150	125	99
Concentrated solar power with storage for base load operation				
Invest costs (US$$_{2005}$/kW)	10140	6080	4870	4870
Fixed O+M costs (US$$_{2005}$/kW)	299	179	143	143
Variable O+M costs (US$$_{2005}$/kW)	0.0	0.0	0.0	0.0
Net efficiency (%)	100	100	100	100
Lifetime (years)	30	30	30	30
Average annual availability (hours)	6100	6100	6100	6100
LCOE (US$$_{2005}$/MWh)	223	134	107	107
Wind onshore				
Invest costs (US$$_{2005}$/kW)	1350	1320	1300	1200
Fixed O+M costs (US$$_{2005}$/kW)	26	24	23	20
Variable O+M costs (US$$_{2005}$/kW)	0.0	0.0	0.0	0.0
Net efficiency (%)	100	100	100	100
Lifetime (years)	25	25	25	25
Average annual availability (hours)	2200	2200	2200	2200
LCOE (US$$_{2005}$/MWh)	79	77	75	69
Wind offshore				
Invest costs (US$$_{2005}$/kW)	3900	2900	2630	2100
Fixed O+M costs (US$$_{2005}$/kW)	75	69	63	50
Variable O+M costs (US$$_{2005}$/kW)	0.0	0.0	0.0	0.0
Net efficiency (%)	100	100	100	100
Lifetime (years)	20	20	20	20
Average annual availability (hours)	3800	3800	3800	3800
LCOE (US$$_{2005}$/MWh)	140	107	97	78

Table 12: Parameters of selected power plant technologies for fossil and nuclear fuels

Technology parameter	2010	2020	2030	2050
Hard coal: advanced atmospheric fluidized bed technology				
Invest costs (US$$_{2005}$/kW)	1750	1750	1750	1750
Fixed O+M costs (US$$_{2005}$/kW)	53	53	53	53
Variable O+M costs (US$$_{2005}$/kW)	0.2	0.2	0.2	0.2
Net efficiency (%)	43	43	43	43
CO_2 capture rate (%)	0	0	0	0
Lifetime (years)	40	40	40	40
Average annual availability (hours)	7900	7900	7900	7900
CO_2 emission factor (kg/MWh)	787	787	787	787
LCOE (US$$_{2005}$/MWh)	64	64	64	64
Hard coal: pulerized coal incl. post combustion CO_2 capture				
Invest costs (US$$_{2005}$/kW)		3150	2520	2520
Fixed O+M costs (US$$_{2005}$/kW)		95	77	77
Variable O+M costs (US$$_{2005}$/kW)		0.2	0.2	0.2
Net efficiency (%)		34	35	35
CO_2 capture rate (%)		85	85	85
Lifetime (years)		30	30	30
Average annual availability (hours)		7900	7900	7900
CO_2 emission factor (kg/MWh)		149	145	145
LCOE (US$$_{2005}$/MWh)		102	90	90
Natural gas combined cycle				
Invest costs (US$$_{2005}$/kW)	880	880	880	880
Fixed O+M costs (US$$_{2005}$/kW)	22	22	22	22
Variable O+M costs (US$$_{2005}$/kW)	0.1	0.1	0.1	0.1
Net efficiency (%)	60	61	63	63
CO_2 capture rate (%)	0	0	0	0
Lifetime (years)	35	35	35	35
Average annual availability (hours)	7900	7900	7900	7900
CO_2 emission factor (kg/MWh)	456	449	438	438
LCOE (US$$_{2005}$/MWh)	81	80	78	78
Natural gas combined cycle with fue gas CO_2 capture				
Invest costs (US$$_{2005}$/kW)		1580	1390	1390
Fixed O+M costs (US$$_{2005}$/kW)		39	34	34
Variable O+M costs (US$$_{2005}$/kW)		0.2	0.2	0.2
Net efficiency (%)		53	56	56
CO_2 capture rate (%)		85	85	85
Lifetime (years)		30	30	30
Average annual availability (hours)		7900	7900	7900
CO_2 emission factor (kg/MWh)		57	54	54
LCOE (US$$_{2005}$/MWh)		84	79	79
Nuclear advanced technology (EPR)				
Invest costs (US$$_{2005}$/kW)	5780	5430	4380	4380
Fixed O+M costs (US$$_{2005}$/kW)	173	163	131	131
Variable O+M costs (US$$_{2005}$/kW)	0.4	0.4	0.4	0.4
Net efficiency (%)	100	100	100	100
Lifetime (years)	60	60	60	60
Average annual availability (hours)	7900	7900	7900	7900
LCOE (US$$_{2005}$/MWh)	107	101	82	82

3.3 Other model input data and assumptions

In the model the total quantity for storage of captured CO_2 is limited to 1660 $GtCO_2$ [2] with about half of the storage potential being available in the Middle East and in the Reforming Economies (figure 1), which results from their large hydrocarbon fields. We assume significant shares of these formations to be available for CO_2 storage in future, either by applying enhanced oil and gas recovery technology or CO_2 storage in depleted oil and gas fields. In the model we also assume an inter-regional transport of liquid CO_2, which means that CO_2 can be stored not only in the region where it is captured but also in regions with expected abundant storage potential.

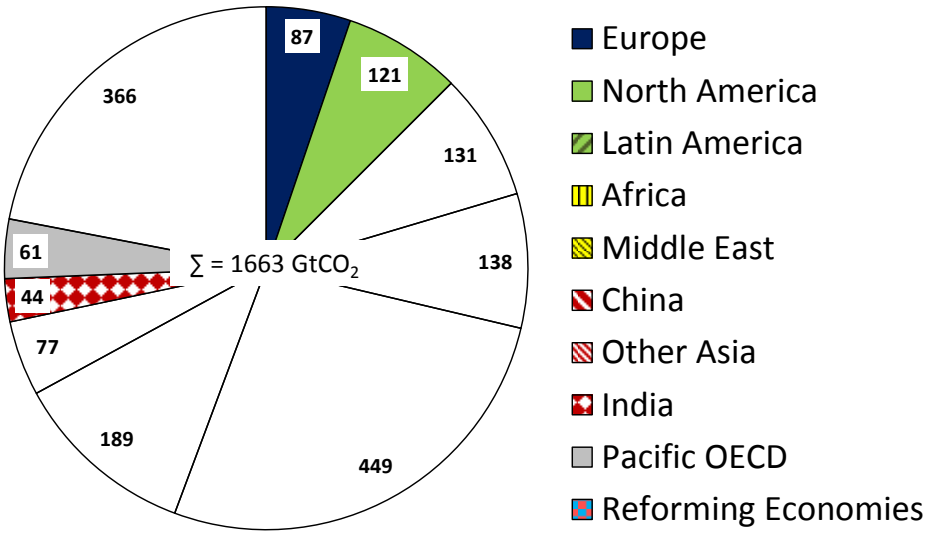


Figure 1: CO_2 storage potential by world regions

The global potential of various types of biomass amounts to about 110 EJ in 2050 and 150 EJ in 2100, which reflects our judgement that limited biomass may be available when sustainability criteria are accounted for and food price issues are prioritised [1, 3, 10]. Europe (Eastern and Western Europe) is expected to provide the largest biomass poteantials with about 20 % of the global potential, followed by Africa with 17 % and China with around 13 %. The model allows for trade of biomass among regions, which refers to both solid biomass and biofuels.

4

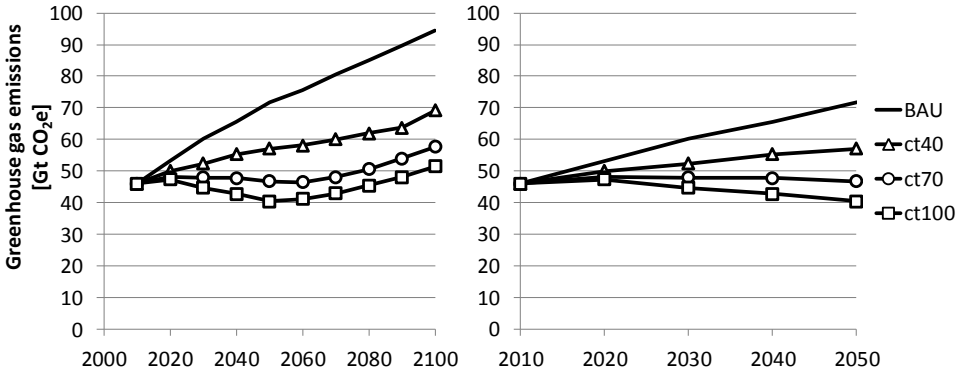
Main results of the model-based analysis

This chapter gives an overview of the main model outcomes focussing on GHG emission reduction and the impact of efficiency measures. Detailed result tables for all four scenarios are provided in Annex A to Annex D.

In the BAU scenario global GHG emissions increase to 60 $GtCO_2e$ in 2030 and further to 72 $GtCO_2e$ in 2050 and 94 $GtCO_2e$ in 2100 (figure 2), which is the result of the growth of population and economic activity at persisting dominance of fossil fuels in future. Essentially GHG emissions of all energy sectors increase over time, while emissions from LULUCF are expected to decline in future as consequence of nature conservation legislation not related to climate change mitigation (figure 3). Between 2010 and 2030 CO_2 emissions grow by 36 %, which exceeds the emissions growth of CH_4 (13 %) and N_2O (21 %). For CO_2 the highest increase in absolute and relative terms can be observed for the industry where in 2030 almost 5 $GtCO_2$ more are emitted compared to 2010. In the same period CO_2 emissions in the transport sector rise by 3.5 $GtCO_2$ (+50 %), and in the power sector by 3.6 $GtCO_2$ (+30 %). Interestingly, improvements of energy efficiency materialise already in the BAU scenario as a result of their competitiveness in order to reduce expenses for fuel input. This applies in to the power sector, where significant efficiency gains due to replacements in the coming two decades can be expected, and to the demand sectors, i.e. for road transport, where fuel prices are usually comparably high. Comparing the BAU scenario results to the future development of the energy economy at an emission intensity at 2010 level globally roughly 3 $GtCO_2e$ of GHG emissions can be reduced through improvements of energy efficieny by 2030.

A tax on GHG emissions reduces cumulative GHG emissions of this century by 20 % in the 40 $ carbon tax scenario, by 30 % in the 70 $ tax scenario and by 36 % in the 100 $ carbon tax scenario (figure 2). Compared to the cumulative reductions until 2100 carbon taxes are less effective in the short to medium-term with worldwide relative reductions towards the BAU scenario between 13 % (ct40) and 26 % (ct100) in 2030. This corresponds to absolute GHG emission reductions from the BAU scenario between 8 and 16 $GtCO_2e$ in 2030 and 15 and 31 $GtCO_2$ in 2050 with the electricity sector being responsible for about 60 % of the emission reductions (figure 4). This implies for the electricity sector to cut GHG emissions compared to the BAU scenario by 30 to 55 % in the carbon

Figure 2: Global GHG emissions in the BAU scenario and in the three carbon tax scenarios



tax scenarios in 2030. In 2050 global electricity production would even be almost carbon neutral under a 100 $ carbon tax regime. Besides the electricity sector industry and upstream fuel supply contribute between 2030 and 2050 with 10 to 20 % each to the total GHG emission reduction when carbon taxes are introduced. The transport sector makes up for about 5-10 % of the total emission reduction until 2050. Compared to emission reductions from energy supply and in the industry and transport sector, contributions from the residential and commercial sector appear very limited.

Figure 3: Global GHG emissions by sector in the BAU scenario

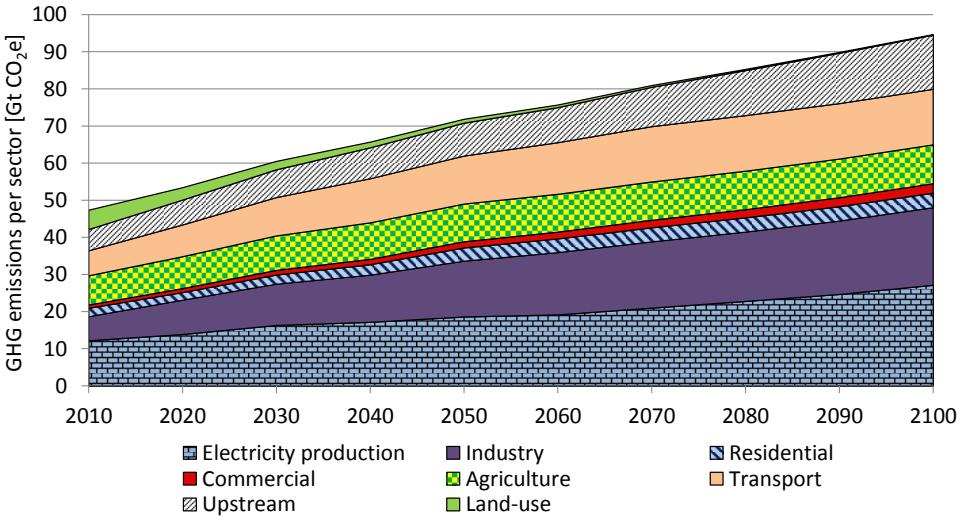
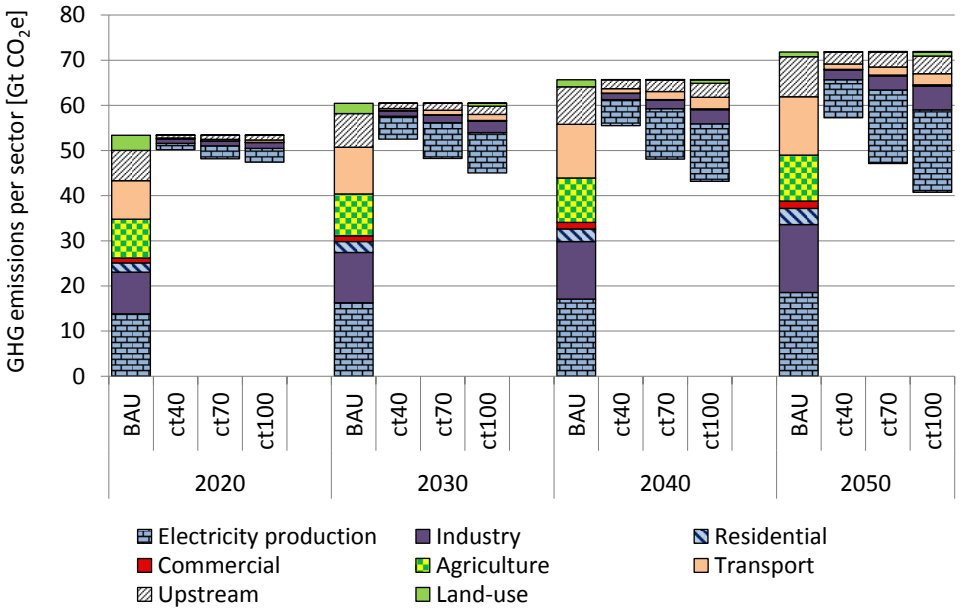


Figure 4: Global GHG emission reductions by sector in the carbon tax scenarios (ct40, ct70, ct100) compared to the BAU scenario



Energy efficiency measures are responsible for 15-25 % of the total global GHG emission reductions compared to the BAU scenario until 2050 with a tendency to have a higher contribution in the near and mid-term (2020/2030) than in the long-run (2050). In the 40 $ carbon tax scenario 23 % of the total GHG emission reductions in 2030 are realised via energy efficiency measures. This share declines with increasing tax level to about 20 % under 70 $ and 100 $ carbon tax level. Compared to the BAU scenario improvements in energy efficiency could offset by 2030 roughly 2 $GtCO_2e$ for a price of carbon of 40 $ per ton of CO_2 and about 3 $GtCO_2e$ under a 100 $ carbon tax scheme (figure 5). The 2030 emission avoidance level of the 40 $ carbon tax scenario hardly increases until 2050, whereas under a 100 $ carbon tax regime emission reductions due to energy efficiency increase from 2030 by 50 % to reach almost 5 $GtCO_2e$ in 2050. It should be emphasised that these emission reductions result from improvements of energy efficiency which are realised additionally to the measures which are already cost-effective under BAU conditions. Hence, energy efficiency measures unlocked through the 40 $ carbon tax and the 70 $ carbon tax effect less GHG emission reduction in 2030 than fuel price induced improvements of energy efficiency in the BAU scenario.

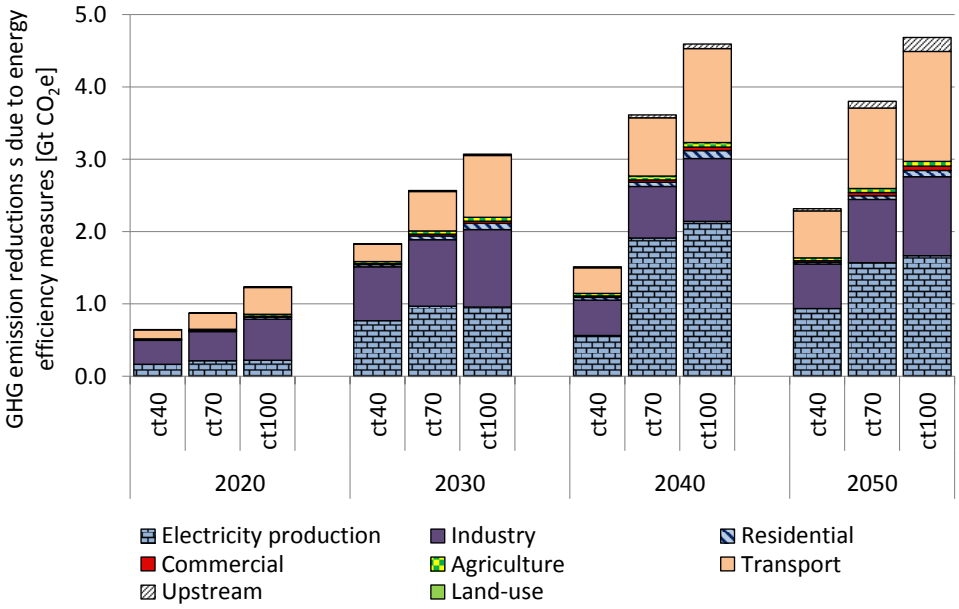
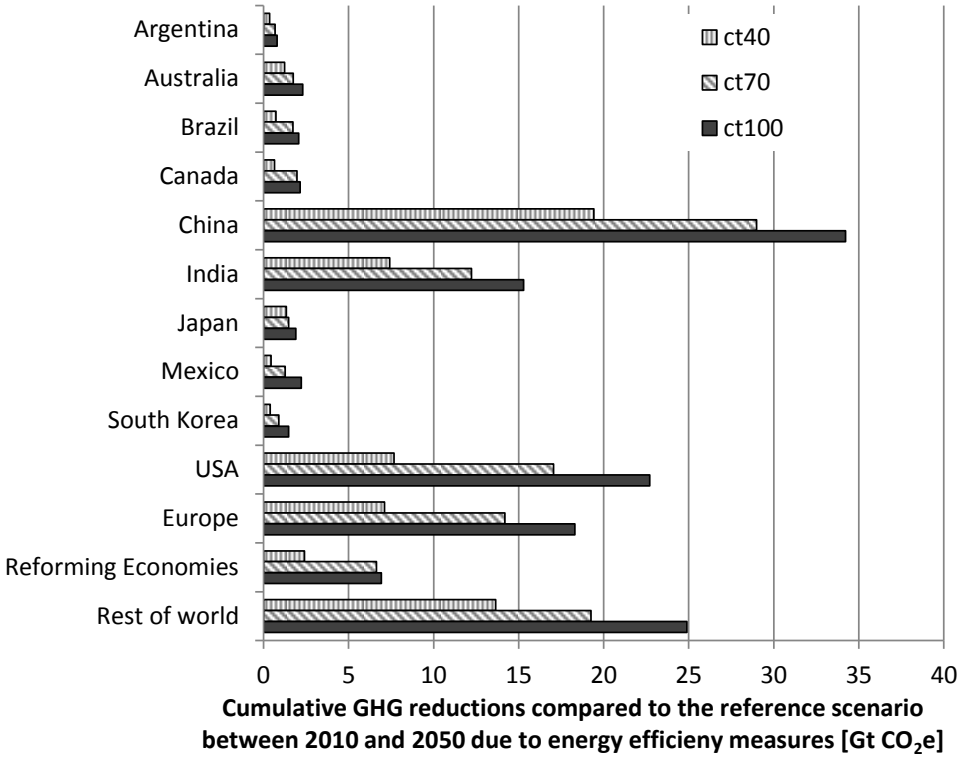


Figure 5: Global GHG emission reductions in the carbon tax scenarios (ct40, ct70, ct100) compared to the bau scenario due to energy efficiency measures

Most of the GHG emission reduction potential based on energy efficiency occurs in the industry in the electricity sector and in the transport sector. Until 2030 the industry has the largest potential globally with 7 $GtCO_2e$ (cumulatively 2015-2030) in the 40 $ carbon tax scenario and 11 $GtCO_2e$ in the 100 $ carbon tax scenario, which corresponds in 2030 to roughly 1 $GtCO_2e$ avoidance potential worldwide. The two industry branches iron & steel and non-metallic minerals, i.e. cement production, reduce GHG emissions at most. In the period 2015 to 2030 energy efficiency in the power sector reduces global GHG emissions by cumulatively 6-7 $GtCO_2e$ over the three carbon tax scenarios. For the year 2030 this means a GHG reduction in the power sector between 0.8 $GtCO_2e$ (ct40) and 1.0 $GtCO_2e$ (ct100). In the transport sector improved energy efficiency reduces cumulative GHG emissions until 2030 compared to the BAU scenario by 3 $GtCO_2e$ under a 40 $ carbon tax regime and up to 8 $GtCO_2e$ under a 100 $ carbon tax, which represents a GHG avoidance in 2030 of 0.2 and 0.9 $GtCO_2e$ respectively. Improvements of the energy efficiency of road transport technology, i.e. busses and trucks, show the highest sensitivity to carbon taxes within the transport sector.

Regarding the regional perspective of GHG emission reductions resulting from energy efficiency improvements, China contributes most with around 25-30 % of the cumulative

Figure 6: Cumulative regional GHG emission reductions in the carbon tax scenarios (ct40, ct70, ct100) compared to the BAU scenario between 2010 and 2050 due to energy efficiency measures



global reduction potential until 2050, followed by the USA, Europe and India with 11-17 % each. For China this corresponds to cumulative emission reductions until 2050 between 19 $GtCO_2$ (ct40) and 34 $GtCO_2$ (ct100), and for India, the USA and Europe between 7 and 23 $GtCO_2$ overall carbon tax scenarios (figure 6). Comparing the regional ranking across the three carbon tax scenarios reveals that emerging economies, such as China and India offer a similar high or even higher energy efficiency based mitigation potential under low carbon price policy than high developed economies, such as Europe and the USA. Responsible for this dynamic are the good opportunities in emerging countries to replace energy intensive fossi-fuel-based technologies with advanced technologies, in particular in the electricity and industry sector. In this regard fast growing economies are well suited to realize rapid technology change and hence allow for significant GHG emission reductions. Chinas importance to reduce emissions by means of energy efficiency improvements is even more pronounced in the period untill 2030, where China holds 38-42 % of global reduction potential by 2030 (over all three carbon tax levels).

Table 13 provides an overview of the contribution of energy efficiency improvements of the regions' total cumulative (2010-2050) GHG emission reductions in the carbon tax scenarios compared to the BAU scenario. For most of the regions this share is in a range between 10 and 20 %, and non of the regions displayed in the table exceeds 30 %. The share of China and India is the highest under a 40 $ carbon tax scheme and decreases with increasing carbon tax as a result of accelerating deployment of other GHG abatement options, such as renewable energy and CCS. For the USA the opposite trend can be observed, which is caused by the fact that renewable energy technologies deploy already at lower carbon taxes due to a higher electricity price level compared to China and India. In consequence, energy efficiency improvements gain importance under increasing carbon taxes. In Europe and Japan, energy efficiency improvements represent a high share over all carbon tax scenarios as a result of their competitivness compared to other emission mitigation options.

Scenario	Share of emission reductions due to energy efficiency measures of total cumulative GHG emission reductions between 2010 and 2050			
	0 - 9 %	10 - 14 %	15 - 19 %	20 - 24 %
ct40	South Korea Ref. Econ.	Argentina Brazil Canada Mexico USA	Australia Rest of world	China India Europe Japan
ct70		Mexico South Korea	Argentina Australia Brazil China USA Ref. Econ. Rest of world	Canada India Japan Europe
ct100		Brazil South Korea Ref. Econ.	Argentina Australia Canada China India Mexico Rest of world	Japan USA Europe

N. B.: Ref. Econ. refers to Reforming Economies

Table 13: Classification of the regions according to their contribution of energy efficiency measures of total GHG emission reduction in the carbon tax scenarios

5

Conclusions and common findings with POLES model

A general finding, which is also supported by POLES, is that there exist energy efficiency measures, in particular in the energy demand sectors where fuel costs are higher than in the supply sector, which allow for net cost savings even under absence of a carbon tax policy as a result of fuel savings and thus reduced fuel expenditures. For TIAM-ECN we find the resulting global GHG emission reduction accumulating to roughly 3 $GtCO_2e$ by 2030 compared to the future development of the energy economy at an emission intensity stagnated at 2010 level. Indeed, the overall energy intensity (primary energy consumption over GDP) decreases significantly over time even in the absence of a carbon tax (40 % between 2010 and 2030, see table 14), indicating many energy savings achieved via price competitiveness of new technologies. Consequently, for these technologies/applications, carbon taxes (at the levels investigated here) are not the main driver for the realisation of energy efficiency measures. Climate policy rather enables supplementary incentives for unlocking further potential to improve energy efficiency.

Index, 2010=100	BAU	carbon tax 40 $	carbon tax 70 $	carbon tax 100 $
POLES	65.6	61.5	59.4	57.8
TIAM-ECN	57.6	53.9	51.9	51.0

Table 14: Global primary energy intensity of GDP in 2030

For the two models POLES and TIAM-ECN we find general agreement on the regional capabilities for GHG emission reduction due to energy efficiency with deviation from the models' average of less than 25 % for most regions (table 15), which represents a strong consistency for such an exercise. This supports the finding regarding the country ranking with China, India and the USA offering prime opportunities for implementing energy efficiency measures to reduce GHG emissions. Moreover, both models agree that efficiency improvements in the energy supply sector contributes significantly, whereas in POLES upstream fuel production and conversion dominates and in TIAM-ECN electricity and heat production. The industry sector offers substantial emission reductions based on more efficient use of energy with the sector of non-metallic mineral production (i.e. cement) being and important sub-sector in both models. Comparing different types of energy models, differences in terms of the deployment of energy efficiency measures under climate policy can be observed whereat bottom-up models typically reserve less

room for energy savings than top-down models [12]. Transferring this statement to our study, coherence between the models is supported by the fact that both models belong to the group of bottom-up energy models, and the results presented here might in tendency rather underestimate possible future contribution of energy efficieny improvement measures to GHG emission reduction.

Table 15: Cumulative emission reduction (2015-2030) due to energy efficiency improvements (units in $MtCO_2e$)

	carbon tax 40 $		carbon tax 70 $		carbon tax 100 $	
Region	POLES	TIAM-ECN	POLES	TIAM-ECN	POLES	TIAM-ECN
World	15252	15617	24067	21580	31071	27753
Europe[1]	298	587	740	809	1136	999
China	6939	6584	10707	8360	13101	10658
India	1466	1617	2214	2022	2720	2206
USA	1294	1089	2159	2154	2932	2457
Canada	191	50	310	239	418	291
Brazil	128	68	213	229	294	300
Australia/New Zealand	173	64	294	98	389	190
Mexico	123	105	209	158	293	264
Russia[2]	1041	306	1602	1135	2050	1356
Japan	249	291	404	321	551	303
Middle East[3]	404	834	666	1276	1035	1530
South Korea	137	83	228	256	303	307

[1] For POLES *Europe* refers to EU-28, for TIAM-ECN to the two native model regions Eastern and Western Europe.
[2] In TIAM-ECN this region represents the countries which belonged to the former Soviet Union.
[3] Here included the Middle East indicative for Saudi Arabia as G20 member.

Further research on GHG emission reduction potentials resulting from energy efficiency improvements would allow to provide more insights in the dynamics within the sectors or even scoping on specific technologies. The models' structure and the models' level of detail determine how accurately energy efficiency measures are represented in the model. If the energy system, or parts of it, is modelled with rather aggregated technology groups and a stylized model structure, post-optimisation or post-simulation procedures (including the corresponding assumptions) are required to assess energy efficiency impacts. Thereby the challenge is to separate energy efficiency effects from other GHG reduction effects, such as fuel switch and CCS. The more technology details the model contains the more precise the distinction between GHG emission reduction effects can be made.

In TIAM-ECN the industry sector is represented with 7 sub-sectors which contain different technology and fuel groups, and which already allow for an analysis of energy efficiency impacts on this level. However, industry branches are often heterogeneous with specific energy efficiency measures for certain applications. Hence, further sub-sectoral distinction of the industry sector would be beneficial for an analysis like this. Regarding energy efficiency improvements in the residential and commercial sector, TIAM-ECN provides detailed results for the fuel conversion part (based on technologies, e.g. boilers). For energy savings due to improvements of buildings and building equipment (e.g. insulation and piping) TIAM-ECN model contains general assumptions on the possible reduction of energy end-use demand, which also include assumptions on demand response not related to energy efficiency, such as changes of living patterns. A dedicated modelling of energy efficiency measures for the building sector would offer more detailled insights on the role of energy efficiency for the commercial and residential sector.

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A

Results BAU scenario

Table 16: Model results on energy and GHG emissions for the World for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	490.4	564.2	644.9	714.2	796.3
Coal	142.3	191.9	229.9	244.4	282.9
Oil / oil products	168.8	174.5	190.8	210.7	223.0
Natural gas	106.1	119.9	148.7	177.9	198.0
Biomass	49.7	51.5	46.8	47.9	53.2
Nuclear	9.7	9.1	11.8	14.7	16.4
Hydro	11.6	13.8	13.9	13.7	14.0
Wind	1.4	1.5	1.5	1.6	2.4
Solar	0.6	0.9	1.0	2.0	5.3
Other renewable	0.2	1.1	0.5	1.1	1.2
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	332.3	409.0	473.9	538.5	610.7
Industry	94.7	118.5	138.6	153.0	174.3
Residential	84.5	90.9	95.2	104.2	107.8
Commercial, Agriculture	35.9	47.7	57.6	69.0	81.6
Transport	87.2	117.3	143.2	169.6	201.4
Non-Energy use	29.9	34.7	39.3	42.8	45.6
Final energy consumption by fuel (EJ)	332.3	409.0	473.9	537.9	610.2
Coal	32.4	43.8	56.9	70.6	95.9
Gases	54.7	73.2	90.9	108.2	124.7
Oil products	133.9	166.8	188.9	206.3	214.9
Biomass	43.0	43.4	37.1	37.8	39.5
Electricity	57.9	77.2	98.3	111.0	127.2
Other renewable	0.4	1.0	0.3	0.8	0.8
Other non-renewable	10.1	3.5	1.4	3.2	7.2
Electricity generation by fuel and technology (TWh)	19982	25592	32132	36170	41187
Coal with CCS	0	0	0	0	0
Coal w/o CCS	8040	11029	14788	17014	19526
Oil with CCS	0	0	0	0	0
Oil w/o CCS	1003	536	133	88	226
Gas with CCS	0	0	0	0	0
Gas w/o CCS	4266	6540	8605	9514	9911
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	284	341	616	738	1099
Nuclear	2697	2514	3265	4097	4558
Hydro	3224	3822	3858	3813	3893
Solar	16	23	30	39	844
Wind	386	421	417	452	653
Other renewable	67	78	88	98	114
Other non-renewable	0	287	330	316	364
Greenhouse gas emissions by emissions type ($MtCO_2e$)	45999	53229	60272	65473	71610
CO_2	35139	41872	47702	51805	57049
CH_4	7232	7368	8185	8890	9465
N_2O	3628	3989	4385	4779	5097
Greenhouse gas emissions by sector ($MtCO_2e$)	45999	53229	60272	65473	71610
Electricity + district heat production	12131	13808	16254	17095	18542
Industry	6488	9122	10969	12552	14850
Residential	2265	2038	2438	2807	3568
Commercial	881	1061	1239	1435	1637
Agriculture	7864	8608	9288	9831	10173
Transport	6747	8549	10344	11906	12942
Other energy supply	5719	6703	7478	8315	8861
Land-use and forestry	3904	3339	2262	1532	1038

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	6.4	6.9	7.5	7.7	7.7
Coal	2.5	3.3	3.7	3.8	3.3
Oil / oil products	2.2	2.1	2.1	2.1	2.0
Natural gas	1.3	1.1	1.2	1.2	1.2
Biomass	0.3	0.2	0.2	0.3	0.6
Nuclear	0.0	0.0	0.0	0.0	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.0	0.1
Solar	0.0	0.0	0.0	0.0	0.2
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	3.8	4.4	4.9	5.2	5.6
Industry	1.3	1.3	1.3	1.4	1.3
Residential	0.5	0.7	0.8	0.9	0.9
Commercial, Agriculture	0.4	0.5	0.6	0.7	0.8
Transport	1.4	1.8	1.9	2.0	2.2
Non-Energy use	0.2	0.2	0.2	0.2	0.2
Final energy consumption by fuel (EJ)	3.8	4.4	4.9	5.2	5.6
Coal	0.2	0.4	0.4	0.5	0.5
Gases	0.7	0.6	0.7	0.8	0.9
Oil products	1.8	2.2	2.3	2.3	2.1
Biomass	0.2	0.2	0.1	0.2	0.5
Electricity	0.9	1.1	1.3	1.3	1.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.1	0.1	0.1
Electricity generation by fuel and technology (TWh)	305	360	412	428	469
Coal with CCS	0	0	0	0	0
Coal w/o CCS	207	242	289	307	279
Oil with CCS	0	0	0	0	0
Oil w/o CCS	3	2	1	2	2
Gas with CCS	0	0	0	0	0
Gas w/o CCS	45	46	47	43	33
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	3	9	9	10	12
Nuclear	0	0	0	0	16
Hydro	36	39	39	39	39
Solar	0	0	0	0	41
Wind	6	7	8	9	27
Other renewable	5	7	7	8	8
Other non-renewable	0	9	11	12	13
Greenhouse gas emissions by emissions type ($MtCO_2e$)	670	761	835	848	804
CO_2	473	566	624	626	569
CH_4	152	146	159	168	178
N_2O	45	49	52	55	57
Greenhouse gas emissions by sector ($MtCO_2e$)	669	761	835	848	804
Electricity + district heat production	220	264	301	301	269
Industry	71	82	86	87	86
Residential	10	14	17	16	16
Commercial	6	7	11	13	14
Agriculture	150	162	173	183	192
Transport	115	129	137	142	133
Other energy supply	76	84	98	97	89
Land-use and forestry	23	19	13	9	6

Table 17: Model results on energy and GHG emissions for Australia for the baseline scenario

Table 18: Model results on energy and GHG emissions for Argentina for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	3.2	3.6	5.0	6.5	8.3
Coal	0.0	0.3	0.5	0.8	1.2
Oil / oil products	1.3	1.4	2.0	2.3	2.7
Natural gas	1.6	1.5	2.0	2.8	3.6
Biomass	0.1	0.2	0.3	0.3	0.3
Nuclear	0.0	0.0	0.1	0.1	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.0	0.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.1	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	2.2	3.0	4.1	5.3	6.8
Industry	0.6	0.8	1.1	1.5	1.9
Residential	0.5	0.6	0.7	0.9	1.1
Commercial, Agriculture	0.3	0.5	0.7	1.0	1.3
Transport	0.6	0.9	1.2	1.6	2.1
Non-Energy use	0.2	0.2	0.3	0.3	0.4
Final energy consumption by fuel (EJ)	2.2	3.0	4.1	5.3	6.8
Coal	0.0	0.0	0.0	0.0	0.1
Gases	0.8	0.8	1.1	1.6	2.1
Oil products	1.0	1.4	1.9	2.5	3.0
Biomass	0.1	0.2	0.2	0.3	0.3
Electricity	0.4	0.6	0.8	1.0	1.2
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	124	185	249	325	402
Coal with CCS	0	0	0	0	0
Coal w/o CCS	2	2	27	27	26
Oil with CCS	0	0	0	0	0
Oil w/o CCS	17	10	4	5	5
Gas with CCS	0	0	0	0	0
Gas w/o CCS	62	131	159	227	297
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	0	1	0	0
Nuclear	7	7	24	31	39
Hydro	34	34	34	34	34
Solar	0	0	0	0	0
Wind	0	0	0	0	0
Other renewable	0	0	0	1	1
Other non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	358	442	568	693	825
CO_2	176	240	346	456	572
CH_4	102	112	125	139	154
N_2O	80	90	97	98	99
Greenhouse gas emissions by sector ($MtCO_2e$)	365	442	568	693	825
Electricity + district heat production	37	55	75	97	119
Industry	36	51	69	95	117
Residential	19	18	23	29	37
Commercial	3	6	10	15	19
Agriculture	163	183	198	205	210
Transport	47	62	90	120	151
Other energy supply	48	59	97	129	170
Land-use and forestry	11	9	6	4	3

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	11.2	12.3	15.8	19.9	25.5
Coal	0.6	1.0	1.7	3.0	5.0
Oil / oil products	4.7	5.0	6.3	8.4	10.3
Natural gas	1.0	1.6	2.8	3.4	4.3
Biomass	3.4	2.8	3.2	3.1	3.8
Nuclear	0.1	0.1	0.1	0.1	0.2
Hydro	1.5	1.7	1.7	1.7	1.7
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.1
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.6	10.4	13.4	17.0	21.3
Industry	3.3	3.8	4.5	5.2	6.0
Residential	1.0	1.0	1.4	1.7	2.0
Commercial, Agriculture	0.8	1.3	1.7	2.2	2.8
Transport	2.9	3.7	5.0	6.8	9.1
Non-Energy use	0.5	0.7	0.9	1.1	1.4
Final energy consumption by fuel (EJ)	8.6	10.4	13.4	17.0	21.3
Coal	0.2	0.6	0.9	1.2	1.6
Gases	0.6	1.1	1.5	1.9	2.5
Oil products	3.7	4.6	6.1	8.1	10.0
Biomass	2.5	2.1	2.1	2.3	2.8
Electricity	1.6	2.0	2.8	3.5	4.3
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	515	619	918	1149	1402
Coal with CCS	0	0	0	0	0
Coal w/o CCS	11	11	87	260	432
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	8	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	36	85	228	312	378
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	31	31	88	55	65
Nuclear	15	15	30	38	46
Hydro	403	466	480	479	477
Solar	0	0	0	0	0
Wind	2	2	3	3	3
Other renewable	0	0	1	1	1
Other non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1721	1704	1880	2162	2493
CO_2	993	928	1072	1327	1632
CH_4	458	495	519	535	553
N_2O	270	282	289	300	308
Greenhouse gas emissions by sector ($MtCO_2e$)	1715	1704	1880	2162	2493
Electricity + district heat production	37	47	149	303	445
Industry	122	179	231	284	358
Residential	17	15	14	14	23
Commercial	4	8	12	17	22
Agriculture	667	699	710	719	723
Transport	210	270	365	493	619
Other energy supply	133	138	165	177	200
Land-use and forestry	524	348	232	154	102

Table 19: Model results on energy and GHG emissions for Brazil for the baseline scenario

Table 20: Model results on energy and GHG emissions for Canada for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.7	11.4	12.2	12.6	12.7
Coal	1.0	2.0	2.1	2.3	2.6
Oil / oil products	3.6	3.7	3.8	3.4	3.1
Natural gas	3.1	3.5	4.1	4.6	4.5
Biomass	0.4	0.5	0.6	0.6	0.6
Nuclear	0.3	0.3	0.2	0.4	0.4
Hydro	1.3	1.3	1.3	1.3	1.3
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.0	0.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.4	8.9	9.6	10.0	10.0
Industry	2.2	2.1	2.2	2.2	2.2
Residential	1.3	1.5	1.7	1.8	1.8
Commercial, Agriculture	1.5	1.5	1.6	1.7	1.8
Transport	2.3	2.7	2.9	3.1	2.9
Non-Energy use	1.1	1.2	1.2	1.2	1.2
Final energy consumption by fuel (EJ)	8.4	8.9	9.6	10.0	10.0
Coal	0.1	0.3	0.3	0.8	1.1
Gases	2.7	2.4	2.8	3.2	3.2
Oil products	3.5	3.8	3.9	3.4	3.0
Biomass	0.4	0.4	0.4	0.5	0.5
Electricity	1.7	1.9	2.0	2.0	2.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	608	661	669	681	676
Coal with CCS	0	0	0	0	0
Coal w/o CCS	92	79	105	96	127
Oil with CCS	0	0	0	0	0
Oil w/o CCS	8	1	0	2	15
Gas with CCS	0	0	0	0	0
Gas w/o CCS	37	112	105	85	32
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	7	9	9	7	7
Nuclear	90	80	63	107	118
Hydro	364	368	374	370	363
Solar	0	0	0	0	0
Wind	10	11	12	13	14
Other renewable	0	0	0	0	0
Other non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	903	855	905	924	937
CO_2	736	682	706	703	696
CH_4	114	112	132	150	166
N_2O	53	61	67	72	75
Greenhouse gas emissions by sector ($MtCO_2e$)	900	855	905	924	937
Electricity + district heat production	249	112	119	105	109
Industry	78	117	120	126	125
Residential	44	45	50	52	54
Commercial	53	47	49	52	54
Agriculture	108	121	131	138	143
Transport	173	191	206	213	197
Other energy supply	136	174	197	216	240
Land-use and forestry	59	49	33	23	15

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	98.2	122.7	145.5	153.8	172.6
Coal	66.6	80.4	92.2	82.0	93.3
Oil / oil products	17.0	19.8	26.3	36.5	41.4
Natural gas	3.1	7.6	11.1	18.2	21.0
Biomass	8.5	10.9	10.0	11.0	10.4
Nuclear	0.3	0.3	2.6	2.8	3.1
Hydro	2.2	3.1	3.0	2.9	2.8
Wind	0.2	0.2	0.2	0.2	0.2
Solar	0.3	0.3	0.1	0.2	0.3
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	57.5	81.2	99.7	115.2	131.9
Industry	28.3	41.0	48.6	51.0	56.1
Residential	14.6	15.9	15.6	17.0	15.9
Commercial, Agriculture	3.7	6.9	9.9	12.8	15.5
Transport	7.1	12.7	20.6	29.7	39.7
Non-Energy use	3.9	4.6	4.9	4.8	4.6
Final energy consumption by fuel (EJ)	57.5	81.2	99.7	114.7	131.5
Coal	20.4	26.4	30.6	31.4	39.4
Gases	2.3	7.3	8.3	13.1	14.1
Oil products	14.0	19.5	26.0	34.4	38.6
Biomass	8.4	10.2	9.5	10.4	9.9
Electricity	10.1	17.6	25.2	24.9	27.4
Other renewable	0.1	0.0	0.0	0.0	0.0
Other non-renewable	2.2	0.3	0.2	0.5	2.1
Electricity generation by fuel and technology (TWh)	3714	5876	8333	8269	9059
Coal with CCS	0	0	0	0	0
Coal w/o CCS	2913	4308	5869	5634	6061
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	33	9	4	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	51	285	593	754	1035
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	11	1	1	0
Nuclear	70	95	711	782	860
Hydro	616	872	841	810	780
Solar	1	1	1	1	1
Wind	45	50	55	59	64
Other renewable	0	0	0	0	1
Other non-renewable	0	222	253	223	256
Greenhouse gas emissions by emissions type ($MtCO_2e$)	9665	12154	14373	14662	16240
CO_2	7812	10668	12776	13037	14591
CH_4	1394	964	1006	1002	1002
N_2O	459	521	590	623	647
Greenhouse gas emissions by sector ($MtCO_2e$)	9711	12154	14373	14662	16240
Electricity + district heat production	3857	4612	5494	4612	4899
Industry	2315	3786	4420	4626	5238
Residential	339	266	279	308	462
Commercial	112	137	180	248	309
Agriculture	1125	1217	1278	1301	1268
Transport	526	932	1486	2105	2477
Other energy supply	1438	1204	1236	1462	1587
Land-use and forestry	0	0	0	0	0

Table 21: Model results on energy and GHG emissions for China for the baseline scenario

Table 22: Model results on energy and GHG emissions for India for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	28.6	36.8	50.4	68.6	91.1
Coal	12.2	18.9	27.5	40.6	55.7
Oil / oil products	6.9	7.4	10.6	13.0	16.3
Natural gas	2.0	2.5	4.7	5.9	7.7
Biomass	6.9	7.2	6.0	6.6	7.2
Nuclear	0.1	0.1	0.9	1.6	3.4
Hydro	0.4	0.5	0.5	0.5	0.5
Wind	0.2	0.2	0.1	0.1	0.1
Solar	0.0	0.0	0.1	0.2	0.3
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	17.6	23.7	35.2	49.7	69.2
Industry	5.7	7.7	13.3	20.7	31.3
Residential	7.1	6.6	6.4	7.0	7.0
Commercial, Agriculture	1.4	2.3	3.6	5.5	7.8
Transport	2.2	5.1	8.9	12.8	19.0
Non-Energy use	1.3	2.0	2.9	3.7	4.1
Final energy consumption by fuel (EJ)	17.6	23.7	35.2	49.7	69.2
Coal	2.3	3.9	8.9	16.1	26.4
Gases	0.7	1.8	3.3	4.1	5.7
Oil products	5.3	7.6	11.1	13.5	16.0
Biomass	6.9	6.5	5.2	5.7	6.2
Electricity	2.4	3.8	6.5	9.6	13.6
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.2	0.6	1.3
Electricity generation by fuel and technology (TWh)	931	1373	2163	3157	4423
Coal with CCS	0	0	0	0	0
Coal w/o CCS	617	938	1441	2165	2889
Oil with CCS	0	0	0	0	0
Oil w/o CCS	26	16	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	111	171	239	303	338
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	34	63	74	71
Nuclear	19	33	256	444	949
Hydro	107	129	129	128	128
Solar	0	0	0	0	0
Wind	50	47	24	26	29
Other renewable	0	0	0	0	0
Other non-renewable	0	6	9	14	18
Greenhouse gas emissions by emissions type ($MtCO_2e$)	2239	3235	4571	6187	8052
CO_2	1564	2476	3743	5298	7129
CH_4	591	661	710	745	750
N_2O	84	98	119	144	172
Greenhouse gas emissions by sector ($MtCO_2e$)	2238	3235	4571	6187	8052
Electricity + district heat production	892	1176	1516	1998	2447
Industry	305	615	1163	1892	2917
Residential	46	35	81	115	249
Commercial	15	26	50	83	124
Agriculture	534	592	649	684	706
Transport	175	370	625	842	1047
Other energy supply	242	398	473	561	554
Land-use and forestry	28	23	16	11	7

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	18.0	20.2	18.6	18.2	17.9
Coal	4.2	5.9	6.1	5.9	6.4
Oil / oil products	8.6	8.5	6.7	6.6	5.5
Natural gas	3.4	3.9	3.8	3.7	3.3
Biomass	0.3	0.3	0.3	0.4	0.8
Nuclear	1.0	0.9	1.3	1.3	1.5
Hydro	0.3	0.3	0.3	0.3	0.3
Wind	0.1	0.1	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.1
Other renewable	0.0	0.3	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	13.1	14.5	14.5	14.4	14.5
Industry	3.3	3.7	3.7	3.5	3.5
Residential	2.0	2.5	2.5	2.4	2.3
Commercial, Agriculture	2.7	2.8	2.6	2.8	2.9
Transport	3.4	3.9	4.2	4.2	4.4
Non-Energy use	1.6	1.6	1.6	1.5	1.5
Final energy consumption by fuel (EJ)	13.1	14.5	14.5	14.4	14.5
Coal	1.0	0.9	1.0	1.1	2.1
Gases	1.4	2.5	3.0	3.0	3.0
Oil products	7.2	7.2	6.7	6.5	5.1
Biomass	0.1	0.1	0.1	0.2	0.6
Electricity	3.4	3.5	3.6	3.5	3.5
Other renewable	0.0	0.3	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.1	0.1	0.1
Electricity generation by fuel and technology (TWh)	1059	1065	1093	1074	1072
Coal with CCS	0	0	0	0	0
Coal w/o CCS	279	313	315	343	324
Oil with CCS	0	0	0	0	0
Oil w/o CCS	84	26	1	2	44
Gas with CCS	0	0	0	0	0
Gas w/o CCS	285	346	285	244	167
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	21	19	26	23	24
Nuclear	280	241	367	367	403
Hydro	75	84	82	80	78
Solar	0	0	1	3	15
Wind	31	31	12	5	11
Other renewable	3	4	5	6	6
Other non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1346	1341	1285	1243	1179
CO_2	1292	1287	1232	1191	1128
CH_4	29	29	28	27	26
N_2O	25	25	26	26	25
Greenhouse gas emissions by sector ($MtCO_2e$)	1345	1341	1285	1243	1179
Electricity + district heat production	423	408	348	346	319
Industry	248	250	237	235	242
Residential	96	80	76	71	66
Commercial	103	96	83	87	95
Agriculture	41	38	36	34	32
Transport	266	280	301	299	278
Other energy supply	164	186	201	169	147
Land-use and forestry	4	4	2	2	1

Table 23: Model results on energy and GHG emissions for Japan for the baseline scenario

Table 24: Model results on energy and GHG emissions for Mexico for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	7.8	8.2	10.2	12.9	15.3
Coal	0.3	0.8	1.4	2.2	2.9
Oil / oil products	4.9	4.5	5.5	6.8	7.7
Natural gas	2.0	2.2	2.5	3.0	3.3
Biomass	0.4	0.5	0.5	0.5	0.8
Nuclear	0.0	0.0	0.1	0.1	0.2
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.3
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	4.6	6.1	8.0	10.1	12.1
Industry	1.1	1.3	1.9	2.5	3.2
Residential	0.7	0.8	0.9	1.1	1.3
Commercial, Agriculture	0.3	0.5	0.7	1.0	1.3
Transport	2.1	2.9	3.7	4.5	5.0
Non-Energy use	0.3	0.5	0.8	1.1	1.5
Final energy consumption by fuel (EJ)	4.6	6.1	8.0	10.1	12.1
Coal	0.0	0.1	0.2	0.3	0.3
Gases	0.6	1.0	1.3	1.7	1.9
Oil products	3.0	3.6	4.7	5.8	6.6
Biomass	0.3	0.4	0.4	0.4	0.6
Electricity	0.7	1.0	1.4	1.9	2.5
Other renewable	0.0	0.0	0.0	0.1	0.1
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	263	326	460	611	801
Coal with CCS	0	0	0	0	0
Coal w/o CCS	30	78	151	265	393
Oil with CCS	0	0	0	0	0
Oil w/o CCS	46	31	4	3	31
Gas with CCS	0	0	0	0	0
Gas w/o CCS	138	160	220	249	217
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	3	2	11	10	10
Nuclear	11	8	28	36	44
Hydro	27	36	34	32	30
Solar	0	0	0	0	59
Wind	2	2	1	2	2
Other renewable	7	7	9	11	12
Other non-renewable	0	1	1	3	4
Greenhouse gas emissions by emissions type ($MtCO_2e$)	583	714	848	1046	1216
CO_2	461	564	694	876	1034
CH_4	100	124	125	136	145
N_2O	22	25	29	34	38
Greenhouse gas emissions by sector ($MtCO_2e$)	581	714	848	1046	1216
Electricity + district heat production	118	149	205	303	397
Industry	51	84	117	148	188
Residential	21	14	15	19	26
Commercial	5	8	13	16	20
Agriculture	94	107	119	129	137
Transport	164	213	267	318	327
Other energy supply	83	102	88	96	111
Land-use and forestry	45	37	25	17	12

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.1	10.6	11.2	11.2	11.2
Coal	2.7	3.6	4.0	4.3	4.6
Oil / oil products	4.4	4.4	4.3	3.9	3.7
Natural gas	1.3	1.9	2.1	2.3	2.2
Biomass	0.1	0.2	0.3	0.2	0.4
Nuclear	0.5	0.5	0.4	0.4	0.3
Hydro	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.0	0.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	6.3	8.0	8.4	8.5	8.5
Industry	1.7	2.7	2.8	2.7	2.6
Residential	0.8	0.8	0.9	1.0	1.0
Commercial, Agriculture	0.9	1.1	1.1	1.2	1.2
Transport	1.6	1.9	2.0	2.1	2.3
Non-Energy use	1.4	1.5	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	6.3	8.0	8.4	8.4	8.5
Coal	0.3	0.4	0.5	0.5	0.5
Gases	0.8	1.3	1.5	1.8	1.8
Oil products	3.4	4.0	3.9	3.6	3.5
Biomass	0.1	0.1	0.1	0.2	0.3
Electricity	1.5	2.1	2.3	2.2	2.3
Other renewable	0.0	0.0	0.0	0.0	0.0
Other non-renewable	0.2	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	453	645	696	674	688
Coal with CCS	0	0	0	0	0
Coal w/o CCS	209	299	375	395	449
Oil with CCS	0	0	0	0	0
Oil w/o CCS	20	12	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	70	180	188	163	150
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	1	11	17	1	0
Nuclear	148	136	109	109	72
Hydro	3	4	4	4	4
Solar	1	1	1	1	11
Wind	2	2	1	1	1
Other renewable	0	0	0	0	0
Other non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	736	771	828	851	857
CO_2	685	719	779	801	808
CH_4	37	36	32	32	31
N_2O	14	15	17	17	18
Greenhouse gas emissions by sector ($MtCO_2e$)	736	771	828	851	857
Electricity + district heat production	332	316	358	360	376
Industry	106	123	125	133	116
Residential	30	36	39	39	40
Commercial	26	27	25	27	28
Agriculture	33	34	35	34	33
Transport	132	143	151	157	156
Other energy supply	77	91	95	100	109
Land-use and forestry	0	0	0	0	0

Table 25: Model results on energy and GHG emissions for South Korea for the baseline scenario

Table 26: Model results on energy and GHG emissions for USA for the baseline scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	86.8	92.2	97.4	96.0	95.1
Coal	21.3	30.6	38.3	33.3	30.5
Oil / oil products	35.9	34.2	33.6	32.7	30.0
Natural gas	22.6	20.0	18.9	20.4	20.1
Biomass	2.6	2.7	2.7	3.4	6.1
Nuclear	3.0	2.8	2.2	4.0	4.4
Hydro	1.0	1.0	1.0	1.0	1.0
Wind	0.3	0.4	0.4	0.5	0.5
Solar	0.1	0.1	0.2	0.5	2.2
Other renewable	0.1	0.4	0.1	0.2	0.2
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	61.6	69.1	72.8	75.2	77.8
Industry	10.8	12.8	13.6	13.7	13.8
Residential	11.0	12.4	13.4	13.8	14.3
Commercial, Agriculture	9.2	10.3	11.0	11.7	12.4
Transport	24.3	27.0	28.0	29.1	30.2
Non-Energy use	6.2	6.5	6.8	6.9	7.0
Final energy consumption by fuel (EJ)	61.6	69.1	72.8	75.2	77.8
Coal	1.0	3.7	5.9	7.6	9.2
Gases	13.9	14.1	14.5	14.9	15.7
Oil products	32.0	35.1	34.8	32.9	29.6
Biomass	1.8	1.9	1.9	2.7	5.1
Electricity	12.6	14.0	15.5	16.5	17.2
Other renewable	0.1	0.4	0.1	0.2	0.2
Other non-renewable	0.3	0.0	0.1	0.5	0.7
Electricity generation by fuel and technology (TWh)	4187	4420	4869	5192	5411
Coal with CCS	0	0	0	0	0
Coal w/o CCS	1893	2150	2715	2636	2305
Oil with CCS	0	0	0	0	0
Oil w/o CCS	50	36	24	52	81
Gas with CCS	0	0	0	0	0
Gas w/o CCS	950	939	983	849	663
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	72	104	104	108	134
Nuclear	830	786	624	1117	1229
Hydro	276	271	271	270	269
Solar	4	4	5	5	563
Wind	95	106	116	127	137
Other renewable	17	20	21	23	25
Other non-renewable	0	5	6	5	4
Greenhouse gas emissions by emissions type ($MtCO_2e$)	6534	7386	7839	7596	7062
CO_2	5629	6410	6794	6495	5932
CH_4	526	530	541	562	565
N_2O	379	446	504	539	565
Greenhouse gas emissions by sector ($MtCO_2e$)	6647	7386	7839	7596	7062
Electricity + district heat production	2340	2496	2716	2497	2129
Industry	620	778	887	932	975
Residential	409	357	379	399	404
Commercial	233	274	295	297	303
Agriculture	610	687	748	767	784
Transport	1840	1963	2008	1960	1827
Other energy supply	595	831	805	745	640
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	211.4	239.4	270.9	306.7	339.0
Coal	31.0	45.0	52.4	66.2	77.3
Oil / oil products	79.4	83.5	89.6	94.9	100.2
Natural gas	64.6	74.2	95.4	112.5	126.8
Biomass	26.7	26.0	22.7	21.7	22.3
Nuclear	4.4	4.0	3.8	3.8	2.8
Hydro	4.6	5.5	5.7	5.6	6.1
Wind	0.5	0.6	0.7	0.7	1.3
Solar	0.1	0.3	0.5	0.8	1.7
Other renewable	0.1	0.4	0.3	0.5	0.5
Other non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	148.8	179.6	203.5	227.9	253.1
Industry	36.5	41.2	45.6	48.7	52.4
Residential	45.1	47.9	50.8	56.6	60.1
Commercial, Agriculture	14.7	20.0	23.9	28.5	33.8
Transport	39.3	54.8	64.8	73.6	84.5
Non-Energy use	13.2	15.7	18.3	20.5	22.3
Final energy consumption by fuel (EJ)	148.8	179.6	203.5	227.8	253.0
Coal	6.8	7.1	8.1	11.2	14.8
Gases	30.4	40.1	52.8	62.1	73.6
Oil products	59.1	77.9	87.6	93.4	97.4
Biomass	22.3	21.4	17.1	15.0	12.6
Electricity	22.6	29.8	37.1	44.6	51.6
Other renewable	0.2	0.3	0.1	0.3	0.3
Other non-renewable	7.3	3.1	0.7	1.3	2.7
Electricity generation by fuel and technology (TWh)	7823	10062	12270	14611	16783
Coal with CCS	0	0	0	0	0
Coal w/o CCS	1789	2610	3414	4885	6241
Oil with CCS	0	0	0	0	0
Oil w/o CCS	717	361	86	19	47
Gas with CCS	0	0	0	0	0
Gas w/o CCS	2479	4084	5558	6285	6600
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	139	111	286	449	776
Nuclear	1228	1112	1053	1065	782
Hydro	1284	1521	1572	1566	1690
Solar	9	16	22	28	154
Wind	142	164	185	206	364
Other renewable	35	40	45	49	59
Other non-renewable	0	45	50	59	70
Greenhouse gas emissions by emissions type ($MtCO_2e$)	21244	23865	26340	29260	31943
CO_2	15318	17330	18936	20994	22957
CH_4	3730	4159	4809	5393	5893
N_2O	2196	2376	2595	2873	3093
Greenhouse gas emissions by sector ($MtCO_2e$)	21092	23865	26340	29260	31943
Electricity + district heat production	3628	4175	4972	6173	7032
Industry	2536	3058	3513	3994	4488
Residential	1234	1159	1466	1744	2191
Commercial	321	424	512	579	648
Agriculture	4339	4769	5212	5637	5946
Transport	3100	3996	4708	5258	5730
Other energy supply	2726	3436	4023	4562	5015
Land-use and forestry	3209	2850	1935	1314	892

Table 27: Model results on energy and GHG emissions for the rest of world for the baseline scenario

B

Results 40$ carbon tax scenario

Table 28: Model results on energy and GHG emissions for the World for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	490.4	546.5	600.0	665.3	732.0
Coal	142.3	169.1	170.4	176.8	186.8
Oil / oil products	168.8	172.9	186.6	199.5	209.7
Natural gas	106.1	125.1	154.2	179.8	198.3
Biomass	49.7	52.2	54.7	62.8	73.6
Nuclear	9.7	9.1	13.6	16.5	19.6
Hydro	11.6	13.8	14.1	14.0	14.2
Wind	1.4	2.2	3.8	9.2	17.8
Solar	0.6	0.9	2.1	5.5	10.5
Other renewable	0.2	1.1	0.5	1.2	1.5
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	349.0	402.1	460.9	521.5	586.0
Industry	97.7	114.7	132.4	147.4	164.7
Residential	90.5	90.3	94.0	102.0	106.3
Commercial, Agriculture	37.9	47.1	55.8	66.8	79.2
Transport	93.1	115.5	139.9	163.2	190.9
Non-Energy use	29.9	34.5	38.8	42.1	44.9
Final energy consumption by fuel (EJ)	349.0	402.1	460.7	521.1	585.5
Coal	27.5	39.5	49.0	63.5	82.8
Gases	59.7	75.4	98.0	113.2	129.9
Oil products	142.8	164.0	182.4	191.5	198.8
Biomass	43.3	43.9	39.8	43.1	43.6
Electricity	67.8	74.8	89.6	104.7	120.0
Other renewable	1.6	1.0	0.3	1.4	1.4
Other Non-renewable	6.3	3.6	1.6	3.8	9.1
Electricity generation by fuel and technology (TWh)	19982	24782	29266	34042	38813
Coal with CCS	0	0	0	20	104
Coal w/o CCS	8040	9462	9398	9806	8513
Oil with CCS	0	0	0	0	0
Oil w/o CCS	1003	536	135	92	217
Gas with CCS	0	0	0	0	0
Gas w/o CCS	4266	7099	9006	9827	9718
Biomass with CCS	0	1	1	1	101
Biomass w/o CCS	284	356	1324	2006	3183
Nuclear	2697	2515	3777	4592	5452
Hydro	3224	3831	3920	3895	3939
Solar	16	23	310	896	2204
Wind	386	618	1049	2542	4950
Other renewable	67	79	94	117	188
Other Non-renewable	0	261	251	247	245
Greenhouse gas emissions by emissions type ($MtCO_2e$)	45999	50009	52295	55279	57023
CO_2	35139	39585	41132	43325	44504
CH_4	7232	6876	7306	7849	8285
N_2O	3628	3549	3857	4105	4234
Greenhouse gas emissions by sector ($MtCO_2e$)	45999	50009	52295	55279	57023
Electricity + district heat production	12131	12378	11181	11350	10097
Industry	6488	8074	9660	11056	12574
Residential	2265	2057	2411	2788	3501
Commercial	881	1066	1270	1490	1714
Agriculture	7864	8596	9254	9774	10111
Transport	6747	8372	9949	10926	11770
Other energy supply	5719	6127	6308	6364	6217
Land-use and forestry	3904	3339	2262	1532	1038

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	3219	7977	10194	14587
Electricity + district heat production	0	1430	5073	5745	8445
Industry	0	1048	1309	1496	2276
Residential	0	-19	27	20	67
Commercial	0	-5	-31	-55	-78
Agriculture	0	12	34	57	62
Transport	0	177	395	980	1172
Other energy supply	0	576	1170	1952	2644
Land-use and forestry	1300	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	644	1835	1514	2318
Electricity + district heat production	0	167	770	565	937
Industry	0	331	744	489	614
Iron and steel	0	174	427	101	162
Chemicals	0	17	36	42	48
Pulp and paper	0	9	16	14	16
Non-ferrous metals	0	2	4	5	5
Non-metalic minerals	0	107	228	289	335
Other industries	0	23	33	38	48
Residential	0	7	31	37	25
Cooking	0	0	7	9	9
Heating and warm water	0	7	24	28	15
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	12	42	55	62
Cooking	0	0	2	4	3
Heating and warm water	0	0	10	16	19
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	12	30	35	40
Transport	0	126	245	355	649
Road cars and small vehicles	0	0	12	58	377
Road buses and trucks	0	87	169	216	192
Rail passengers	0	0	1	1	1
Rail freight	0	1	4	5	5
Marine navigation	0	14	23	23	21
Aviation	0	23	36	53	53
Other energy supply	0	1	3	13	31
Land-use and forestry	0	0	0	0	0

Table 29: Model results on GHG emissions reductions for World for the 40$ carbon tax scenario

Table 30: Model results on energy and GHG emissions for Australia for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	6.4	6.7	6.6	6.4	6.3
Coal	2.5	3.1	2.3	1.6	0.9
Oil / oil products	2.2	2.1	2.1	2.1	2.1
Natural gas	1.3	1.1	1.3	1.2	1.1
Biomass	0.3	0.2	0.5	0.6	0.8
Nuclear	0.0	0.0	0.0	0.0	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.2	0.3	0.4
Solar	0.0	0.0	0.1	0.3	0.7
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	3.9	4.4	4.8	5.1	5.4
Industry	1.1	1.2	1.3	1.3	1.3
Residential	0.5	0.6	0.8	0.8	0.9
Commercial, Agriculture	0.4	0.5	0.6	0.7	0.8
Transport	1.6	1.8	1.9	2.0	2.2
Non-Energy use	0.2	0.2	0.2	0.2	0.2
Final energy consumption by fuel (EJ)	3.9	4.4	4.8	5.1	5.4
Coal	0.3	0.3	0.3	0.4	0.4
Gases	0.5	0.7	0.8	0.9	0.9
Oil products	2.0	2.1	2.3	2.2	2.1
Biomass	0.2	0.2	0.1	0.2	0.5
Electricity	0.9	1.0	1.2	1.2	1.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	305	344	381	407	469
Coal with CCS	0	0	0	0	0
Coal w/o CCS	207	228	156	102	40
Oil with CCS	0	0	0	0	0
Oil w/o CCS	3	2	1	2	2
Gas with CCS	0	0	0	0	0
Gas w/o CCS	45	44	50	19	13
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	3	8	51	51	51
Nuclear	0	0	8	8	16
Hydro	36	39	39	39	39
Solar	0	0	0	85	182
Wind	6	7	58	85	107
Other renewable	5	7	8	8	8
Other Non-renewable	0	9	10	10	11
Greenhouse gas emissions by emissions type ($MtCO_2e$)	670	715	661	590	515
CO_2	473	544	479	401	315
CH_4	152	124	132	139	147
N_2O	45	46	49	51	53
Greenhouse gas emissions by sector ($MtCO_2e$)	669	715	661	590	515
Electricity + district heat production	220	246	165	99	40
Industry	71	76	79	80	79
Residential	10	14	18	16	15
Commercial	6	9	12	13	13
Agriculture	150	162	172	182	191
Transport	115	128	137	139	130
Other energy supply	76	61	64	52	41
Land-use and forestry	23	19	13	9	6

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	46	175	258	290
Electricity + district heat production	0	18	136	202	229
Industry	0	7	7	8	7
Residential	0	0	-1	0	1
Commercial	0	-2	-1	0	1
Agriculture	0	0	0	1	1
Transport	0	1	0	3	3
Other energy supply	0	23	33	45	48
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	2	8	27	85
Electricity + district heat production	0	1	1	21	80
Industry	0	1	3	3	2
Iron and steel	0	0	1	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	1	1	0
Non-metalic minerals	0	0	1	1	0
Other industries	0	0	1	1	0
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	0	4	3	2
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	3	2	1
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	1	1	1
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 31: Model results on GHG emissions reductions for Australia for the 40$ carbon tax scenario

Table 32: Model results on energy and GHG emissions for Argentina for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	3.2	3.6	4.5	5.8	7.2
Coal	0.0	0.3	0.3	0.5	0.6
Oil / oil products	1.3	1.4	1.8	2.1	2.6
Natural gas	1.6	1.5	1.8	2.5	3.3
Biomass	0.1	0.3	0.3	0.3	0.3
Nuclear	0.0	0.0	0.1	0.1	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.0	0.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.1	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	2.3	3.0	4.0	5.2	6.6
Industry	0.6	0.8	1.1	1.4	1.8
Residential	0.5	0.6	0.7	0.9	1.1
Commercial, Agriculture	0.3	0.5	0.7	1.0	1.3
Transport	0.7	0.9	1.2	1.5	2.1
Non-Energy use	0.2	0.2	0.3	0.3	0.4
Final energy consumption by fuel (EJ)	2.3	3.0	4.0	5.2	6.6
Coal	0.0	0.0	0.0	0.2	0.3
Gases	0.8	0.8	1.1	1.5	2.1
Oil products	1.0	1.4	1.9	2.2	2.6
Biomass	0.1	0.2	0.2	0.2	0.3
Electricity	0.4	0.5	0.7	1.0	1.2
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	124	183	239	309	390
Coal with CCS	0	0	0	0	0
Coal w/o CCS	2	2	2	1	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	17	10	5	5	5
Gas with CCS	0	0	0	0	0
Gas w/o CCS	62	127	169	233	294
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	2	2	0	0
Nuclear	7	7	24	31	39
Hydro	34	34	37	37	37
Solar	0	0	0	0	11
Wind	0	0	0	1	1
Other renewable	0	0	0	1	1
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	358	429	509	605	697
CO_2	176	236	302	388	471
CH_4	102	103	110	120	129
N_2O	80	89	97	97	98
Greenhouse gas emissions by sector ($MtCO_2e$)	365	429	509	605	697
Electricity + district heat production	37	53	61	82	101
Industry	36	48	68	93	115
Residential	19	18	22	28	36
Commercial	3	6	10	15	19
Agriculture	163	182	197	204	208
Transport	47	62	89	112	144
Other energy supply	48	52	56	68	70
Land-use and forestry	11	9	6	4	3

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	13	59	88	128
Electricity + district heat production	0	2	14	15	18
Industry	0	3	2	2	1
Residential	0	0	0	0	1
Commercial	0	0	0	0	0
Agriculture	0	0	1	1	2
Transport	0	0	1	8	6
Other energy supply	0	8	41	61	100
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	1	4	13	17
Electricity + district heat production	0	0	0	0	0
Industry	0	1	2	3	3
Iron and steel	0	0	0	0	0
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	0	1	2	2
Other industries	0	0	0	1	1
Residential	0	0	0	0	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	1	1
Transport	0	0	0	8	10
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	0	7	10
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	0	0	0
Other energy supply	0	0	0	0	2
Land-use and forestry	0	0	0	0	0

Table 33: Model results on GHG emissions reductions for Argentina for the 40$ carbon tax scenario

Table 34: Model results on energy and GHG emissions for Brazil for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	11.2	12.4	15.8	19.6	24.4
Coal	0.6	1.0	1.6	3.0	3.9
Oil / oil products	4.7	4.8	6.2	7.5	9.2
Natural gas	1.0	2.0	2.3	2.5	3.9
Biomass	3.4	2.8	3.6	4.5	5.0
Nuclear	0.1	0.1	0.1	0.1	0.2
Hydro	1.5	1.7	1.8	1.8	1.8
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.3
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	10.4	13.3	16.5	20.7
Industry	3.1	3.8	4.4	5.1	5.8
Residential	1.0	1.0	1.4	1.7	2.0
Commercial, Agriculture	0.8	1.3	1.7	2.1	2.7
Transport	3.1	3.7	4.9	6.4	8.9
Non-Energy use	0.5	0.7	0.9	1.1	1.4
Final energy consumption by fuel (EJ)	8.5	10.4	13.2	16.5	20.7
Coal	0.4	0.6	0.8	1.5	2.1
Gases	0.4	1.1	1.6	1.9	2.6
Oil products	3.9	4.6	6.0	7.2	8.9
Biomass	2.2	2.1	2.1	2.3	2.8
Electricity	1.6	2.0	2.7	3.5	4.2
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	515	672	911	1146	1373
Coal with CCS	0	0	0	4	72
Coal w/o CCS	11	11	69	146	134
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	8	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	36	131	153	192	298
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	31	31	144	239	255
Nuclear	15	15	30	38	46
Hydro	403	472	510	509	508
Solar	0	0	0	0	41
Wind	2	2	3	12	11
Other renewable	0	0	1	8	9
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1721	1709	1800	1962	2163
CO_2	993	943	1020	1164	1342
CH_4	458	488	496	505	522
N_2O	270	278	284	293	299
Greenhouse gas emissions by sector ($MtCO_2e$)	1715	1709	1800	1962	2163
Electricity + district heat production	37	62	108	177	208
Industry	122	174	219	265	339
Residential	17	15	14	14	23
Commercial	4	8	12	17	22
Agriculture	667	698	708	717	720
Transport	210	266	363	462	589
Other energy supply	133	138	145	156	159
Land-use and forestry	524	348	232	154	102

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	-5	80	200	330
Electricity + district heat production	0	-16	41	126	237
Industry	0	5	12	19	19
Residential	0	0	0	0	0
Commercial	0	0	0	0	0
Agriculture	0	1	2	2	3
Transport	0	3	3	32	30
Other energy supply	0	0	21	21	40
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	3	7	36	26
Electricity + district heat production	0	0	0	1	1
Industry	0	2	4	7	9
Iron and steel	0	1	1	1	1
Chemicals	0	0	0	1	1
Pulp and paper	0	0	0	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	2	4	5
Other industries	0	0	0	1	1
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	2	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	1	2
Transport	0	1	1	26	13
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	0	25	11
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	1	1
Aviation	0	0	1	1	1
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 35: Model results on GHG emissions reductions for Brazil for the 40$ carbon tax scenario

Table 36: Model results on energy and GHG emissions for Canada for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.7	11.3	11.7	11.7	11.9
Coal	1.0	1.6	1.3	1.0	1.2
Oil / oil products	3.6	3.8	3.6	3.5	3.3
Natural gas	3.1	3.6	4.2	4.4	4.3
Biomass	0.4	0.6	0.9	1.0	1.0
Nuclear	0.3	0.3	0.4	0.4	0.4
Hydro	1.3	1.3	1.3	1.3	1.3
Wind	0.0	0.0	0.0	0.0	0.4
Solar	0.0	0.0	0.0	0.0	0.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	8.9	9.4	9.4	9.7
Industry	2.1	2.1	2.1	2.1	2.1
Residential	1.4	1.5	1.7	1.8	1.8
Commercial, Agriculture	1.5	1.5	1.6	1.7	1.8
Transport	2.4	2.6	2.8	2.6	2.7
Non-Energy use	1.1	1.2	1.2	1.2	1.2
Final energy consumption by fuel (EJ)	8.5	8.9	9.4	9.4	9.7
Coal	0.0	0.2	0.3	0.3	0.6
Gases	2.2	2.5	2.8	2.9	2.8
Oil products	3.7	3.7	3.7	3.4	3.2
Biomass	0.3	0.5	0.7	0.9	0.9
Electricity	2.2	1.9	1.9	1.9	2.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	608	658	664	642	664
Coal with CCS	0	0	0	0	0
Coal w/o CCS	92	72	38	28	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	8	1	0	7	21
Gas with CCS	0	0	0	0	0
Gas w/o CCS	37	116	125	114	52
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	7	9	9	3	1
Nuclear	90	80	107	107	118
Hydro	364	369	374	370	363
Solar	0	0	0	0	0
Wind	10	11	12	13	110
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	903	813	789	762	756
CO_2	736	652	616	578	552
CH_4	114	109	116	123	139
N_2O	53	52	57	61	65
Greenhouse gas emissions by sector ($MtCO_2e$)	900	813	789	762	756
Electricity + district heat production	249	107	77	67	27
Industry	78	100	104	102	99
Residential	44	45	50	58	58
Commercial	53	47	48	51	53
Agriculture	108	121	130	137	142
Transport	173	187	184	156	160
Other energy supply	136	158	163	169	202
Land-use and forestry	59	49	33	23	15

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	42	116	162	181
Electricity + district heat production	0	5	42	39	82
Industry	0	17	17	24	26
Residential	0	0	0	-5	-4
Commercial	0	0	0	0	1
Agriculture	0	0	0	0	1
Transport	0	4	22	57	38
Other energy supply	0	17	34	47	38
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	2	6	39	17
Electricity + district heat production	0	0	0	0	0
Industry	0	1	2	3	3
Iron and steel	0	0	0	0	0
Chemicals	0	0	0	0	0
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	0	0	0	0
Other industries	0	1	1	1	1
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	0	3	32	10
Road cars and small vehicles	0	0	0	30	8
Road buses and trucks	0	0	2	1	0
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	0	0	0
Other energy supply	0	0	0	3	3
Land-use and forestry	0	0	0	0	0

Table 37: Model results on GHG emissions reductions for Canada for the 40$ carbon tax scenario

Table 38: Model results on energy and GHG emissions for China for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	98.2	116.8	127.9	142.1	153.5
Coal	66.6	73.2	71.5	69.3	68.7
Oil / oil products	17.0	19.7	26.2	32.6	37.3
Natural gas	3.1	9.0	13.3	18.1	21.0
Biomass	8.5	10.9	10.9	12.5	12.5
Nuclear	0.3	0.3	2.6	2.8	3.1
Hydro	2.2	3.1	3.0	2.9	2.8
Wind	0.2	0.2	0.2	3.2	6.7
Solar	0.3	0.3	0.1	0.6	1.2
Other renewable	0.0	0.0	0.0	0.0	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	58.6	77.9	95.3	111.1	124.0
Industry	28.3	38.5	45.5	49.1	51.2
Residential	15.1	15.8	15.5	16.1	15.5
Commercial, Agriculture	4.2	6.8	9.5	12.3	15.0
Transport	7.1	12.2	20.1	28.9	37.8
Non-Energy use	3.9	4.6	4.8	4.7	4.5
Final energy consumption by fuel (EJ)	58.6	77.9	95.3	110.9	123.9
Coal	17.8	23.5	28.0	30.2	33.7
Gases	3.3	8.6	11.3	14.6	16.5
Oil products	13.6	18.8	25.2	30.1	33.7
Biomass	9.6	10.2	10.4	11.9	12.0
Electricity	13.8	16.4	20.0	23.0	25.2
Other renewable	0.0	0.0	0.0	0.5	0.5
Other Non-renewable	0.6	0.3	0.3	0.6	2.4
Electricity generation by fuel and technology (TWh)	3714	5523	6665	7631	8331
Coal with CCS	0	0	0	0	0
Coal w/o CCS	2913	3951	4361	4304	3770
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	33	9	4	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	51	310	492	640	723
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	11	2	1	1
Nuclear	70	95	711	782	860
Hydro	616	872	841	810	780
Solar	1	1	1	1	129
Wind	45	50	55	902	1875
Other renewable	0	0	0	1	11
Other Non-renewable	0	201	193	186	183
Greenhouse gas emissions by emissions type ($MtCO_2e$)	9665	11302	12154	12777	12942
CO_2	7812	9908	10695	11310	11501
CH_4	1394	942	957	956	932
N_2O	459	451	502	512	509
Greenhouse gas emissions by sector ($MtCO_2e$)	9711	11302	12154	12777	12942
Electricity + district heat production	3857	4276	3769	3532	3144
Industry	2315	3353	4058	4424	4615
Residential	339	270	295	328	408
Commercial	112	137	192	265	336
Agriculture	1125	1212	1277	1285	1265
Transport	526	884	1422	1839	2191
Other energy supply	1438	1169	1141	1104	982
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	852	2219	1885	3299
Electricity + district heat production	0	336	1725	1080	1756
Industry	0	433	362	202	623
Residential	0	-5	-16	-19	54
Commercial	0	0	-12	-17	-28
Agriculture	0	4	1	16	3
Transport	0	48	63	266	286
Other energy supply	0	35	96	358	604
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	260	797	257	628
Electricity + district heat production	0	0	269	82	412
Industry	0	221	482	132	178
Iron and steel	0	158	375	18	39
Chemicals	0	6	7	7	15
Pulp and paper	0	1	2	1	1
Non-ferrous metals	0	0	1	1	1
Non-metalic minerals	0	49	91	98	98
Other industries	0	7	7	8	23
Residential	0	1	8	8	9
Cooking	0	0	6	6	7
Heating and warm water	0	1	2	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	5	10	13	19
Cooking	0	0	1	1	2
Heating and warm water	0	0	1	2	5
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	5	9	10	13
Transport	0	32	27	22	10
Road cars and small vehicles	0	0	5	8	0
Road buses and trucks	0	28	14	1	0
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	1	1
Marine navigation	0	2	3	3	3
Aviation	0	2	3	8	5
Other energy supply	0	0	0	0	1
Land-use and forestry	0	0	0	0	0

Table 39: Model results on GHG emissions reductions for China for the 40$ carbon tax scenario

Table 40: Model results on energy and GHG emissions for India for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	28.6	35.4	47.8	65.2	88.3
Coal	12.2	17.5	26.2	37.3	51.7
Oil / oil products	6.9	7.3	9.4	11.1	15.4
Natural gas	2.0	2.5	3.6	5.9	8.1
Biomass	6.9	7.2	7.0	8.6	8.1
Nuclear	0.1	0.1	0.9	1.6	3.4
Hydro	0.4	0.5	0.5	0.5	0.5
Wind	0.2	0.2	0.1	0.2	0.9
Solar	0.0	0.0	0.1	0.2	0.3
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	16.2	23.2	33.6	47.5	66.6
Industry	4.7	7.4	12.6	19.6	29.5
Residential	6.6	6.6	6.3	6.9	6.9
Commercial, Agriculture	1.2	2.2	3.4	5.1	7.4
Transport	2.4	5.1	8.4	12.4	18.8
Non-Energy use	1.3	2.0	2.9	3.6	4.0
Final energy consumption by fuel (EJ)	16.2	23.2	33.5	47.4	66.4
Coal	1.9	3.5	7.3	13.6	22.2
Gases	0.5	2.2	4.6	5.8	8.5
Oil products	4.6	7.3	9.5	11.1	14.9
Biomass	6.7	6.7	6.2	7.7	7.2
Electricity	2.5	3.6	6.0	8.8	12.4
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.1	0.5	1.2
Electricity generation by fuel and technology (TWh)	931	1284	1978	2897	4040
Coal with CCS	0	0	0	0	0
Coal w/o CCS	617	864	1261	1907	2322
Oil with CCS	0	0	0	0	0
Oil w/o CCS	26	16	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	111	170	233	292	298
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	20	66	67	67
Nuclear	19	33	256	444	949
Hydro	107	129	129	128	128
Solar	0	0	0	0	0
Wind	50	47	24	45	257
Other renewable	0	0	0	0	0
Other Non-renewable	0	5	9	13	18
Greenhouse gas emissions by emissions type ($MtCO_2e$)	2239	3003	3801	5190	6806
CO_2	1564	2283	3038	4370	5935
CH_4	591	643	674	716	751
N_2O	84	76	89	104	121
Greenhouse gas emissions by sector ($MtCO_2e$)	2238	3003	3801	5190	6806
Electricity + district heat production	892	1072	1159	1673	1957
Industry	305	513	925	1521	2313
Residential	46	38	82	115	249
Commercial	15	31	56	90	134
Agriculture	534	589	645	681	710
Transport	175	349	507	656	967
Other energy supply	242	386	410	444	469
Land-use and forestry	28	23	16	11	7

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	232	771	996	1246
Electricity + district heat production	0	104	356	325	490
Industry	0	101	238	372	604
Residential	0	-3	-1	0	0
Commercial	0	-5	-6	-8	-10
Agriculture	0	3	4	4	-4
Transport	0	21	117	186	81
Other energy supply	0	12	63	118	85
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	28	267	232	215
Electricity + district heat production	0	6	149	76	13
Industry	0	19	73	116	186
Iron and steel	0	4	28	52	89
Chemicals	0	1	3	4	4
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	13	39	58	91
Other industries	0	0	2	1	1
Residential	0	1	3	3	1
Cooking	0	0	0	0	0
Heating and warm water	0	1	3	3	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	4	6	4
Cooking	0	0	0	1	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	4	4	4
Transport	0	1	38	31	10
Road cars and small vehicles	0	0	7	11	0
Road buses and trucks	0	0	27	14	6
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	1	0
Marine navigation	0	0	0	0	0
Aviation	0	1	3	5	3
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 41: Model results on GHG emissions reductions for India for the 40$ carbon tax scenario

Table 42: Model results on energy and GHG emissions for Japan for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	18.0	20.3	18.0	17.8	17.1
Coal	4.2	5.9	5.5	5.2	5.1
Oil / oil products	8.6	8.7	6.6	6.4	5.3
Natural gas	3.4	3.8	3.7	3.6	3.1
Biomass	0.3	0.3	0.5	0.7	1.1
Nuclear	1.0	0.9	1.3	1.3	1.5
Hydro	0.3	0.3	0.3	0.3	0.3
Wind	0.1	0.1	0.0	0.1	0.5
Solar	0.0	0.0	0.1	0.1	0.1
Other renewable	0.0	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	14.6	14.5	14.2	14.2	14.4
Industry	3.6	3.7	3.6	3.5	3.4
Residential	2.8	2.5	2.4	2.4	2.3
Commercial, Agriculture	2.9	2.8	2.6	2.8	2.9
Transport	3.7	3.9	4.0	4.1	4.3
Non-Energy use	1.6	1.6	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	14.6	14.5	14.1	14.2	14.4
Coal	0.9	0.9	0.9	1.2	2.1
Gases	1.7	2.5	3.0	3.1	3.1
Oil products	7.9	7.2	6.5	6.2	4.9
Biomass	0.0	0.1	0.1	0.3	0.7
Electricity	3.6	3.5	3.4	3.4	3.3
Other renewable	0.4	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.1	0.1	0.1
Electricity generation by fuel and technology (TWh)	1059	1064	1047	1032	1028
Coal with CCS	0	0	0	0	0
Coal w/o CCS	279	307	261	251	166
Oil with CCS	0	0	0	0	0
Oil w/o CCS	84	26	1	2	16
Gas with CCS	0	0	0	0	0
Gas w/o CCS	285	347	263	236	147
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	21	23	55	59	46
Nuclear	280	242	367	367	403
Hydro	75	84	82	80	78
Solar	0	0	1	3	27
Wind	31	31	12	24	133
Other renewable	3	4	5	10	12
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1346	1329	1197	1139	1005
CO_2	1292	1280	1150	1093	962
CH_4	29	28	26	25	24
N_2O	25	21	21	20	19
Greenhouse gas emissions by sector ($MtCO_2e$)	1345	1329	1197	1139	1005
Electricity + district heat production	423	397	297	277	188
Industry	248	246	226	223	229
Residential	96	80	74	69	64
Commercial	103	96	87	93	98
Agriculture	41	38	36	34	32
Transport	266	279	287	288	267
Other energy supply	164	190	188	154	126
Land-use and forestry	4	4	2	2	1

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	13	88	104	173
Electricity + district heat production	0	11	52	69	130
Industry	0	4	11	12	13
Residential	0	0	2	2	2
Commercial	0	0	-5	-5	-3
Agriculture	0	0	0	0	0
Transport	0	1	14	11	10
Other energy supply	0	-4	13	15	21
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	5	49	40	40
Electricity + district heat production	0	0	29	24	30
Industry	0	3	5	5	5
Iron and steel	0	1	1	1	1
Chemicals	0	0	1	1	1
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	2	2	2	2
Other industries	0	1	1	1	1
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	1	14	10	3
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	12	7	1
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	1	1	1
Aviation	0	1	1	2	1
Other energy supply	0	0	0	0	1
Land-use and forestry	0	0	0	0	0

Table 43: Model results on GHG emissions reductions for Japan for the 40$ carbon tax scenario

Table 44: Model results on energy and GHG emissions for Mexico for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	7.8	8.1	10.0	12.4	14.2
Coal	0.3	0.7	1.2	1.6	1.5
Oil / oil products	4.9	4.5	5.3	6.5	7.5
Natural gas	2.0	2.2	2.5	2.8	2.7
Biomass	0.4	0.5	0.6	0.7	0.9
Nuclear	0.0	0.0	0.1	0.1	0.2
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.2	0.3
Solar	0.0	0.0	0.0	0.2	0.8
Other renewable	0.0	0.0	0.1	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	4.6	6.1	7.8	9.8	11.9
Industry	0.9	1.3	1.8	2.4	3.1
Residential	0.7	0.8	0.9	1.1	1.2
Commercial, Agriculture	0.3	0.5	0.7	0.9	1.2
Transport	2.3	2.9	3.6	4.4	4.9
Non-Energy use	0.3	0.5	0.7	1.0	1.4
Final energy consumption by fuel (EJ)	4.6	6.1	7.8	9.8	11.9
Coal	0.0	0.1	0.1	0.1	0.2
Gases	0.5	1.0	1.4	1.9	2.0
Oil products	3.0	3.6	4.5	5.5	6.4
Biomass	0.3	0.4	0.4	0.4	0.7
Electricity	0.8	0.9	1.4	1.9	2.5
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	263	320	445	595	772
Coal with CCS	0	0	0	0	0
Coal w/o CCS	30	76	139	199	192
Oil with CCS	0	0	0	0	0
Oil w/o CCS	46	31	4	1	30
Gas with CCS	0	0	0	0	0
Gas w/o CCS	138	156	204	200	132
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	3	2	21	22	21
Nuclear	11	8	28	36	44
Hydro	27	36	34	32	30
Solar	0	0	0	26	213
Wind	2	3	3	61	87
Other renewable	7	7	12	17	21
Other Non-renewable	0	1	1	2	1
Greenhouse gas emissions by emissions type ($MtCO_2e$)	583	695	800	933	982
CO_2	461	557	662	785	831
CH_4	100	115	112	118	118
N_2O	22	23	26	31	33
Greenhouse gas emissions by sector ($MtCO_2e$)	581	695	800	933	982
Electricity + district heat production	118	145	190	238	225
Industry	51	80	108	132	170
Residential	21	14	14	18	24
Commercial	5	8	12	16	21
Agriculture	94	106	117	126	134
Transport	164	213	259	310	321
Other energy supply	83	92	75	75	75
Land-use and forestry	45	37	25	17	12

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	18	48	113	234
Electricity + district heat production	0	4	16	65	172
Industry	0	4	9	16	18
Residential	0	0	0	1	1
Commercial	0	0	1	0	-1
Agriculture	0	1	2	2	2
Transport	0	0	8	8	5
Other energy supply	0	10	13	21	36
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	4	14	13	13
Electricity + district heat production	0	2	1	2	5
Industry	0	2	3	4	5
Iron and steel	0	0	0	0	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	2	3	4
Other industries	0	0	0	1	0
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	1	1
Transport	0	0	7	5	1
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	7	4	0
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	0	1	1
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 45: Model results on GHG emissions reductions for Mexico for the 40$ carbon tax scenario

Table 46: Model results on energy and GHG emissions for South Korea for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.1	10.5	10.4	10.2	9.7
Coal	2.7	3.5	3.3	2.9	2.0
Oil / oil products	4.4	4.3	4.1	3.8	3.3
Natural gas	1.3	1.9	2.0	2.3	2.4
Biomass	0.1	0.2	0.4	0.5	0.7
Nuclear	0.5	0.5	0.6	0.6	0.6
Hydro	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.1
Solar	0.0	0.0	0.1	0.1	0.5
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	7.5	7.9	8.0	8.0	8.1
Industry	2.6	2.7	2.5	2.4	2.3
Residential	0.8	0.8	0.9	0.9	1.0
Commercial, Agriculture	1.0	1.0	1.1	1.1	1.2
Transport	1.8	1.9	2.0	2.1	2.2
Non-Energy use	1.4	1.5	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	7.5	7.9	8.0	8.0	8.1
Coal	0.2	0.3	0.3	0.3	0.5
Gases	0.9	1.4	2.0	2.3	2.4
Oil products	3.8	3.9	3.4	3.2	2.8
Biomass	0.1	0.1	0.1	0.1	0.3
Electricity	2.4	2.1	2.0	2.0	2.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.1	0.1	0.1	0.0	0.0
Electricity generation by fuel and technology (TWh)	453	640	617	594	600
Coal with CCS	0	0	0	0	0
Coal w/o CCS	209	312	284	243	126
Oil with CCS	0	0	0	0	0
Oil w/o CCS	20	12	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	70	163	139	126	91
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	1	11	28	46	46
Nuclear	148	136	158	163	180
Hydro	3	4	4	4	4
Solar	1	1	1	11	120
Wind	2	2	1	1	34
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	736	753	726	698	585
CO_2	685	704	680	652	540
CH_4	37	36	32	32	31
N_2O	14	13	14	14	13
Greenhouse gas emissions by sector ($MtCO_2e$)	736	753	726	698	585
Electricity + district heat production	332	319	273	241	137
Industry	106	117	111	115	115
Residential	30	34	36	37	36
Commercial	26	27	26	27	29
Agriculture	33	34	35	34	33
Transport	132	142	150	155	154
Other energy supply	77	79	96	89	80
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	18	102	153	273
Electricity + district heat production	0	-3	85	119	239
Industry	0	6	14	18	0
Residential	0	1	3	2	4
Commercial	0	1	0	1	-1
Agriculture	0	0	0	0	0
Transport	0	1	1	1	2
Other energy supply	0	12	-1	12	29
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	5	7	13	14
Electricity + district heat production	0	1	0	3	6
Industry	0	2	4	5	3
Iron and steel	0	0	0	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	3	3	2
Other industries	0	0	0	0	0
Residential	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	0	2	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	1	1	1	1
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	0	0	0	0
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	1	1	1	1
Aviation	0	0	0	1	1
Other energy supply	0	0	0	0	1
Land-use and forestry	0	0	0	0	0

Table 47: Model results on GHG emissions reductions for South Korea for the 40$ carbon tax scenario

Table 48: Model results on energy and GHG emissions for USA for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	86.8	88.0	87.5	85.2	81.7
Coal	21.3	23.8	23.0	17.5	14.0
Oil / oil products	35.9	35.0	34.4	32.6	27.8
Natural gas	22.6	20.9	18.1	18.3	19.3
Biomass	2.6	2.8	3.7	5.3	6.5
Nuclear	3.0	2.8	3.7	4.0	4.4
Hydro	1.0	1.0	1.0	1.0	1.0
Wind	0.3	1.1	2.5	3.7	4.8
Solar	0.1	0.2	1.1	2.5	3.6
Other renewable	0.1	0.4	0.1	0.3	0.3
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	65.6	68.4	71.5	73.9	73.3
Industry	11.7	12.6	13.1	13.2	13.3
Residential	12.9	12.2	13.2	13.6	14.1
Commercial, Agriculture	9.5	10.2	10.7	11.6	12.2
Transport	25.3	26.9	27.8	28.9	26.9
Non-Energy use	6.2	6.5	6.7	6.7	6.9
Final energy consumption by fuel (EJ)	65.6	68.4	71.5	73.9	73.3
Coal	0.8	3.4	4.6	6.7	7.8
Gases	14.6	14.3	15.3	15.6	16.1
Oil products	33.8	34.9	34.6	31.8	26.5
Biomass	2.0	1.9	2.0	3.7	5.5
Electricity	13.7	13.5	14.7	15.3	16.3
Other renewable	0.6	0.4	0.1	0.3	0.3
Other Non-renewable	0.0	0.0	0.1	0.6	0.9
Electricity generation by fuel and technology (TWh)	4187	4258	4595	4789	5086
Coal with CCS	0	0	0	13	6
Coal w/o CCS	1893	1580	1139	839	459
Oil with CCS	0	0	0	0	0
Oil w/o CCS	50	36	25	53	81
Gas with CCS	0	0	0	0	0
Gas w/o CCS	950	1150	916	565	601
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	72	105	233	223	134
Nuclear	830	786	1016	1117	1229
Hydro	276	271	271	270	269
Solar	4	4	284	665	937
Wind	95	302	686	1019	1342
Other renewable	17	20	21	23	25
Other Non-renewable	0	4	3	3	2
Greenhouse gas emissions by emissions type ($MtCO_2e$)	6534	6686	6154	5593	4904
CO_2	5629	5845	5298	4704	3991
CH_4	526	457	430	445	464
N_2O	379	384	426	444	449
Greenhouse gas emissions by sector ($MtCO_2e$)	6647	6686	6154	5593	4904
Electricity + district heat production	2340	2026	1392	984	660
Industry	620	679	743	771	773
Residential	409	367	372	387	394
Commercial	233	273	304	325	331
Agriculture	610	687	745	768	777
Transport	1840	1954	1977	1882	1577
Other energy supply	595	700	621	477	392
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	700	1685	2003	2158
Electricity + district heat production	0	469	1324	1513	1468
Industry	0	100	144	161	202
Residential	0	-9	8	12	10
Commercial	0	1	-9	-28	-28
Agriculture	0	0	4	-1	6
Transport	0	9	31	77	250
Other energy supply	0	131	184	268	248
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	42	134	108	484
Electricity + district heat production	0	17	80	61	189
Industry	0	16	28	28	29
Iron and steel	0	1	1	1	1
Chemicals	0	4	8	9	10
Pulp and paper	0	5	8	8	7
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	4	5	5	7
Other industries	0	3	5	5	3
Residential	0	0	3	5	1
Cooking	0	0	0	1	1
Heating and warm water	0	0	3	4	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	4	4	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	2	2	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	2	2	2
Transport	0	7	19	10	258
Road cars and small vehicles	0	0	0	0	235
Road buses and trucks	0	0	9	1	9
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	1	1
Marine navigation	0	2	3	2	1
Aviation	0	5	5	5	12
Other energy supply	0	0	0	0	5
Land-use and forestry	0	0	0	0	0

Table 49: Model results on GHG emissions reductions for USA for the 40$ carbon tax scenario

Table 50: Model results on energy supply and demand for the rest of world for the 40$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	211.4	233.5	259.6	289.0	317.8
Coal	31.0	38.3	34.0	37.0	37.2
Oil / oil products	79.4	81.4	87.0	91.3	95.9
Natural gas	64.6	76.6	101.3	118.1	129.1
Biomass	26.7	26.4	26.3	28.3	36.6
Nuclear	4.4	4.0	3.9	5.4	5.6
Hydro	4.6	5.5	5.8	5.8	6.1
Wind	0.5	0.6	0.7	1.4	3.6
Solar	0.1	0.3	0.5	1.3	3.0
Other renewable	0.1	0.4	0.3	0.5	0.7
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	158.6	177.4	199.1	220.7	245.1
Industry	38.9	40.7	44.5	47.3	50.8
Residential	48.1	47.8	50.2	55.8	59.5
Commercial, Agriculture	15.7	19.8	23.3	27.6	32.7
Transport	42.7	53.7	63.1	69.8	80.1
Non-Energy use	13.2	15.5	18.1	20.2	22.0
Final energy consumption by fuel (EJ)	158.6	177.4	199.1	220.7	245.0
Coal	5.2	6.5	6.3	9.1	12.9
Gases	34.2	40.2	54.0	62.7	72.9
Oil products	65.5	76.5	84.8	88.6	92.7
Biomass	21.7	21.5	17.5	15.3	12.6
Electricity	25.9	29.3	35.5	42.8	49.5
Other renewable	0.4	0.3	0.1	0.3	0.3
Other Non-renewable	5.6	3.1	1.0	1.8	4.2
Electricity generation by fuel and technology (TWh)	7823	9835	11724	14000	16058
Coal with CCS	0	0	0	4	26
Coal w/o CCS	1789	2058	1688	1787	1302
Oil with CCS	0	0	0	0	0
Oil w/o CCS	717	361	87	20	61
Gas with CCS	0	0	0	0	0
Gas w/o CCS	2479	4385	6262	7212	7070
Biomass with CCS	0	1	1	1	101
Biomass w/o CCS	139	135	714	1295	2561
Nuclear	1228	1112	1073	1498	1568
Hydro	1284	1522	1600	1615	1703
Solar	9	16	22	104	544
Wind	142	164	196	379	993
Other renewable	35	40	46	50	99
Other Non-renewable	0	41	35	34	29
Greenhouse gas emissions by emissions type ($MtCO_2e$)	21244	22576	23704	25029	25669
CO_2	15318	16632	17192	17881	18065
CH_4	3730	3829	4221	4670	5028
N_2O	2196	2115	2292	2478	2576
Greenhouse gas emissions by sector ($MtCO_2e$)	21092	22576	23704	25029	25669
Electricity + district heat production	3628	3675	3690	3980	3409
Industry	2536	2689	3019	3331	3726
Residential	1234	1162	1433	1718	2194
Commercial	321	424	512	578	658
Agriculture	4339	4766	5193	5607	5899
Transport	3100	3908	4574	4928	5269
Other energy supply	2726	3102	3349	3575	3621
Land-use and forestry	3209	2850	1935	1314	892

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	1290	2636	4231	6274
Electricity + district heat production	0	500	1283	2193	3623
Industry	0	369	494	663	762
Residential	0	-4	33	26	-3
Commercial	0	0	0	1	-10
Agriculture	0	3	18	31	47
Transport	0	88	134	330	461
Other energy supply	0	333	674	987	1394
Land-use and forestry	1300	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	292	542	736	779
Electricity + district heat production	0	140	239	295	200
Industry	0	62	137	182	192
Iron and steel	0	8	20	26	28
Chemicals	0	6	14	19	17
Pulp and paper	0	2	4	3	4
Non-ferrous metals	0	2	2	3	3
Non-metalic minerals	0	35	82	112	123
Other industries	0	10	16	20	17
Residential	0	4	15	17	10
Cooking	0	0	1	1	0
Heating and warm water	0	4	14	16	10
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	4	19	25	28
Cooking	0	0	1	2	2
Heating and warm water	0	0	6	9	10
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	4	12	15	16
Transport	0	81	130	207	331
Road cars and small vehicles	0	0	0	8	134
Road buses and trucks	0	59	95	155	154
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	1	1
Marine navigation	0	9	14	14	14
Aviation	0	13	21	28	28
Other energy supply	0	0	2	9	18
Land-use and forestry	0	0	0	0	0

Table 51: Model results on emissions for the rest of world for the 40$ carbon tax scenario

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Results 70$ carbon tax scenario

Table 52: Model results on energy and GHG emissions for the World for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	490.4	535.0	574.8	633.8	706.1
Coal	142.3	152.1	136.5	140.7	154.9
Oil / oil products	168.8	171.7	179.5	188.7	199.9
Natural gas	106.1	127.5	156.2	175.9	190.4
Biomass	49.7	53.6	62.8	73.9	88.3
Nuclear	9.7	11.8	14.6	16.5	19.6
Hydro	11.6	13.8	14.2	14.3	14.3
Wind	1.4	2.3	7.1	14.3	19.8
Solar	0.6	1.0	2.9	7.7	16.9
Other renewable	0.2	1.1	1.0	1.8	2.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	348.7	398.7	448.9	506.9	571.0
Industry	97.4	114.1	128.7	144.1	161.3
Residential	90.5	89.2	91.4	99.8	104.5
Commercial, Agriculture	37.9	46.7	54.9	65.7	77.7
Transport	93.1	114.3	135.6	155.7	183.1
Non-Energy use	29.9	34.4	38.4	41.6	44.3
Final energy consumption by fuel (EJ)	348.7	398.7	448.7	506.5	570.4
Coal	27.5	38.9	45.2	59.7	78.0
Gases	59.6	75.8	100.6	117.9	138.9
Oil products	142.9	161.7	171.5	176.4	183.7
Biomass	43.4	43.5	40.5	43.7	40.4
Electricity	67.4	74.2	87.8	102.3	116.7
Other renewable	1.6	1.0	0.8	1.4	1.4
Other Non-renewable	6.3	3.5	2.2	5.2	11.3
Electricity generation by fuel and technology (TWh)	19982	24586	28566	33126	37659
Coal with CCS	0	0	76	2052	3558
Coal w/o CCS	8040	8054	5809	3821	1763
Oil with CCS	0	0	0	0	0
Oil w/o CCS	1003	536	138	98	228
Gas with CCS	0	0	0	0	6
Gas w/o CCS	4266	7346	9642	9480	7843
Biomass with CCS	0	82	456	1022	3041
Biomass w/o CCS	284	475	1672	2061	1908
Nuclear	2697	3283	4063	4592	5431
Hydro	3224	3833	3951	3983	3971
Solar	16	23	383	1560	3873
Wind	386	639	1965	3981	5501
Other renewable	67	79	208	289	361
Other Non-renewable	0	236	202	188	176
Greenhouse gas emissions by emissions type ($MtCO_2e$)	45999	48048	47860	47717	46775
CO_2	35139	37778	36797	35917	34455
CH_4	7232	6729	7228	7726	8114
N_2O	3628	3541	3835	4074	4206
Greenhouse gas emissions by sector ($MtCO_2e$)	45999	48048	47860	47717	46772
Electricity + district heat production	12131	10958	8330	5932	2259
Industry	6488	7978	9092	10362	11419
Residential	2265	2091	2396	2783	3526
Commercial	881	1060	1246	1500	1755
Agriculture	7864	8578	9231	9753	10073
Transport	6747	8218	9370	10138	11141
Other energy supply	5719	5828	5932	5717	5561
Land-use and forestry	3904	3339	2262	1532	1038

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	5180	12412	17756	24838
Electricity + district heat production	0	2851	7924	11163	16283
Industry	0	1145	1877	2190	3431
Residential	0	-53	42	25	42
Commercial	0	1	-7	-65	-118
Agriculture	0	30	57	78	100
Transport	0	331	974	1767	1801
Other energy supply	0	876	1545	2599	3300
Land-use and forestry	1300	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	874	2568	3614	3804
Electricity + district heat production	0	216	970	1913	1571
Industry	0	402	920	711	874
Iron and steel	0	180	479	190	238
Chemicals	0	20	60	70	79
Pulp and paper	0	14	22	23	26
Non-ferrous metals	0	4	6	6	8
Non-metalic minerals	0	155	298	363	452
Other industries	0	29	56	59	72
Residential	0	10	51	59	52
Cooking	0	1	8	10	10
Heating and warm water	0	9	43	49	42
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	24	68	85	100
Cooking	0	1	7	10	12
Heating and warm water	0	5	15	21	30
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	18	46	54	58
Transport	0	220	545	806	1112
Road cars and small vehicles	0	1	72	300	691
Road buses and trucks	0	177	366	375	301
Rail passengers	0	0	1	2	1
Rail freight	0	2	6	8	7
Marine navigation	0	16	40	41	34
Aviation	0	24	60	80	78
Other energy supply	0	3	14	40	95
Land-use and forestry	0	0	0	0	0

Table 53: Model results on GHG emissions reductions for World for the 70$ carbon tax scenario

Table 54: Model results on energy and GHG emissions for Australia for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	6.4	6.6	6.1	6.0	6.4
Coal	2.5	2.8	1.2	0.8	0.6
Oil / oil products	2.2	2.1	2.0	1.9	2.0
Natural gas	1.3	1.1	1.6	1.4	1.2
Biomass	0.3	0.3	0.6	0.9	1.3
Nuclear	0.0	0.0	0.0	0.0	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.1	0.2	0.3	0.4
Solar	0.0	0.0	0.2	0.5	0.6
Other renewable	0.0	0.0	0.1	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	3.9	4.3	4.7	5.0	5.4
Industry	1.1	1.2	1.3	1.3	1.3
Residential	0.5	0.6	0.8	0.8	0.9
Commercial, Agriculture	0.4	0.5	0.6	0.7	0.8
Transport	1.6	1.7	1.8	2.0	2.1
Non-Energy use	0.2	0.2	0.2	0.2	0.2
Final energy consumption by fuel (EJ)	3.9	4.3	4.7	5.0	5.4
Coal	0.3	0.3	0.4	0.4	0.4
Gases	0.5	0.7	0.8	0.9	0.9
Oil products	2.0	2.1	2.1	2.0	2.0
Biomass	0.2	0.2	0.2	0.4	0.5
Electricity	0.9	1.0	1.1	1.2	1.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.1	0.1
Electricity generation by fuel and technology (TWh)	305	342	374	406	469
Coal with CCS	0	0	0	14	7
Coal w/o CCS	207	204	46	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	3	2	1	2	2
Gas with CCS	0	0	0	0	0
Gas w/o CCS	45	42	88	40	19
Biomass with CCS	0	4	26	27	66
Biomass w/o CCS	3	8	29	30	26
Nuclear	0	0	8	8	16
Hydro	36	39	39	39	39
Solar	0	0	59	141	165
Wind	6	27	57	85	107
Other renewable	5	7	13	12	12
Other Non-renewable	0	9	8	10	10
Greenhouse gas emissions by emissions type ($MtCO_2e$)	670	681	538	460	417
CO_2	473	511	359	271	219
CH_4	152	124	131	139	146
N_2O	45	46	48	50	53
Greenhouse gas emissions by sector ($MtCO_2e$)	669	681	538	460	417
Electricity + district heat production	220	223	57	-5	-42
Industry	71	75	78	79	78
Residential	10	14	17	15	14
Commercial	6	9	12	13	13
Agriculture	150	162	172	181	190
Transport	115	124	130	119	121
Other energy supply	76	57	59	49	37
Land-use and forestry	23	19	13	9	6

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	80	297	388	387
Electricity + district heat production	0	41	244	306	312
Industry	0	8	8	9	8
Residential	0	0	-1	1	2
Commercial	0	-2	-1	0	1
Agriculture	0	0	1	1	2
Transport	0	6	7	24	12
Other energy supply	0	27	39	48	51
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	4	12	95	64
Electricity + district heat production	0	1	1	85	55
Industry	0	2	4	4	4
Iron and steel	0	0	1	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	1	1	1
Non-metalic minerals	0	0	1	1	1
Other industries	0	0	1	1	1
Residential	0	0	0	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	0	1	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	2	5	4	3
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	1	3	2	1
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	1	2	2	2
Other energy supply	0	0	0	1	1
Land-use and forestry	0	0	0	0	0

Table 55: Model results on GHG emissions reductions for Australia for the 70$ carbon tax scenario

Table 56: Model results on energy and GHG emissions for Argentina for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	3.2	3.6	4.3	5.6	6.9
Coal	0.0	0.3	0.3	0.4	0.6
Oil / oil products	1.3	1.4	1.7	2.1	2.5
Natural gas	1.6	1.5	1.8	2.5	3.0
Biomass	0.1	0.3	0.3	0.3	0.3
Nuclear	0.0	0.0	0.1	0.1	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.2
Other renewable	0.0	0.0	0.0	0.0	0.1
Other Non-renewable	0.1	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	2.3	2.9	3.9	5.0	6.5
Industry	0.6	0.8	1.1	1.4	1.8
Residential	0.5	0.6	0.7	0.9	1.1
Commercial, Agriculture	0.3	0.5	0.7	0.9	1.2
Transport	0.7	0.9	1.1	1.5	2.0
Non-Energy use	0.2	0.2	0.3	0.3	0.4
Final energy consumption by fuel (EJ)	2.3	2.9	3.9	5.0	6.5
Coal	0.0	0.0	0.1	0.2	0.3
Gases	0.8	0.8	1.1	1.5	2.1
Oil products	1.0	1.4	1.7	2.1	2.5
Biomass	0.1	0.2	0.2	0.2	0.3
Electricity	0.4	0.5	0.7	0.9	1.2
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	124	182	234	303	382
Coal with CCS	0	0	0	0	17
Coal w/o CCS	2	2	1	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	17	10	5	5	5
Gas with CCS	0	0	0	0	0
Gas w/o CCS	62	124	160	218	224
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	2	2	0	0
Nuclear	7	7	24	31	39
Hydro	34	36	41	41	41
Solar	0	0	0	0	40
Wind	0	0	1	7	10
Other renewable	0	0	0	1	6
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	358	428	493	579	653
CO_2	176	236	287	363	430
CH_4	102	103	110	119	125
N_2O	80	89	96	97	98
Greenhouse gas emissions by sector ($MtCO_2e$)	365	428	493	579	653
Electricity + district heat production	37	52	58	76	77
Industry	36	47	65	89	112
Residential	19	18	22	28	35
Commercial	3	6	10	15	19
Agriculture	163	182	196	203	208
Transport	47	62	83	106	141
Other energy supply	48	52	53	59	59
Land-use and forestry	11	9	6	4	3

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	14	75	114	172
Electricity + district heat production	0	3	18	21	43
Industry	0	4	4	6	4
Residential	0	0	1	1	2
Commercial	0	0	0	0	0
Agriculture	0	0	1	2	2
Transport	0	0	7	14	10
Other energy supply	0	7	44	71	111
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	2	12	23	30
Electricity + district heat production	0	0	0	3	3
Industry	0	1	3	4	5
Iron and steel	0	0	0	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	2	2	2
Other industries	0	0	1	1	2
Residential	0	0	0	0	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	2	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	2	2
Transport	0	0	7	12	13
Road cars and small vehicles	0	0	1	1	1
Road buses and trucks	0	0	5	10	11
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	0	0	1
Other energy supply	0	0	0	1	6
Land-use and forestry	0	0	0	0	0

Table 57: Model results on GHG emissions reductions for Argentina for the 70$ carbon tax scenario

Table 58: Model results on energy and GHG emissions for Brazil for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	11.2	12.2	15.3	18.6	23.7
Coal	0.6	1.0	1.5	2.1	3.7
Oil / oil products	4.7	4.5	5.4	6.9	8.6
Natural gas	1.0	1.9	2.1	2.4	3.5
Biomass	3.4	3.1	4.2	4.5	5.0
Nuclear	0.1	0.1	0.1	0.1	0.2
Hydro	1.5	1.7	1.9	1.9	1.9
Wind	0.0	0.0	0.0	0.3	0.3
Solar	0.0	0.0	0.1	0.3	0.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	10.3	12.8	16.0	20.5
Industry	3.1	3.7	4.4	5.0	5.7
Residential	1.0	1.0	1.3	1.7	2.0
Commercial, Agriculture	0.8	1.3	1.7	2.1	2.6
Transport	3.1	3.6	4.6	6.2	8.8
Non-Energy use	0.5	0.7	0.9	1.1	1.3
Final energy consumption by fuel (EJ)	8.5	10.3	12.8	16.0	20.5
Coal	0.4	0.6	1.1	1.5	2.0
Gases	0.4	1.1	1.5	2.1	2.9
Oil products	3.9	4.3	5.3	6.8	8.5
Biomass	2.2	2.3	2.1	2.1	2.7
Electricity	1.6	1.9	2.7	3.4	4.2
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.2
Electricity generation by fuel and technology (TWh)	515	660	907	1123	1361
Coal with CCS	0	0	0	38	179
Coal w/o CCS	11	13	15	19	6
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	8	1	1	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	36	113	108	89	153
Biomass with CCS	0	1	1	1	0
Biomass w/o CCS	31	35	202	262	273
Nuclear	15	15	30	38	46
Hydro	403	472	534	533	531
Solar	0	0	0	65	89
Wind	2	2	10	70	75
Other renewable	0	0	6	8	9
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1721	1679	1703	1806	1983
CO_2	993	916	926	1011	1166
CH_4	458	486	494	502	518
N_2O	270	278	283	293	299
Greenhouse gas emissions by sector ($MtCO_2e$)	1715	1679	1703	1806	1983
Electricity + district heat production	37	55	47	44	55
Industry	122	174	217	263	335
Residential	17	15	14	14	22
Commercial	4	8	12	17	22
Agriculture	667	697	707	716	719
Transport	210	247	328	443	577
Other energy supply	133	135	147	154	150
Land-use and forestry	524	348	232	154	102

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	25	177	356	509
Electricity + district heat production	0	-8	102	259	390
Industry	0	5	15	21	23
Residential	0	0	0	0	1
Commercial	0	0	0	0	0
Agriculture	0	2	3	3	3
Transport	0	22	38	50	42
Other energy supply	0	3	19	24	49
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	5	35	66	66
Electricity + district heat production	0	0	0	8	25
Industry	0	3	5	11	16
Iron and steel	0	1	1	2	3
Chemicals	0	0	0	1	2
Pulp and paper	0	0	0	1	2
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	3	5	7
Other industries	0	0	1	1	1
Residential	0	0	0	0	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	2	2	3
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	2	2	3
Transport	0	1	27	45	21
Road cars and small vehicles	0	0	3	4	0
Road buses and trucks	0	0	22	38	16
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	1	1	2
Aviation	0	0	1	2	3
Other energy supply	0	0	0	0	1
Land-use and forestry	0	0	0	0	0

Table 59: Model results on GHG emissions reductions for Brazil for the 70$ carbon tax scenario

Table 60: Model results on energy and GHG emissions for Canada for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.7	11.3	11.2	11.6	12.3
Coal	1.0	1.5	1.0	0.7	1.1
Oil / oil products	3.6	3.7	3.2	3.4	3.1
Natural gas	3.1	3.7	4.1	3.9	4.0
Biomass	0.4	0.7	1.1	1.8	2.1
Nuclear	0.3	0.3	0.4	0.4	0.4
Hydro	1.3	1.3	1.3	1.3	1.3
Wind	0.0	0.0	0.0	0.0	0.2
Solar	0.0	0.0	0.0	0.0	0.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	8.8	9.0	9.3	9.6
Industry	2.1	2.0	2.1	2.1	2.1
Residential	1.4	1.5	1.7	1.8	1.8
Commercial, Agriculture	1.5	1.5	1.6	1.7	1.8
Transport	2.4	2.6	2.5	2.5	2.7
Non-Energy use	1.1	1.2	1.2	1.2	1.2
Final energy consumption by fuel (EJ)	8.5	8.8	9.0	9.3	9.6
Coal	0.0	0.2	0.2	0.2	0.8
Gases	2.2	2.5	2.8	2.9	2.9
Oil products	3.7	3.7	3.2	3.2	2.8
Biomass	0.3	0.6	0.9	0.9	0.9
Electricity	2.2	1.9	1.9	2.0	2.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.1	0.1	0.1
Electricity generation by fuel and technology (TWh)	608	655	641	654	688
Coal with CCS	0	0	0	20	10
Coal w/o CCS	92	72	23	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	8	1	0	7	21
Gas with CCS	0	0	0	0	0
Gas w/o CCS	37	111	104	53	3
Biomass with CCS	0	2	12	82	120
Biomass w/o CCS	7	9	9	2	0
Nuclear	90	80	107	107	118
Hydro	364	369	374	370	363
Solar	0	0	0	0	0
Wind	10	11	12	13	53
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	903	803	705	594	584
CO_2	736	639	539	419	385
CH_4	114	112	110	115	134
N_2O	53	52	56	60	65
Greenhouse gas emissions by sector ($MtCO_2e$)	900	803	705	594	584
Electricity + district heat production	249	103	45	-50	-89
Industry	78	98	98	97	93
Residential	44	45	54	54	53
Commercial	53	46	48	51	53
Agriculture	108	121	129	135	142
Transport	173	180	147	144	159
Other energy supply	136	162	150	140	158
Land-use and forestry	59	49	33	23	15

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	52	200	330	353
Electricity + district heat production	0	9	74	155	198
Industry	0	19	23	29	32
Residential	0	0	-4	-1	1
Commercial	0	0	1	1	1
Agriculture	0	0	2	3	1
Transport	0	11	58	68	39
Other energy supply	0	13	47	75	82
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	7	35	103	53
Electricity + district heat production	0	0	0	55	31
Industry	0	2	4	4	4
Iron and steel	0	0	1	1	1
Chemicals	0	0	1	1	1
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	0	0	0	0
Other industries	0	1	1	1	2
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	1	1
Transport	0	4	29	40	12
Road cars and small vehicles	0	0	25	36	9
Road buses and trucks	0	3	2	2	2
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	1
Marine navigation	0	0	0	0	0
Aviation	0	0	1	1	1
Other energy supply	0	0	1	3	4
Land-use and forestry	0	0	0	0	0

Table 61: Model results on GHG emissions reductions for Canada for the 70$ carbon tax scenario

Table 62: Model results on energy and GHG emissions for China for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	98.2	110.3	118.3	128.1	137.6
Coal	66.6	65.9	58.6	53.1	46.6
Oil / oil products	17.0	19.6	27.3	31.6	37.6
Natural gas	3.1	8.6	12.4	16.8	21.0
Biomass	8.5	10.3	11.6	13.0	13.8
Nuclear	0.3	2.3	2.6	2.8	3.1
Hydro	2.2	3.1	3.0	2.9	2.8
Wind	0.2	0.2	2.1	5.8	7.6
Solar	0.3	0.3	0.6	2.0	5.2
Other renewable	0.0	0.0	0.0	0.0	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	58.4	76.9	90.9	105.6	117.3
Industry	28.1	38.3	43.3	48.2	50.3
Residential	15.1	15.1	14.0	14.9	14.5
Commercial, Agriculture	4.2	6.7	9.2	12.0	14.6
Transport	7.1	12.2	19.7	25.8	33.5
Non-Energy use	3.9	4.6	4.7	4.7	4.5
Final energy consumption by fuel (EJ)	58.4	76.9	90.9	105.5	117.2
Coal	17.7	23.7	24.2	27.9	30.7
Gases	3.3	8.7	12.9	17.0	21.2
Oil products	13.6	18.3	22.3	24.5	29.1
Biomass	9.6	9.7	11.1	12.4	9.8
Electricity	13.5	16.3	19.5	22.2	23.2
Other renewable	0.0	0.0	0.5	0.5	0.5
Other Non-renewable	0.6	0.3	0.5	1.0	2.7
Electricity generation by fuel and technology (TWh)	3714	5453	6370	7245	7594
Coal with CCS	0	0	76	502	339
Coal w/o CCS	2913	3348	3010	1899	841
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	33	9	4	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	51	312	968	1095	940
Biomass with CCS	0	0	0	0	366
Biomass w/o CCS	2	11	2	1	1
Nuclear	70	646	711	782	860
Hydro	616	872	841	810	780
Solar	1	1	1	378	1235
Wind	45	50	595	1624	2101
Other renewable	0	0	0	9	11
Other Non-renewable	0	180	156	141	119
Greenhouse gas emissions by emissions type ($MtCO_2e$)	9665	10473	10791	10499	9724
CO_2	7812	9095	9357	9069	8334
CH_4	1394	930	939	931	898
N_2O	459	448	495	498	492
Greenhouse gas emissions by sector ($MtCO_2e$)	9711	10473	10791	10499	9724
Electricity + district heat production	3857	3574	3156	2123	959
Industry	2315	3286	3613	4013	3898
Residential	339	308	313	365	496
Commercial	112	135	175	269	377
Agriculture	1125	1209	1272	1280	1259
Transport	526	848	1221	1480	1883
Other energy supply	1438	1113	1041	969	853
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	1681	3582	4163	6516
Electricity + district heat production	0	1038	2338	2489	3941
Industry	0	500	807	613	1340
Residential	0	-42	-35	-57	-34
Commercial	0	3	4	-21	-68
Agriculture	0	7	7	21	9
Transport	0	84	265	625	594
Other energy supply	0	90	196	493	734
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	358	956	714	872
Electricity + district heat production	0	69	324	328	364
Industry	0	247	554	218	279
Iron and steel	0	158	403	52	58
Chemicals	0	6	15	15	22
Pulp and paper	0	1	2	2	2
Non-ferrous metals	0	1	1	1	2
Non-metalic minerals	0	73	121	131	164
Other industries	0	7	13	17	31
Residential	0	1	12	14	16
Cooking	0	0	6	7	7
Heating and warm water	0	1	6	7	9
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	8	18	23	27
Cooking	0	0	1	1	2
Heating and warm water	0	2	3	4	6
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	6	14	17	19
Transport	0	33	47	126	186
Road cars and small vehicles	0	0	5	84	148
Road buses and trucks	0	28	27	24	21
Rail passengers	0	0	1	1	1
Rail freight	0	1	2	2	2
Marine navigation	0	2	5	6	5
Aviation	0	2	6	8	10
Other energy supply	0	0	0	5	0
Land-use and forestry	0	0	0	0	0

Table 63: Model results on GHG emissions reductions for China for the 70$ carbon tax scenario

Table 64: Model results on energy and GHG emissions for India for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	28.6	33.9	45.9	63.4	86.8
Coal	12.2	15.7	23.7	35.1	50.6
Oil / oil products	6.9	7.1	8.5	11.0	15.1
Natural gas	2.0	2.4	3.5	4.7	6.6
Biomass	6.9	7.4	8.2	9.3	9.0
Nuclear	0.1	0.7	0.9	1.6	3.4
Hydro	0.4	0.5	0.5	0.5	0.5
Wind	0.2	0.2	0.5	1.0	1.3
Solar	0.0	0.0	0.1	0.2	0.3
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	16.2	22.9	32.7	46.2	65.6
Industry	4.7	7.4	12.3	19.0	29.0
Residential	6.6	6.4	6.0	6.6	6.8
Commercial, Agriculture	1.2	2.1	3.3	5.0	7.3
Transport	2.4	5.0	8.2	12.1	18.6
Non-Energy use	1.3	2.0	2.8	3.5	3.9
Final energy consumption by fuel (EJ)	16.2	22.9	32.6	46.1	65.4
Coal	1.9	3.4	7.1	13.1	22.0
Gases	0.5	2.2	4.7	6.1	8.8
Oil products	4.6	7.2	8.6	10.7	14.7
Biomass	6.7	6.7	6.3	7.6	6.9
Electricity	2.5	3.5	5.8	8.4	12.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.1	0.2	1.0
Electricity generation by fuel and technology (TWh)	931	1266	1912	2770	3934
Coal with CCS	0	0	0	340	1474
Coal w/o CCS	617	704	1010	1052	544
Oil with CCS	0	0	0	0	0
Oil w/o CCS	26	16	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	111	134	180	347	249
Biomass with CCS	0	9	36	30	63
Biomass w/o CCS	2	34	145	144	140
Nuclear	19	189	256	444	949
Hydro	107	129	129	128	128
Solar	0	0	0	0	0
Wind	50	47	148	272	369
Other renewable	0	0	0	0	0
Other Non-renewable	0	5	8	13	18
Greenhouse gas emissions by emissions type ($MtCO_2e$)	2239	2780	3425	4363	5378
CO_2	1564	2066	2660	3536	4521
CH_4	591	639	678	727	739
N_2O	84	75	87	101	119
Greenhouse gas emissions by sector ($MtCO_2e$)	2238	2780	3425	4363	5378
Electricity + district heat production	892	887	877	987	585
Industry	305	514	908	1474	2285
Residential	46	42	86	119	243
Commercial	15	31	58	93	135
Agriculture	534	587	643	688	709
Transport	175	340	448	620	966
Other energy supply	242	357	388	372	448
Land-use and forestry	28	23	16	11	7

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	455	1147	1823	2674
Electricity + district heat production	0	289	638	1012	1863
Industry	0	101	254	418	632
Residential	0	-6	-5	-4	6
Commercial	0	-5	-8	-11	-11
Agriculture	0	5	5	-4	-2
Transport	0	30	177	222	81
Other energy supply	0	41	84	190	106
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	38	328	378	478
Electricity + district heat production	0	10	180	156	185
Industry	0	23	94	169	227
Iron and steel	0	8	37	87	118
Chemicals	0	1	5	8	6
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	13	49	72	101
Other industries	0	1	2	2	2
Residential	0	1	4	4	4
Cooking	0	0	0	0	0
Heating and warm water	0	1	4	4	4
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	2	6	7	6
Cooking	0	0	0	1	1
Heating and warm water	0	0	0	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	2	5	6	5
Transport	0	2	44	42	54
Road cars and small vehicles	0	0	7	11	19
Road buses and trucks	0	0	32	22	27
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	1	1
Marine navigation	0	0	0	0	0
Aviation	0	1	4	7	6
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 65: Model results on GHG emissions reductions for India for the 70$ carbon tax scenario

Table 66: Model results on energy and GHG emissions for Japan for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	18.0	20.0	17.7	17.4	16.7
Coal	4.2	5.7	4.9	4.9	4.0
Oil / oil products	8.6	8.7	6.6	5.9	5.3
Natural gas	3.4	3.5	3.7	3.4	3.0
Biomass	0.3	0.3	0.6	1.0	1.7
Nuclear	1.0	1.1	1.3	1.3	1.5
Hydro	0.3	0.3	0.3	0.3	0.3
Wind	0.1	0.1	0.2	0.4	0.6
Solar	0.0	0.0	0.1	0.1	0.2
Other renewable	0.0	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	14.6	14.5	14.0	14.1	14.2
Industry	3.6	3.7	3.5	3.4	3.3
Residential	2.8	2.5	2.4	2.4	2.3
Commercial, Agriculture	2.9	2.8	2.6	2.7	2.9
Transport	3.7	3.9	4.0	4.1	4.3
Non-Energy use	1.6	1.6	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	14.6	14.5	14.0	14.1	14.2
Coal	0.9	0.9	0.9	1.7	1.9
Gases	1.7	2.5	3.1	3.1	3.1
Oil products	7.9	7.2	6.5	5.6	4.8
Biomass	0.0	0.1	0.1	0.3	0.9
Electricity	3.6	3.4	3.4	3.3	3.3
Other renewable	0.4	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.1	0.1	0.1
Electricity generation by fuel and technology (TWh)	1059	1061	1033	1022	1019
Coal with CCS	0	0	0	0	0
Coal w/o CCS	279	277	206	151	67
Oil with CCS	0	0	0	0	0
Oil w/o CCS	84	26	1	2	20
Gas with CCS	0	0	0	0	0
Gas w/o CCS	285	312	259	213	146
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	21	23	57	82	66
Nuclear	280	303	367	367	403
Hydro	75	84	82	80	78
Solar	0	0	2	4	50
Wind	31	31	50	113	177
Other renewable	3	4	9	10	12
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1346	1291	1135	1053	899
CO_2	1292	1242	1088	1007	857
CH_4	29	28	26	25	23
N_2O	25	21	21	20	19
Greenhouse gas emissions by sector ($MtCO_2e$)	1345	1291	1135	1053	899
Electricity + district heat production	423	359	254	198	116
Industry	248	245	221	225	217
Residential	96	80	74	69	64
Commercial	103	96	87	92	97
Agriculture	41	38	36	34	32
Transport	266	279	285	284	256
Other energy supply	164	190	175	150	115
Land-use and forestry	4	4	2	2	1

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	51	150	191	280
Electricity + district heat production	0	49	94	148	203
Industry	0	5	16	10	25
Residential	0	0	2	2	2
Commercial	0	0	-4	-5	-2
Agriculture	0	0	0	0	0
Transport	0	1	16	14	21
Other energy supply	0	-4	26	19	31
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	8	48	49	42
Electricity + district heat production	0	1	21	28	24
Industry	0	3	9	9	9
Iron and steel	0	1	1	1	1
Chemicals	0	0	2	2	2
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	2	4	4	4
Other industries	0	1	1	1	1
Residential	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	1	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	3	16	11	6
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	2	12	7	2
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	1	1	2	1
Aviation	0	1	2	2	2
Other energy supply	0	0	1	0	1
Land-use and forestry	0	0	0	0	0

Table 67: Model results on GHG emissions reductions for Japan for the 70$ carbon tax scenario

Table 68: Model results on energy and GHG emissions for Mexico for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	7.8	8.1	9.7	12.0	13.8
Coal	0.3	0.7	0.8	1.4	1.2
Oil / oil products	4.9	4.5	5.2	6.4	7.5
Natural gas	2.0	2.2	2.6	2.6	2.4
Biomass	0.4	0.5	0.7	0.8	1.0
Nuclear	0.0	0.0	0.1	0.1	0.2
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.2	0.2	0.3
Solar	0.0	0.0	0.0	0.2	1.0
Other renewable	0.0	0.0	0.1	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	4.6	6.0	7.6	9.7	11.7
Industry	0.9	1.3	1.8	2.4	3.0
Residential	0.7	0.8	0.9	1.1	1.2
Commercial, Agriculture	0.3	0.5	0.7	0.9	1.2
Transport	2.3	2.9	3.5	4.3	4.8
Non-Energy use	0.3	0.5	0.7	1.0	1.4
Final energy consumption by fuel (EJ)	4.6	6.0	7.6	9.7	11.7
Coal	0.0	0.1	0.1	0.1	0.1
Gases	0.5	1.0	1.4	1.8	1.9
Oil products	3.0	3.6	4.4	5.4	6.3
Biomass	0.3	0.4	0.4	0.5	0.8
Electricity	0.8	0.9	1.3	1.8	2.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.1	0.1
Electricity generation by fuel and technology (TWh)	263	317	436	591	747
Coal with CCS	0	0	0	161	137
Coal w/o CCS	30	74	73	21	10
Oil with CCS	0	0	0	0	0
Oil w/o CCS	46	31	6	1	29
Gas with CCS	0	0	0	0	0
Gas w/o CCS	138	151	208	186	112
Biomass with CCS	0	4	26	26	22
Biomass w/o CCS	3	3	2	1	0
Nuclear	11	8	28	36	44
Hydro	27	36	34	32	30
Solar	0	0	0	44	254
Wind	2	3	46	65	88
Other renewable	7	7	12	17	21
Other Non-renewable	0	1	1	1	1
Greenhouse gas emissions by emissions type ($MtCO_2e$)	583	681	724	749	790
CO_2	461	548	586	604	642
CH_4	100	110	112	115	115
N_2O	22	23	26	30	33
Greenhouse gas emissions by sector ($MtCO_2e$)	581	681	724	749	790
Electricity + district heat production	118	137	122	75	60
Industry	51	79	106	123	145
Residential	21	14	14	18	24
Commercial	5	8	12	16	21
Agriculture	94	106	116	126	134
Transport	164	212	253	301	316
Other energy supply	83	87	75	73	78
Land-use and forestry	45	37	25	17	12

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	32	125	297	426
Electricity + district heat production	0	11	84	228	337
Industry	0	5	11	25	43
Residential	0	0	0	1	1
Commercial	0	0	1	0	-1
Agriculture	0	1	2	3	3
Transport	0	0	14	16	10
Other energy supply	0	14	13	24	33
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	5	21	42	59
Electricity + district heat production	0	2	1	21	42
Industry	0	2	5	7	8
Iron and steel	0	0	0	1	1
Chemicals	0	0	1	1	1
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	3	5	5
Other industries	0	0	1	1	1
Residential	0	0	0	0	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	2	2	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	2	2
Transport	0	0	12	11	7
Road cars and small vehicles	0	0	3	4	5
Road buses and trucks	0	0	8	5	0
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	1	2	1
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 69: Model results on GHG emissions reductions for Mexico for the 70$ carbon tax scenario

Table 70: Model results on energy and GHG emissions for South Korea for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.1	10.4	10.1	9.8	8.9
Coal	2.7	3.5	3.0	2.5	1.7
Oil / oil products	4.4	4.2	4.0	3.5	2.9
Natural gas	1.3	1.9	2.0	2.3	1.9
Biomass	0.1	0.2	0.4	0.5	0.7
Nuclear	0.5	0.5	0.6	0.6	0.6
Hydro	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.1	0.1	0.1
Solar	0.0	0.1	0.1	0.2	0.8
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	7.5	7.8	7.8	7.9	7.8
Industry	2.7	2.6	2.5	2.4	2.3
Residential	0.8	0.8	0.9	0.9	1.0
Commercial, Agriculture	1.0	1.0	1.1	1.1	1.2
Transport	1.8	1.8	1.9	2.0	2.0
Non-Energy use	1.4	1.5	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	7.5	7.8	7.8	7.9	7.8
Coal	0.3	0.3	0.3	0.3	0.8
Gases	0.9	1.4	2.1	2.4	2.5
Oil products	3.8	3.8	3.3	2.8	1.9
Biomass	0.1	0.0	0.1	0.3	0.5
Electricity	2.4	2.1	2.0	1.9	1.9
Other renewable	0.0	0.1	0.0	0.0	0.0
Other Non-renewable	0.1	0.1	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	453	633	604	582	589
Coal with CCS	0	0	0	0	7
Coal w/o CCS	209	303	258	211	52
Oil with CCS	0	0	0	0	0
Oil w/o CCS	20	12	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	70	161	129	116	81
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	1	14	29	21	21
Nuclear	148	136	163	163	180
Hydro	3	4	4	4	4
Solar	1	1	1	41	209
Wind	2	2	19	26	34
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	736	741	686	637	475
CO_2	685	693	641	592	432
CH_4	37	36	32	32	31
N_2O	14	13	14	13	12
Greenhouse gas emissions by sector ($MtCO_2e$)	736	741	686	637	475
Electricity + district heat production	332	313	253	214	86
Industry	106	116	113	117	109
Residential	30	33	35	36	36
Commercial	26	26	26	27	28
Agriculture	33	34	34	34	33
Transport	132	137	141	132	116
Other energy supply	77	83	84	77	67
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	29	141	213	382
Electricity + district heat production	0	3	105	146	290
Industry	0	8	12	16	7
Residential	0	3	4	3	4
Commercial	0	1	0	1	0
Agriculture	0	0	1	0	0
Transport	0	6	10	24	40
Other energy supply	0	8	11	24	43
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	16	20	21	33
Electricity + district heat production	0	2	2	3	7
Industry	0	6	8	9	5
Iron and steel	0	1	1	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	5	6	7	3
Other industries	0	0	0	0	1
Residential	0	1	2	2	1
Cooking	0	1	1	1	1
Heating and warm water	0	0	1	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	1	2	3
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	6	7	5	17
Road cars and small vehicles	0	0	1	1	14
Road buses and trucks	0	5	4	1	1
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	1	1	2	2
Aviation	0	0	1	1	1
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 71: Model results on GHG emissions reductions for South Korea for the 70$ carbon tax scenario

Table 72: Model results on energy and GHG emissions for USA for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	86.8	85.7	84.2	82.1	78.8
Coal	21.3	20.1	14.7	12.8	10.4
Oil / oil products	35.9	34.1	32.9	31.1	26.4
Natural gas	22.6	22.9	23.1	20.0	20.0
Biomass	2.6	3.1	4.8	6.3	7.4
Nuclear	3.0	2.8	3.7	4.0	4.4
Hydro	1.0	1.0	1.0	1.0	1.0
Wind	0.3	1.1	2.5	3.7	4.8
Solar	0.1	0.2	1.1	2.5	3.6
Other renewable	0.1	0.4	0.4	0.7	0.8
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	65.7	67.2	70.2	72.3	71.4
Industry	11.7	12.3	12.7	12.7	12.9
Residential	12.9	12.2	12.9	13.3	13.9
Commercial, Agriculture	9.5	10.1	10.7	11.5	12.2
Transport	25.3	26.0	27.3	28.1	25.5
Non-Energy use	6.2	6.5	6.6	6.7	6.8
Final energy consumption by fuel (EJ)	65.7	67.2	70.2	72.3	71.4
Coal	0.8	2.9	4.6	5.4	6.9
Gases	14.6	14.8	15.9	16.8	16.6
Oil products	33.8	34.0	33.1	30.5	25.2
Biomass	2.1	1.7	1.9	3.5	5.3
Electricity	13.7	13.4	14.4	15.1	16.2
Other renewable	0.6	0.4	0.1	0.3	0.3
Other Non-renewable	0.0	0.0	0.1	0.6	0.9
Electricity generation by fuel and technology (TWh)	4187	4215	4526	4745	5078
Coal with CCS	0	0	0	486	243
Coal w/o CCS	1893	1301	267	45	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	50	36	25	53	81
Gas with CCS	0	0	0	0	0
Gas w/o CCS	950	1321	1513	617	550
Biomass with CCS	0	18	112	110	78
Biomass w/o CCS	72	153	248	223	174
Nuclear	830	786	1016	1117	1229
Hydro	276	271	271	270	269
Solar	4	4	286	668	941
Wind	95	302	686	1019	1342
Other renewable	17	20	100	135	170
Other Non-renewable	0	3	2	2	1
Greenhouse gas emissions by emissions type ($MtCO_2e$)	6534	6342	5424	4696	4228
CO_2	5629	5522	4563	3808	3326
CH_4	526	439	440	447	456
N_2O	379	381	422	441	446
Greenhouse gas emissions by sector ($MtCO_2e$)	6647	6342	5424	4696	4228
Electricity + district heat production	2340	1822	766	244	227
Industry	620	675	738	719	725
Residential	409	367	353	372	387
Commercial	233	272	303	323	329
Agriculture	610	686	744	761	776
Transport	1840	1885	1937	1824	1483
Other energy supply	595	636	585	452	301
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	1044	2415	2900	2834
Electricity + district heat production	0	674	1950	2252	1902
Industry	0	104	149	212	250
Residential	0	-9	27	27	17
Commercial	0	2	-8	-26	-26
Agriculture	0	0	4	6	8
Transport	0	78	71	135	344
Other energy supply	0	196	220	293	339
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	118	194	650	742
Electricity + district heat production	0	14	80	565	352
Industry	0	23	42	39	43
Iron and steel	0	1	2	1	1
Chemicals	0	4	13	14	15
Pulp and paper	0	8	10	10	10
Non-ferrous metals	0	1	0	1	0
Non-metalic minerals	0	6	9	9	11
Other industries	0	5	8	5	5
Residential	0	0	9	12	3
Cooking	0	0	0	1	1
Heating and warm water	0	0	9	11	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	4	6	6	5
Cooking	0	0	0	0	0
Heating and warm water	0	2	2	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	2	4	3	3
Transport	0	77	57	28	326
Road cars and small vehicles	0	0	0	0	297
Road buses and trucks	0	69	40	12	15
Rail passengers	0	0	0	0	0
Rail freight	0	1	2	2	1
Marine navigation	0	2	5	3	2
Aviation	0	5	11	10	12
Other energy supply	0	0	0	1	14
Land-use and forestry	0	0	0	0	0

Table 73: Model results on GHG emissions reductions for USA for the 70$ carbon tax scenario

Table 74: Model results on energy supply and demand for the rest of world for the 70$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	211.4	232.9	252.0	279.3	314.2
Coal	31.0	34.8	26.7	26.9	34.3
Oil / oil products	79.4	82.0	82.8	85.0	89.1
Natural gas	64.6	77.9	99.4	115.9	123.7
Biomass	26.7	27.4	30.2	35.5	46.0
Nuclear	4.4	4.0	4.9	5.4	5.6
Hydro	4.6	5.5	5.8	6.0	6.1
Wind	0.5	0.6	1.2	2.5	4.1
Solar	0.1	0.3	0.6	1.5	4.5
Other renewable	0.1	0.4	0.4	0.6	0.7
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	158.5	177.0	195.2	215.9	241.0
Industry	38.9	40.6	43.7	46.4	49.7
Residential	48.1	47.6	49.8	55.4	59.0
Commercial, Agriculture	15.7	19.7	22.9	27.0	31.9
Transport	42.7	53.7	61.0	67.1	78.7
Non-Energy use	13.2	15.5	17.9	19.9	21.7
Final energy consumption by fuel (EJ)	158.5	177.0	195.2	215.8	240.8
Coal	5.2	6.4	6.3	9.0	12.1
Gases	34.1	40.1	54.2	63.3	76.2
Oil products	65.6	76.3	81.0	82.9	85.8
Biomass	21.7	21.8	17.3	15.3	11.7
Electricity	25.9	29.2	35.0	41.9	48.7
Other renewable	0.4	0.3	0.1	0.3	0.3
Other Non-renewable	5.6	3.0	1.3	3.0	6.0
Electricity generation by fuel and technology (TWh)	7823	9803	11529	13686	15799
Coal with CCS	0	0	0	492	1145
Coal w/o CCS	1789	1755	899	423	243
Oil with CCS	0	0	0	0	0
Oil w/o CCS	717	361	86	24	69
Gas with CCS	0	0	0	0	6
Gas w/o CCS	2479	4565	5925	6505	5366
Biomass with CCS	0	44	243	746	2326
Biomass w/o CCS	139	183	948	1295	1208
Nuclear	1228	1113	1354	1498	1547
Hydro	1284	1522	1604	1675	1707
Solar	9	16	34	219	889
Wind	142	164	341	688	1145
Other renewable	35	40	68	97	120
Other Non-renewable	0	39	28	22	26
Greenhouse gas emissions by emissions type ($MtCO_2e$)	21244	22148	22236	22280	21643
CO_2	15318	16311	15792	15236	14143
CH_4	3730	3723	4158	4574	4929
N_2O	2196	2114	2285	2470	2572
Greenhouse gas emissions by sector ($MtCO_2e$)	21092	22148	22236	22280	21641
Electricity + district heat production	3628	3433	2695	2025	227
Industry	2536	2671	2934	3163	3422
Residential	1234	1156	1413	1692	2152
Commercial	321	423	504	583	660
Agriculture	4339	4756	5182	5595	5872
Transport	3100	3905	4397	4684	5123
Other energy supply	2726	2955	3177	3223	3294
Land-use and forestry	3209	2850	1935	1314	892

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	1717	4104	6981	10302
Electricity + district heat production	0	742	2278	4147	6805
Industry	0	388	578	831	1067
Residential	0	2	53	52	39
Commercial	0	0	7	-4	-11
Agriculture	0	13	30	43	74
Transport	0	91	311	574	607
Other energy supply	0	480	846	1338	1721
Land-use and forestry	1300	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	312	909	1474	1366
Electricity + district heat production	0	117	361	661	483
Industry	0	89	190	237	276
Iron and steel	0	10	32	43	51
Chemicals	0	9	24	29	31
Pulp and paper	0	3	6	6	9
Non-ferrous metals	0	2	2	3	4
Non-metalic minerals	0	52	100	127	154
Other industries	0	14	26	29	27
Residential	0	6	22	26	25
Cooking	0	0	1	1	0
Heating and warm water	0	6	21	25	24
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	7	30	39	49
Cooking	0	0	5	8	9
Heating and warm water	0	1	8	10	17
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	6	17	21	23
Transport	0	92	294	483	466
Road cars and small vehicles	0	0	26	158	198
Road buses and trucks	0	68	210	252	205
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	2	2
Marine navigation	0	10	25	25	22
Aviation	0	13	31	45	39
Other energy supply	0	1	11	28	67
Land-use and forestry	0	0	0	0	0

Table 75: Model results on emissions for the rest of world for the 70$ carbon tax scenario

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Results 100$ carbon tax scenario

Table 76: Model results on energy and GHG emissions for the World for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	490.4	529.2	563.5	616.7	686.6
Coal	142.3	147.4	123.5	127.7	137.1
Oil / oil products	168.8	169.6	174.3	176.6	189.6
Natural gas	106.1	126.2	155.9	173.1	187.8
Biomass	49.7	55.5	67.7	81.3	94.7
Nuclear	9.7	11.8	14.9	16.5	19.6
Hydro	11.6	13.9	14.4	14.4	14.4
Wind	1.4	2.5	8.3	14.9	20.1
Solar	0.6	1.1	3.5	10.4	21.2
Other renewable	0.2	1.1	1.0	1.9	2.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	348.4	394.9	441.8	496.5	558.7
Industry	97.2	113.0	126.8	141.9	158.5
Residential	90.5	88.9	90.7	99.0	103.4
Commercial, Agriculture	37.9	46.3	54.2	64.6	76.8
Transport	93.0	112.2	131.9	149.7	176.0
Non-Energy use	29.9	34.4	38.2	41.3	44.0
Final energy consumption by fuel (EJ)	348.4	394.8	441.8	496.2	557.9
Coal	27.4	37.5	41.7	55.9	70.2
Gases	59.6	76.0	102.6	120.5	146.1
Oil products	142.9	158.9	165.8	163.5	171.1
Biomass	43.4	44.1	42.1	48.2	42.1
Electricity	67.2	73.9	86.5	101.5	115.7
Other renewable	1.6	1.0	1.0	1.6	1.6
Other Non-renewable	6.3	3.4	2.1	4.9	11.1
Electricity generation by fuel and technology (TWh)	19982	24467	28133	32811	37315
Coal with CCS	0	0	76	2771	4192
Coal w/o CCS	8040	7972	5096	2607	589
Oil with CCS	0	0	0	0	0
Oil w/o CCS	1003	536	138	107	254
Gas with CCS	0	0	3	8	13
Gas w/o CCS	4266	7114	9056	8647	6314
Biomass with CCS	0	119	698	1392	3713
Biomass w/o CCS	284	582	1728	1855	1587
Nuclear	2697	3278	4148	4592	5431
Hydro	3224	3848	3995	4004	3994
Solar	16	23	470	2215	5111
Wind	386	685	2297	4134	5593
Other renewable	67	79	231	301	365
Other Non-renewable	0	231	197	178	160
Greenhouse gas emissions by emissions type ($MtCO_2e$)	45999	47281	44640	42723	40406
CO_2	35139	37043	33617	31009	28192
CH_4	7232	6701	7200	7661	8028
N_2O	3628	3537	3823	4053	4185
Greenhouse gas emissions by sector ($MtCO_2e$)	45999	47281	44639	42720	40400
Electricity + district heat production	12131	10742	7308	4383	301
Industry	6488	7791	8216	9096	9284
Residential	2265	2085	2369	2719	3448
Commercial	881	1056	1243	1459	1742
Agriculture	7864	8562	9221	9728	10054
Transport	6747	8033	8989	9336	10460
Other energy supply	5719	5674	5674	5224	4946
Land-use and forestry	3904	3339	1620	775	165

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	5948	15633	22754	31210
Electricity + district heat production	0	3067	8947	12713	18241
Industry	0	1331	2753	3455	5566
Residential	0	-47	69	89	120
Commercial	0	5	-4	-25	-106
Agriculture	0	46	68	103	119
Transport	0	516	1354	2570	2482
Other energy supply	0	1029	1804	3091	3915
Land-use and forestry	1300	0	642	757	873
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	1239	3073	4595	4685
Electricity + district heat production	0	223	957	2144	1669
Industry	0	566	1072	867	1091
Iron and steel	0	282	542	229	311
Chemicals	0	22	67	86	107
Pulp and paper	0	16	32	32	47
Non-ferrous metals	0	4	6	10	10
Non-metalic minerals	0	201	351	426	518
Other industries	0	41	74	83	98
Residential	0	29	87	111	87
Cooking	0	1	10	12	12
Heating and warm water	0	28	77	99	74
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	39	84	110	125
Cooking	0	4	8	11	15
Heating and warm water	0	9	19	35	43
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	27	57	64	67
Transport	0	371	855	1300	1521
Road cars and small vehicles	0	4	176	634	991
Road buses and trucks	0	305	524	495	357
Rail passengers	0	1	2	2	2
Rail freight	0	4	8	10	9
Marine navigation	0	22	56	58	46
Aviation	0	36	88	101	117
Other energy supply	0	10	19	63	192
Land-use and forestry	0	0	0	0	0

Table 77: Model results on GHG emissions reductions for World for the 100$ carbon tax scenario

Table 78: Model results on energy and GHG emissions for Australia for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	6.4	6.6	6.0	5.8	6.1
Coal	2.5	2.7	1.1	0.5	0.4
Oil / oil products	2.2	2.1	1.9	1.6	1.7
Natural gas	1.3	1.1	1.4	1.4	1.3
Biomass	0.3	0.3	0.9	1.2	1.5
Nuclear	0.0	0.0	0.0	0.0	0.1
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.1	0.2	0.3	0.4
Solar	0.0	0.1	0.3	0.5	0.6
Other renewable	0.0	0.0	0.1	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	3.9	4.3	4.7	4.7	5.0
Industry	1.1	1.2	1.3	1.2	1.2
Residential	0.5	0.6	0.8	0.8	0.9
Commercial, Agriculture	0.4	0.5	0.6	0.7	0.8
Transport	1.6	1.7	1.8	1.8	1.9
Non-Energy use	0.2	0.2	0.2	0.2	0.2
Final energy consumption by fuel (EJ)	3.9	4.3	4.7	4.7	5.0
Coal	0.3	0.3	0.3	0.2	0.2
Gases	0.5	0.7	0.8	1.0	1.0
Oil products	2.0	2.0	2.0	1.7	1.7
Biomass	0.2	0.2	0.3	0.5	0.5
Electricity	0.9	1.0	1.1	1.2	1.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.1	0.1
Electricity generation by fuel and technology (TWh)	305	341	374	403	465
Coal with CCS	0	0	0	14	7
Coal w/o CCS	207	203	41	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	3	2	1	2	2
Gas with CCS	0	0	0	0	0
Gas w/o CCS	45	42	58	20	5
Biomass with CCS	0	8	48	58	91
Biomass w/o CCS	3	8	16	16	14
Nuclear	0	0	8	8	16
Hydro	36	39	39	39	39
Solar	0	0	85	140	162
Wind	6	24	58	85	107
Other renewable	5	7	13	13	14
Other Non-renewable	0	8	8	8	8
Greenhouse gas emissions by emissions type ($MtCO_2e$)	670	667	476	381	345
CO_2	473	497	298	193	149
CH_4	152	124	130	138	144
N_2O	45	46	48	50	52
Greenhouse gas emissions by sector ($MtCO_2e$)	669	667	476	381	345
Electricity + district heat production	220	218	24	-39	-68
Industry	71	74	72	62	57
Residential	10	14	17	15	14
Commercial	6	9	12	13	13
Agriculture	150	161	172	181	190
Transport	115	121	117	98	101
Other energy supply	76	51	51	43	36
Land-use and forestry	23	19	11	6	3

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	95	359	468	459
Electricity + district heat production	0	46	278	340	338
Industry	0	9	14	25	30
Residential	0	0	0	1	2
Commercial	0	-2	-1	0	1
Agriculture	0	1	1	1	2
Transport	0	8	20	45	31
Other energy supply	0	33	46	54	53
Land-use and forestry	0	0	1	2	3
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	10	19	116	86
Electricity + district heat production	0	1	2	85	53
Industry	0	2	5	6	5
Iron and steel	0	1	1	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	1	2	1
Non-metalic minerals	0	0	1	1	1
Other industries	0	1	1	1	1
Residential	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	1	0
Transport	0	6	11	23	24
Road cars and small vehicles	0	0	0	14	19
Road buses and trucks	0	5	8	6	2
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	1	2	2	3
Other energy supply	0	0	0	1	2
Land-use and forestry	0	0	0	0	0

Table 79: Model results on GHG emissions reductions for Australia for the 100$ carbon tax scenario

Table 80: Model results on energy and GHG emissions for Argentina for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	3.2	3.5	4.2	5.3	6.6
Coal	0.0	0.3	0.3	0.4	0.9
Oil / oil products	1.3	1.4	1.7	2.1	2.5
Natural gas	1.6	1.4	1.7	2.1	2.2
Biomass	0.1	0.3	0.3	0.3	0.3
Nuclear	0.0	0.0	0.1	0.1	0.1
Hydro	0.1	0.1	0.2	0.2	0.2
Wind	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.0	0.1	0.3
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.1	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	2.3	2.9	3.8	5.0	6.4
Industry	0.6	0.8	1.0	1.4	1.8
Residential	0.5	0.6	0.7	0.9	1.0
Commercial, Agriculture	0.3	0.5	0.7	0.9	1.2
Transport	0.7	0.9	1.1	1.5	2.0
Non-Energy use	0.2	0.2	0.3	0.3	0.4
Final energy consumption by fuel (EJ)	2.3	2.9	3.8	5.0	6.4
Coal	0.0	0.0	0.0	0.2	0.3
Gases	0.8	0.8	1.1	1.6	2.2
Oil products	1.0	1.4	1.8	2.1	2.4
Biomass	0.1	0.2	0.2	0.2	0.2
Electricity	0.4	0.5	0.7	0.9	1.2
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	124	181	230	296	377
Coal with CCS	0	0	0	15	81
Coal w/o CCS	2	2	1	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	17	10	5	5	5
Gas with CCS	0	0	0	0	0
Gas w/o CCS	62	121	144	169	120
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	2	2	3	3	3
Nuclear	7	7	24	31	39
Hydro	34	38	45	47	48
Solar	0	0	0	13	63
Wind	0	0	4	7	10
Other renewable	0	0	4	5	6
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	358	423	476	543	578
CO_2	176	231	271	331	362
CH_4	102	102	109	116	118
N_2O	80	89	96	97	98
Greenhouse gas emissions by sector ($MtCO_2e$)	365	423	476	543	578
Electricity + district heat production	37	51	52	60	41
Industry	36	47	60	80	98
Residential	19	18	22	28	35
Commercial	3	6	10	14	19
Agriculture	163	182	196	202	207
Transport	47	62	82	106	137
Other energy supply	48	49	49	50	40
Land-use and forestry	11	9	5	3	1

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	19	92	150	247
Electricity + district heat production	0	4	23	38	79
Industry	0	4	9	15	19
Residential	0	0	1	1	2
Commercial	0	0	0	0	0
Agriculture	0	1	2	3	3
Transport	0	0	8	14	14
Other energy supply	0	10	48	79	130
Land-use and forestry	0	0	1	1	1
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	3	14	27	36
Electricity + district heat production	0	0	0	4	4
Industry	0	1	4	6	7
Iron and steel	0	0	0	1	1
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	1	2	3	3
Other industries	0	0	1	2	2
Residential	0	0	0	1	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	1	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	2	3	3
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	2	2	3
Transport	0	0	7	13	14
Road cars and small vehicles	0	0	1	1	1
Road buses and trucks	0	0	5	11	12
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	1
Aviation	0	0	1	1	1
Other energy supply	0	0	0	1	6
Land-use and forestry	0	0	0	0	0

Table 81: Model results on GHG emissions reductions for Argentina for the 100$ carbon tax scenario

Table 82: Model results on energy and GHG emissions for Brazil for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	11.2	12.2	15.1	18.3	23.2
Coal	0.6	1.0	1.1	1.8	2.7
Oil / oil products	4.7	4.5	5.6	6.8	8.5
Natural gas	1.0	1.6	2.1	2.4	3.4
Biomass	3.4	3.3	4.2	4.3	5.3
Nuclear	0.1	0.1	0.1	0.1	0.2
Hydro	1.5	1.7	1.9	2.0	2.0
Wind	0.0	0.0	0.1	0.3	0.4
Solar	0.0	0.0	0.1	0.5	0.7
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	10.3	12.7	15.9	20.1
Industry	3.1	3.7	4.3	4.9	5.5
Residential	1.0	1.0	1.3	1.7	2.0
Commercial, Agriculture	0.8	1.3	1.6	2.1	2.6
Transport	3.1	3.6	4.6	6.2	8.7
Non-Energy use	0.5	0.7	0.9	1.1	1.3
Final energy consumption by fuel (EJ)	8.5	10.3	12.7	15.8	19.9
Coal	0.4	0.6	0.7	1.3	1.5
Gases	0.4	1.1	1.7	2.2	3.0
Oil products	3.9	4.3	5.5	6.8	8.5
Biomass	2.2	2.3	2.1	2.1	2.7
Electricity	1.6	1.9	2.7	3.4	4.1
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.1
Electricity generation by fuel and technology (TWh)	515	648	895	1115	1339
Coal with CCS	0	0	0	22	80
Coal w/o CCS	11	12	8	10	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	8	1	1	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	36	74	80	75	114
Biomass with CCS	0	1	6	6	90
Biomass w/o CCS	31	64	207	219	191
Nuclear	15	15	30	38	46
Hydro	403	472	534	549	547
Solar	0	0	0	117	162
Wind	2	2	23	70	99
Other renewable	0	0	6	8	9
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1721	1658	1506	1603	1657
CO_2	993	897	729	809	845
CH_4	458	483	493	502	514
N_2O	270	278	283	292	298
Greenhouse gas emissions by sector ($MtCO_2e$)	1715	1658	1506	1603	1657
Electricity + district heat production	37	40	28	28	-35
Industry	122	174	208	225	203
Residential	17	15	14	14	22
Commercial	4	8	12	17	22
Agriculture	667	697	706	716	718
Transport	210	247	326	441	576
Other energy supply	133	129	131	158	199
Land-use and forestry	524	348	82	4	-48

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	47	374	559	836
Electricity + district heat production	0	7	121	275	480
Industry	0	6	24	58	156
Residential	0	0	0	0	1
Commercial	0	0	0	0	0
Agriculture	0	2	4	3	4
Transport	0	23	40	52	44
Other energy supply	0	10	35	19	1
Land-use and forestry	0	0	150	150	150
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	9	41	68	88
Electricity + district heat production	0	1	0	2	31
Industry	0	4	9	14	22
Iron and steel	0	1	2	3	7
Chemicals	0	0	1	1	3
Pulp and paper	0	0	1	2	3
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	2	4	6	8
Other industries	0	0	1	1	2
Residential	0	0	0	0	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	3	3	4
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	3	3	3
Transport	0	3	29	48	29
Road cars and small vehicles	0	0	3	4	7
Road buses and trucks	0	2	23	39	16
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	1	2	2
Aviation	0	0	2	3	4
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 83: Model results on GHG emissions reductions for Brazil for the 100$ carbon tax scenario

Table 84: Model results on energy and GHG emissions for Canada for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.7	11.1	11.0	11.4	12.2
Coal	1.0	1.1	0.6	0.9	1.2
Oil / oil products	3.6	3.8	3.3	3.1	2.9
Natural gas	3.1	3.7	3.9	3.7	4.0
Biomass	0.4	0.9	1.5	1.9	2.2
Nuclear	0.3	0.3	0.4	0.4	0.4
Hydro	1.3	1.3	1.3	1.3	1.3
Wind	0.0	0.0	0.0	0.0	0.1
Solar	0.0	0.0	0.0	0.0	0.0
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	8.5	8.8	8.9	9.2	9.6
Industry	2.1	2.0	2.0	2.1	2.1
Residential	1.4	1.5	1.7	1.8	1.8
Commercial, Agriculture	1.5	1.5	1.5	1.7	1.8
Transport	2.4	2.6	2.5	2.5	2.7
Non-Energy use	1.1	1.2	1.2	1.2	1.2
Final energy consumption by fuel (EJ)	8.5	8.8	8.9	9.2	9.6
Coal	0.0	0.2	0.1	0.3	0.8
Gases	2.2	2.5	2.8	3.0	3.0
Oil products	3.7	3.5	3.1	2.9	2.7
Biomass	0.3	0.7	0.9	0.9	0.7
Electricity	2.2	1.9	1.9	2.0	2.2
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.1	0.1
Electricity generation by fuel and technology (TWh)	608	650	653	662	721
Coal with CCS	0	0	0	51	25
Coal w/o CCS	92	72	23	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	8	1	0	9	21
Gas with CCS	0	0	0	1	1
Gas w/o CCS	37	100	86	16	6
Biomass with CCS	0	7	49	95	156
Biomass w/o CCS	7	9	2	0	0
Nuclear	90	80	107	107	118
Hydro	364	370	375	370	363
Solar	0	0	0	0	0
Wind	10	11	12	13	30
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	903	762	625	530	509
CO_2	736	598	461	361	326
CH_4	114	113	108	109	118
N_2O	53	52	56	60	64
Greenhouse gas emissions by sector ($MtCO_2e$)	900	762	625	530	509
Electricity + district heat production	249	94	7	-74	-118
Industry	78	94	90	87	92
Residential	44	45	49	51	53
Commercial	53	46	48	51	53
Agriculture	108	121	130	135	141
Transport	173	171	142	146	153
Other energy supply	136	143	128	116	126
Land-use and forestry	59	49	29	17	8

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	92	280	394	428
Electricity + district heat production	0	18	111	179	227
Industry	0	23	30	39	33
Residential	0	0	1	1	1
Commercial	0	0	1	1	1
Agriculture	0	0	0	3	2
Transport	0	20	64	66	44
Other energy supply	0	32	69	99	113
Land-use and forestry	0	0	4	6	8
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	9	40	110	56
Electricity + district heat production	0	1	2	55	31
Industry	0	3	5	5	5
Iron and steel	0	0	1	1	1
Chemicals	0	0	1	1	1
Pulp and paper	0	0	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	0	0	0	0
Other industries	0	1	2	2	2
Residential	0	0	1	1	0
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	1	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	1	2	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	1	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	1	1	1
Transport	0	5	30	41	13
Road cars and small vehicles	0	0	25	36	9
Road buses and trucks	0	4	2	2	2
Rail passengers	0	0	0	0	0
Rail freight	0	0	1	1	1
Marine navigation	0	0	1	1	0
Aviation	0	0	1	1	1
Other energy supply	0	0	1	6	5
Land-use and forestry	0	0	0	0	0

Table 85: Model results on GHG emissions reductions for Canada for the 100$ carbon tax scenario

Table 86: Model results on energy and GHG emissions for China for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	98.2	109.3	117.8	126.2	134.7
Coal	66.6	65.1	58.7	52.2	42.9
Oil / oil products	17.0	19.5	26.0	30.1	37.5
Natural gas	3.1	8.3	12.8	16.6	21.0
Biomass	8.5	10.5	11.7	13.3	14.1
Nuclear	0.3	2.3	2.6	2.8	3.1
Hydro	2.2	3.1	3.0	2.9	2.8
Wind	0.2	0.2	2.4	5.6	7.6
Solar	0.3	0.3	0.6	2.6	5.7
Other renewable	0.0	0.0	0.0	0.0	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	58.2	76.3	90.4	104.4	115.6
Industry	27.9	37.9	42.9	47.4	49.3
Residential	15.1	15.2	14.0	15.0	14.3
Commercial, Agriculture	4.2	6.6	9.2	11.9	14.4
Transport	7.1	12.0	19.5	25.5	33.1
Non-Energy use	3.8	4.6	4.7	4.7	4.4
Final energy consumption by fuel (EJ)	58.2	76.2	90.4	104.3	115.4
Coal	17.6	23.4	24.4	27.6	29.4
Gases	3.4	8.4	12.9	16.7	21.3
Oil products	13.6	18.1	21.7	23.4	29.2
Biomass	9.7	9.7	11.0	12.8	9.8
Electricity	13.2	16.3	19.4	22.4	22.9
Other renewable	0.0	0.0	0.5	0.5	0.5
Other Non-renewable	0.6	0.3	0.5	1.0	2.3
Electricity generation by fuel and technology (TWh)	3714	5456	6359	7286	7482
Coal with CCS	0	0	76	612	475
Coal w/o CCS	2913	3348	3010	1789	489
Oil with CCS	0	0	0	0	0
Oil w/o CCS	16	33	9	4	10
Gas with CCS	0	0	0	0	0
Gas w/o CCS	51	310	877	1044	874
Biomass with CCS	0	7	7	0	392
Biomass w/o CCS	2	12	8	1	1
Nuclear	70	646	711	782	860
Hydro	616	872	841	810	780
Solar	1	1	1	537	1380
Wind	45	50	662	1560	2102
Other renewable	0	0	0	9	11
Other Non-renewable	0	178	155	137	109
Greenhouse gas emissions by emissions type ($MtCO_2e$)	9665	10352	10326	9745	8681
CO_2	7812	8979	8893	8320	7297
CH_4	1394	926	939	929	893
N_2O	459	447	495	496	491
Greenhouse gas emissions by sector ($MtCO_2e$)	9711	10352	10326	9745	8681
Electricity + district heat production	3857	3540	3095	2014	668
Industry	2315	3226	3299	3524	3187
Residential	339	306	299	350	481
Commercial	112	134	175	247	367
Agriculture	1125	1206	1272	1280	1259
Transport	526	838	1210	1434	1907
Other energy supply	1438	1102	1024	945	859
Land-use and forestry	0	0	-48	-48	-48

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	1802	4046	4916	7560
Electricity + district heat production	0	1072	2399	2597	4231
Industry	0	560	1121	1102	2051
Residential	0	-40	-20	-41	-19
Commercial	0	3	4	1	-58
Agriculture	0	11	7	21	9
Transport	0	95	275	670	570
Other energy supply	0	102	212	517	727
Land-use and forestry	0	0	48	48	48
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	506	1119	836	961
Electricity + district heat production	0	69	381	348	363
Industry	0	369	619	268	352
Iron and steel	0	249	431	52	77
Chemicals	0	6	15	22	30
Pulp and paper	0	1	2	2	3
Non-ferrous metals	0	1	1	2	2
Non-metalic minerals	0	98	151	163	200
Other industries	0	13	19	25	40
Residential	0	18	41	44	18
Cooking	0	0	6	7	7
Heating and warm water	0	18	35	37	11
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	12	22	26	37
Cooking	0	1	1	1	3
Heating and warm water	0	2	4	5	12
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	9	17	19	22
Transport	0	38	55	133	191
Road cars and small vehicles	0	0	5	84	148
Road buses and trucks	0	33	30	24	18
Rail passengers	0	0	1	1	1
Rail freight	0	1	3	3	3
Marine navigation	0	2	8	9	5
Aviation	0	2	9	12	15
Other energy supply	0	0	1	17	0
Land-use and forestry	0	0	0	0	0

Table 87: Model results on GHG emissions reductions for China for the 100$ carbon tax scenario

Table 88: Model results on energy and GHG emissions for India for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	28.6	33.5	44.4	61.9	81.6
Coal	12.2	15.4	19.4	31.7	45.4
Oil / oil products	6.9	6.9	8.3	11.0	12.6
Natural gas	2.0	2.4	5.7	5.6	6.3
Biomass	6.9	7.5	8.9	10.3	10.7
Nuclear	0.1	0.7	0.9	1.6	3.4
Hydro	0.4	0.5	0.5	0.5	0.5
Wind	0.2	0.2	0.7	1.0	1.3
Solar	0.0	0.0	0.1	0.4	1.4
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	16.2	22.7	32.1	45.7	62.4
Industry	4.7	7.4	12.1	18.6	28.6
Residential	6.5	6.4	5.8	6.6	6.8
Commercial, Agriculture	1.2	2.1	3.3	5.0	7.2
Transport	2.4	4.8	8.1	12.0	16.0
Non-Energy use	1.3	2.0	2.8	3.4	3.9
Final energy consumption by fuel (EJ)	16.2	22.7	32.1	45.6	62.4
Coal	1.9	3.4	6.8	12.7	21.5
Gases	0.5	2.2	4.8	6.2	8.9
Oil products	4.6	7.0	8.4	10.6	12.0
Biomass	6.7	6.6	6.2	7.6	7.0
Electricity	2.4	3.5	5.6	8.3	12.1
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.2	0.2	0.9
Electricity generation by fuel and technology (TWh)	931	1257	1862	2732	3929
Coal with CCS	0	0	0	649	1590
Coal w/o CCS	617	687	534	436	27
Oil with CCS	0	0	0	0	0
Oil w/o CCS	26	16	1	1	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	111	134	504	485	204
Biomass with CCS	0	22	117	117	225
Biomass w/o CCS	2	31	134	130	111
Nuclear	19	189	256	444	949
Hydro	107	129	129	128	128
Solar	0	0	0	58	309
Wind	50	47	182	271	370
Other renewable	0	0	0	0	0
Other Non-renewable	0	5	6	11	16
Greenhouse gas emissions by emissions type ($MtCO_2e$)	2239	2716	3004	3711	4327
CO_2	1564	2003	2223	2899	3482
CH_4	591	639	696	714	733
N_2O	84	75	85	99	111
Greenhouse gas emissions by sector ($MtCO_2e$)	2238	2716	3004	3711	4327
Electricity + district heat production	892	847	538	485	38
Industry	305	510	871	1387	2129
Residential	46	42	83	113	238
Commercial	15	31	56	91	136
Agriculture	534	586	639	687	708
Transport	175	324	438	615	773
Other energy supply	242	352	366	325	301
Land-use and forestry	28	23	14	8	4

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	519	1567	2475	3726
Electricity + district heat production	0	329	977	1513	2409
Industry	0	104	292	505	787
Residential	0	-6	-2	2	11
Commercial	0	-5	-6	-8	-11
Agriculture	0	6	10	-3	-2
Transport	0	46	187	227	274
Other energy supply	0	45	107	236	253
Land-use and forestry	0	0	2	3	4
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	76	290	529	635
Electricity + district heat production	0	16	90	254	240
Industry	0	31	120	194	270
Iron and steel	0	12	56	104	148
Chemicals	0	1	6	8	7
Pulp and paper	0	1	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	16	54	79	111
Other industries	0	2	3	2	2
Residential	0	1	4	9	6
Cooking	0	0	0	0	0
Heating and warm water	0	1	4	9	6
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	3	6	7	7
Cooking	0	0	0	1	1
Heating and warm water	0	0	0	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	3	5	6	5
Transport	0	25	70	65	89
Road cars and small vehicles	0	3	7	11	44
Road buses and trucks	0	20	56	43	33
Rail passengers	0	0	0	1	0
Rail freight	0	0	1	1	1
Marine navigation	0	0	1	1	0
Aviation	0	1	5	8	10
Other energy supply	0	0	0	0	23
Land-use and forestry	0	0	0	0	0

Table 89: Model results on GHG emissions reductions for India for the 100$ carbon tax scenario

Table 90: Model results on energy and GHG emissions for Japan for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	18.0	20.1	17.4	16.9	16.4
Coal	4.2	5.7	4.7	4.3	3.5
Oil / oil products	8.6	8.7	6.6	6.0	5.4
Natural gas	3.4	3.6	3.4	3.2	2.9
Biomass	0.3	0.4	0.7	1.1	1.9
Nuclear	1.0	1.1	1.3	1.3	1.5
Hydro	0.3	0.3	0.3	0.3	0.3
Wind	0.1	0.1	0.3	0.4	0.6
Solar	0.0	0.0	0.1	0.1	0.2
Other renewable	0.0	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	14.6	14.4	13.9	14.0	14.0
Industry	3.6	3.6	3.5	3.4	3.3
Residential	2.8	2.5	2.4	2.4	2.3
Commercial, Agriculture	2.9	2.8	2.6	2.7	2.9
Transport	3.7	3.8	3.9	4.1	4.2
Non-Energy use	1.6	1.6	1.5	1.5	1.4
Final energy consumption by fuel (EJ)	14.6	14.4	13.9	14.0	14.0
Coal	0.9	0.9	0.8	1.5	1.8
Gases	1.7	2.5	3.1	3.1	3.1
Oil products	7.9	7.1	6.4	5.5	4.7
Biomass	0.0	0.1	0.2	0.4	0.9
Electricity	3.7	3.4	3.3	3.3	3.3
Other renewable	0.4	0.3	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.1	0.1	0.2
Electricity generation by fuel and technology (TWh)	1059	1055	1025	1010	1008
Coal with CCS	0	0	0	57	29
Coal w/o CCS	279	277	206	97	44
Oil with CCS	0	0	0	0	0
Oil w/o CCS	84	26	1	0	23
Gas with CCS	0	0	0	0	0
Gas w/o CCS	285	311	223	181	109
Biomass with CCS	0	0	0	0	0
Biomass w/o CCS	21	23	59	81	80
Nuclear	280	298	367	367	403
Hydro	75	84	82	80	78
Solar	0	0	2	19	53
Wind	31	31	75	119	177
Other renewable	3	4	9	10	12
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	1346	1280	1094	947	808
CO_2	1292	1231	1047	902	766
CH_4	29	28	26	25	23
N_2O	25	21	21	20	19
Greenhouse gas emissions by sector ($MtCO_2e$)	1345	1280	1094	947	808
Electricity + district heat production	423	361	243	140	88
Industry	248	234	201	194	181
Residential	96	80	74	68	62
Commercial	103	96	87	92	97
Agriculture	41	38	36	34	32
Transport	266	276	280	282	249
Other energy supply	164	192	172	137	99
Land-use and forestry	4	4	2	1	1

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	62	191	296	371
Electricity + district heat production	0	47	105	207	230
Industry	0	16	37	41	61
Residential	0	0	2	2	5
Commercial	0	0	-4	-4	-2
Agriculture	0	0	1	0	0
Transport	0	4	21	17	28
Other energy supply	0	-5	30	32	47
Land-use and forestry	0	0	0	0	1
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	10	40	56	84
Electricity + district heat production	0	0	9	29	52
Industry	0	6	12	11	12
Iron and steel	0	1	2	2	2
Chemicals	0	1	2	2	3
Pulp and paper	0	1	1	1	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	3	5	5	5
Other industries	0	1	2	2	2
Residential	0	0	1	1	2
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	0	1	1	1
Cooking	0	0	0	0	0
Heating and warm water	0	0	1	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	4	17	13	7
Road cars and small vehicles	0	0	0	0	0
Road buses and trucks	0	2	13	8	2
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	1	2	2	2
Aviation	0	2	3	3	3
Other energy supply	0	0	0	1	10
Land-use and forestry	0	0	0	0	0

Table 91: Model results on GHG emissions reductions for Japan for the 100$ carbon tax scenario

Table 92: Model results on energy and GHG emissions for Mexico for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	7.8	7.9	9.6	11.7	13.0
Coal	0.3	0.5	0.4	1.2	1.4
Oil / oil products	4.9	4.3	5.1	6.3	6.4
Natural gas	2.0	2.4	2.8	2.4	2.5
Biomass	0.4	0.5	0.8	0.8	1.0
Nuclear	0.0	0.0	0.1	0.1	0.2
Hydro	0.1	0.1	0.1	0.1	0.1
Wind	0.0	0.0	0.2	0.2	0.3
Solar	0.0	0.0	0.1	0.4	1.0
Other renewable	0.0	0.0	0.1	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	4.6	5.9	7.5	9.6	10.9
Industry	0.9	1.3	1.8	2.3	3.0
Residential	0.7	0.8	0.9	1.0	1.2
Commercial, Agriculture	0.3	0.5	0.7	0.9	1.2
Transport	2.3	2.8	3.5	4.3	4.0
Non-Energy use	0.3	0.5	0.7	1.0	1.4
Final energy consumption by fuel (EJ)	4.6	5.9	7.5	9.6	10.8
Coal	0.0	0.1	0.1	0.1	0.1
Gases	0.5	1.0	1.4	1.7	2.0
Oil products	3.0	3.5	4.3	5.3	5.3
Biomass	0.3	0.4	0.4	0.5	0.7
Electricity	0.8	0.9	1.3	1.8	2.4
Other renewable	0.0	0.0	0.0	0.1	0.1
Other Non-renewable	0.0	0.0	0.0	0.1	0.1
Electricity generation by fuel and technology (TWh)	263	312	430	585	751
Coal with CCS	0	0	0	157	159
Coal w/o CCS	30	35	24	0	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	46	31	6	1	15
Gas with CCS	0	0	0	0	0
Gas w/o CCS	138	185	231	168	117
Biomass with CCS	0	4	30	30	26
Biomass w/o CCS	3	2	2	1	0
Nuclear	11	8	28	36	44
Hydro	27	36	34	32	30
Solar	0	0	16	77	250
Wind	2	3	46	65	88
Other renewable	7	7	12	17	21
Other Non-renewable	0	0	0	1	1
Greenhouse gas emissions by emissions type ($MtCO_2e$)	583	657	676	683	664
CO_2	461	524	537	540	518
CH_4	100	109	114	113	114
N_2O	22	23	26	30	31
Greenhouse gas emissions by sector ($MtCO_2e$)	581	657	676	683	664
Electricity + district heat production	118	119	89	50	42
Industry	51	77	92	97	105
Residential	21	14	14	15	22
Commercial	5	8	12	16	20
Agriculture	94	105	116	126	133
Transport	164	205	250	297	259
Other energy supply	83	91	81	69	77
Land-use and forestry	45	37	22	13	6

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	57	172	363	553
Electricity + district heat production	0	30	117	253	355
Industry	0	6	26	51	82
Residential	0	0	0	4	4
Commercial	0	0	1	0	0
Agriculture	0	2	3	3	4
Transport	0	7	17	20	68
Other energy supply	0	11	6	27	35
Land-use and forestry	0	0	3	4	6
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	13	26	61	123
Electricity + district heat production	0	2	0	34	44
Industry	0	3	7	9	9
Iron and steel	0	0	1	1	1
Chemicals	0	0	1	1	1
Pulp and paper	0	0	0	0	1
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	2	4	6	6
Other industries	0	1	1	1	1
Residential	0	0	0	1	1
Cooking	0	0	0	1	1
Heating and warm water	0	0	0	1	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	2	2	3
Cooking	0	0	0	0	0
Heating and warm water	0	0	0	0	0
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	1	2	2	2
Transport	0	7	16	14	65
Road cars and small vehicles	0	0	3	4	62
Road buses and trucks	0	7	11	7	1
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	0	0	0	0
Aviation	0	0	1	2	2
Other energy supply	0	0	0	0	0
Land-use and forestry	0	0	0	0	0

Table 93: Model results on GHG emissions reductions for Mexico for the 100$ carbon tax scenario

Table 94: Model results on energy and GHG emissions for South Korea for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	9.1	10.4	10.0	8.7	8.5
Coal	2.7	3.5	2.9	1.5	1.3
Oil / oil products	4.4	4.2	3.9	2.8	2.9
Natural gas	1.3	1.9	2.0	2.3	1.9
Biomass	0.1	0.2	0.4	0.6	0.7
Nuclear	0.5	0.5	0.6	0.6	0.6
Hydro	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.1	0.1	0.1
Solar	0.0	0.1	0.2	0.8	0.9
Other renewable	0.0	0.0	0.0	0.0	0.0
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	7.5	7.8	7.7	7.6	7.7
Industry	2.7	2.6	2.4	2.3	2.2
Residential	0.8	0.8	0.9	0.9	1.0
Commercial, Agriculture	1.0	1.0	1.0	1.1	1.1
Transport	1.8	1.8	1.9	1.8	1.9
Non-Energy use	1.4	1.5	1.5	1.4	1.4
Final energy consumption by fuel (EJ)	7.5	7.8	7.7	7.6	7.7
Coal	0.3	0.3	0.3	0.4	0.8
Gases	0.9	1.4	2.1	2.5	2.6
Oil products	3.8	3.8	3.1	2.3	1.7
Biomass	0.1	0.0	0.1	0.4	0.6
Electricity	2.4	2.1	2.0	1.9	1.9
Other renewable	0.0	0.1	0.0	0.0	0.0
Other Non-renewable	0.1	0.0	0.0	0.0	0.0
Electricity generation by fuel and technology (TWh)	453	630	592	572	581
Coal with CCS	0	0	0	21	10
Coal w/o CCS	209	297	240	62	21
Oil with CCS	0	0	0	0	0
Oil w/o CCS	20	12	1	0	0
Gas with CCS	0	0	0	0	0
Gas w/o CCS	70	163	128	74	83
Biomass with CCS	0	0	2	2	1
Biomass w/o CCS	1	14	22	10	8
Nuclear	148	136	163	163	180
Hydro	3	4	4	4	4
Solar	1	1	13	211	240
Wind	2	2	19	26	34
Other renewable	0	0	0	0	0
Other Non-renewable	0	0	0	0	0
Greenhouse gas emissions by emissions type ($MtCO_2e$)	736	731	655	473	419
CO_2	685	687	610	430	376
CH_4	37	31	31	31	31
N_2O	14	13	13	12	12
Greenhouse gas emissions by sector ($MtCO_2e$)	736	731	655	473	419
Electricity + district heat production	332	309	240	84	60
Industry	106	113	103	113	99
Residential	30	33	35	35	34
Commercial	26	26	25	27	28
Agriculture	33	34	34	34	33
Transport	132	136	134	109	105
Other energy supply	77	80	82	71	59
Land-use and forestry	0	0	0	0	0

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	40	173	377	439
Electricity + district heat production	0	7	118	276	316
Industry	0	10	21	20	17
Residential	0	3	4	4	5
Commercial	0	1	0	1	0
Agriculture	0	0	1	0	0
Transport	0	8	17	47	51
Other energy supply	0	11	13	29	50
Land-use and forestry	0	0	0	0	0
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	18	26	56	48
Electricity + district heat production	0	1	3	18	5
Industry	0	7	9	11	6
Iron and steel	0	1	1	2	2
Chemicals	0	0	0	0	0
Pulp and paper	0	0	0	0	0
Non-ferrous metals	0	0	0	0	0
Non-metalic minerals	0	6	7	8	3
Other industries	0	0	0	1	1
Residential	0	1	2	2	2
Cooking	0	1	1	1	1
Heating and warm water	0	0	1	1	1
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	1	1	2	3
Cooking	0	0	0	0	0
Heating and warm water	0	0	1	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Transport	0	8	11	23	25
Road cars and small vehicles	0	0	1	12	17
Road buses and trucks	0	6	7	6	4
Rail passengers	0	0	0	0	0
Rail freight	0	0	0	0	0
Marine navigation	0	1	2	2	2
Aviation	0	1	1	2	2
Other energy supply	0	0	0	0	8
Land-use and forestry	0	0	0	0	0

Table 95: Model results on GHG emissions reductions for South Korea for the 100$ carbon tax scenario

Table 96: Model results on energy and GHG emissions for USA for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	86.8	85.1	81.8	76.9	77.0
Coal	21.3	19.2	12.0	11.3	8.2
Oil / oil products	35.9	34.3	32.2	26.3	25.1
Natural gas	22.6	22.9	23.7	19.6	21.2
Biomass	2.6	3.2	5.2	7.6	7.7
Nuclear	3.0	2.8	3.7	4.0	4.4
Hydro	1.0	1.0	1.0	1.0	1.0
Wind	0.3	1.1	2.6	3.8	4.9
Solar	0.1	0.2	1.2	2.6	3.6
Other renewable	0.1	0.4	0.4	0.7	0.8
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	65.7	66.9	69.1	68.1	69.6
Industry	11.7	12.2	12.4	12.6	12.3
Residential	12.9	12.1	12.8	13.2	13.7
Commercial, Agriculture	9.5	10.1	10.6	11.4	12.2
Transport	25.3	26.0	26.7	24.3	24.6
Non-Energy use	6.2	6.5	6.6	6.7	6.8
Final energy consumption by fuel (EJ)	65.7	66.9	69.1	68.1	69.6
Coal	0.8	2.3	3.6	4.8	4.5
Gases	14.6	15.1	16.6	17.0	18.1
Oil products	33.8	33.8	31.9	25.1	23.6
Biomass	2.1	1.9	2.7	5.3	6.1
Electricity	13.7	13.4	14.1	15.0	16.2
Other renewable	0.6	0.4	0.1	0.3	0.3
Other Non-renewable	0.0	0.0	0.1	0.6	1.0
Electricity generation by fuel and technology (TWh)	4187	4198	4413	4684	5071
Coal with CCS	0	0	0	525	273
Coal w/o CCS	1893	1285	185	1	0
Oil with CCS	0	0	0	0	0
Oil w/o CCS	50	36	26	53	81
Gas with CCS	0	0	0	0	0
Gas w/o CCS	950	1344	1532	594	546
Biomass with CCS	0	20	123	118	97
Biomass w/o CCS	72	128	164	149	89
Nuclear	830	786	1016	1117	1229
Hydro	276	271	271	270	269
Solar	4	4	286	669	942
Wind	95	302	709	1051	1374
Other renewable	17	20	100	135	170
Other Non-renewable	0	3	2	2	1
Greenhouse gas emissions by emissions type ($MtCO_2e$)	6534	6261	5001	3938	3780
CO_2	5629	5443	4144	3066	2878
CH_4	526	437	436	439	458
N_2O	379	381	420	432	444
Greenhouse gas emissions by sector ($MtCO_2e$)	6647	6261	5001	3938	3780
Electricity + district heat production	2340	1816	681	198	215
Industry	620	621	630	623	520
Residential	409	365	361	368	377
Commercial	233	271	301	321	329
Agriculture	610	685	743	759	772
Transport	1840	1875	1857	1432	1391
Other energy supply	595	628	547	356	295
Land-use and forestry	0	0	-118	-118	-118

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	0	1126	2838	3658	3283
Electricity + district heat production	0	679	2035	2299	1914
Industry	0	157	257	309	456
Residential	0	-8	18	31	27
Commercial	0	4	-6	-24	-26
Agriculture	0	2	6	8	12
Transport	0	88	152	528	437
Other energy supply	0	204	258	389	345
Land-use and forestry	0	0	118	118	118
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	125	242	1032	872
Electricity + district heat production	0	14	78	613	357
Industry	0	24	47	48	68
Iron and steel	0	2	2	2	2
Chemicals	0	4	13	14	20
Pulp and paper	0	8	13	13	25
Non-ferrous metals	0	1	1	1	1
Non-metalic minerals	0	6	10	10	11
Other industries	0	5	8	8	9
Residential	0	1	10	15	12
Cooking	0	0	0	1	1
Heating and warm water	0	1	10	13	11
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	4	8	7	6
Cooking	0	0	0	0	0
Heating and warm water	0	2	3	2	2
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	2	5	5	4
Transport	0	81	98	346	406
Road cars and small vehicles	0	0	0	282	367
Road buses and trucks	0	68	74	42	18
Rail passengers	0	0	0	0	0
Rail freight	0	1	2	2	1
Marine navigation	0	3	6	4	2
Aviation	0	9	16	16	18
Other energy supply	0	1	1	3	22
Land-use and forestry	0	0	0	0	0

Table 97: Model results on GHG emissions reductions for USA for the 100$ carbon tax scenario

Table 98: Model results on energy supply and demand for the rest of world for the 100$ carbon tax scenario

Indicator	2010	2020	2030	2040	2050
Primary energy consumption by fuel (EJ)	211.4	229.5	246.0	273.5	307.2
Coal	31.0	33.1	22.6	21.8	29.2
Oil / oil products	79.4	80.0	79.7	80.3	84.1
Natural gas	64.6	77.0	96.5	113.7	121.2
Biomass	26.7	28.3	33.1	40.0	49.2
Nuclear	4.4	4.0	5.2	5.4	5.6
Hydro	4.6	5.5	5.9	6.0	6.1
Wind	0.5	0.8	1.8	3.1	4.3
Solar	0.1	0.4	0.9	2.4	6.7
Other renewable	0.1	0.4	0.4	0.7	0.7
Other Non-renewable	0.0	0.0	0.0	0.0	0.0
Final energy consumption by sector (EJ)	158.4	174.6	191.0	212.3	237.3
Industry	38.8	40.2	43.1	45.7	49.2
Residential	48.1	47.4	49.3	54.8	58.4
Commercial, Agriculture	15.7	19.4	22.4	26.3	31.4
Transport	42.7	52.1	58.3	65.8	76.8
Non-Energy use	13.2	15.5	17.8	19.8	21.5
Final energy consumption by fuel (EJ)	158.4	174.6	191.0	212.3	237.0
Coal	5.1	6.0	4.5	6.9	9.3
Gases	34.1	40.2	55.5	65.6	81.0
Oil products	65.6	74.3	77.5	77.9	79.3
Biomass	21.7	21.8	17.8	17.5	12.7
Electricity	25.8	29.0	34.3	41.3	48.0
Other renewable	0.4	0.3	0.2	0.4	0.4
Other Non-renewable	5.6	3.0	1.2	2.7	6.2
Electricity generation by fuel and technology (TWh)	7823	9738	11299	13466	15591
Coal with CCS	0	0	0	647	1464
Coal w/o CCS	1789	1754	822	212	8
Oil with CCS	0	0	0	0	0
Oil w/o CCS	717	361	86	32	96
Gas with CCS	0	0	3	7	12
Gas w/o CCS	2479	4330	5194	5820	4134
Biomass with CCS	0	50	316	966	2635
Biomass w/o CCS	139	289	1112	1245	1090
Nuclear	1228	1113	1439	1498	1547
Hydro	1284	1534	1642	1675	1707
Solar	9	16	65	374	1549
Wind	142	214	508	867	1203
Other renewable	35	41	86	104	121
Other Non-renewable	0	37	25	18	24
Greenhouse gas emissions by emissions type ($MtCO_2e$)	21244	21775	20800	20166	18639
CO_2	15318	15953	14403	13158	11193
CH_4	3730	3710	4118	4545	4882
N_2O	2196	2112	2279	2463	2565
Greenhouse gas emissions by sector ($MtCO_2e$)	21092	21775	20799	20163	18634
Electricity + district heat production	3628	3346	2310	1436	-631
Industry	2536	2622	2590	2703	2615
Residential	1234	1154	1401	1661	2111
Commercial	321	421	506	570	659
Agriculture	4339	4748	5176	5575	5862
Transport	3100	3778	4154	4375	4808
Other energy supply	2726	2857	3042	2954	2853
Land-use and forestry	3209	2850	1620	888	357

Indicator	2010	2020	2030	2040	2050
Greenhouse gas emission reduction compared to BAU ($MtCO_2e$)	1300	2090	5541	9097	13309
Electricity + district heat production	0	829	2662	4736	7663
Industry	0	437	922	1291	1874
Residential	0	5	65	83	80
Commercial	0	3	5	9	-11
Agriculture	0	22	35	63	84
Transport	0	218	554	883	921
Other energy supply	0	578	981	1607	2162
Land-use and forestry	1300	0	315	425	535
Greenhouse gas emission reduction compared to BAU due to energy efficieny measures ($MtCO_2e$)	0	460	1216	1706	1696
Electricity + district heat production	0	119	392	702	488
Industry	0	116	236	295	334
Iron and steel	0	16	46	61	71
Chemicals	0	10	29	38	42
Pulp and paper	0	4	12	12	12
Non-ferrous metals	0	1	3	4	5
Non-metalic minerals	0	68	112	145	168
Other industries	0	18	34	37	35
Residential	0	8	28	37	43
Cooking	0	0	2	2	2
Heating and warm water	0	8	25	35	42
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	0	0	0	0
Commercial and Agriculture	0	16	37	56	60
Cooking	0	3	6	8	10
Heating and warm water	0	4	8	23	23
Cooling	0	0	0	0	0
Other electric consumption	0	0	0	0	0
Other fuel consumption	0	10	22	25	27
Transport	0	194	509	583	657
Road cars and small vehicles	0	0	130	184	317
Road buses and trucks	0	160	295	308	249
Rail passengers	0	0	0	0	0
Rail freight	0	1	2	2	3
Marine navigation	0	13	35	36	30
Aviation	0	20	47	52	59
Other energy supply	0	8	15	34	114
Land-use and forestry	0	0	0	0	0

Table 99: Model results on emissions for the rest of world for the 100$ carbon tax scenario

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