Impacts of good practice policies on regional and global greenhouse gas emissions

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Summary

This report identifies good practice policies (see Box 1) that are currently implemented by individual countries and calculates the impact on greenhouse gas emissions on the global level if these policies were implemented widely. The study covers on an illustrative set of sectors, and provides detail for six example large emitting countries (China, United States, India, Brazil, the Russian Federation and Japan)[1]. The choice of sectors, regions and methodologies means the study considers around 65% of global emissions.

The starting point of this study is an earlier report (den Elzen et al., 2015) which analysed the impact of enhanced policies on greenhouse gas emission reductions in the 13 largest emitting countries/regions (Australia, Brazil, Canada, China, the European Union, India, Indonesia, Japan, Mexico, the Russian Federation, South Korea, Turkey, and the United States) compared to the emission trajectories based on the most efficient current and planned climate policies.

The research question of that study was to find out how far countries could reduce emissions with three to five selected most efficient enhanced mitigation measures related to different areas of climate policy in each country, which are related to current national priorities. These areas include support for renewable energy, fuel efficiency in passenger transport, or a phase-down of fluorinated gases. The mitigation measures in this report all relate to the up-scaling of low-carbon energy supply, improvements in energy efficiency, and the adoption of low-emission technologies in all sectors.

The analysis in this report extends the scope in three ways:

- It covers more policy areas and enhanced mitigation measures for each country, to illustrate a comprehensive picture of how emissions could develop under the application of existing “good practice” policies.
- It scales up the analysis to the global level, to illustrate how global emissions would develop if all countries would implement good practice policies.
- It assesses the impact of GHG reductions on a sectoral level using sector specific indicators.

The purpose of this study is to test how much in terms of emission reductions could be delivered from replicating existing policy approaches in further sectors in other regions. It aims at contributing to identify practical ways to enhance emission reduction on the ground. This study is only a first step: “good practice” mainly refers to a policy with significant mitigation impact. All these “good practices” have been implemented by a broad number of countries across regions and proven their feasibility (e.g. car fuel efficiency standards). In this sense, “good practice” does not necessarily mean cost-effective, compatibility with national processes, or stakeholder interests.

[1] We do not consider the European Union separately, but refer to other studies which have analysed the impact of enhanced policies on its emissions (compare e.g. (Bossman, Eichhammer, & Elsland, 2012; Greenpeace, 2012; Labat et al., 2015)). For more detail, see (den Elzen et al., 2015)

Box 1 Definition good practice policies and context of assessment

> **Good practice policies** are climate- and energy policies that have been - or are being - implemented in specific countries and have resulted in significant deviation from business-as-usual emissions development in specific (sub-)sectors. These policies show it is technically and politically possible to implement such policies in one country. We translate this into global implementation to illustrate the impact of replicating very ambitious climate policies and try to learn how far it could bring the world to hold global warming below 2°C.
>
> Further, we give an indication of what these good practice policies mean for the decarbonisation of sectors. Note that, although we show results for six exemplary large emitting countries, the approach does not give a recipe for these specific countries on how to implement ambitious climate policies. It merely inspires to show the possibilities of some chosen standard measures. Actual implementation should consider local circumstances and criteria that go further than mere emission reduction. Based on these considerations, other measures might be more appropriate based on these considerations.

1.1 Main findings

If current good practice policies were to be implemented by all countries, global emissions in 2020 and 2030 are projected to decrease emissions close to the range necessary to hold global warming below 2°C. This requires fast implementation of policies, as well as complete geographical and broad sectoral coverage. All the parameters chosen for this analysis are based on analysis of policies that have already been implemented by example countries.

Other main findings of the report are:

- **There is a large potential in replicating good practice policies: this could bring GHG emissions close to the level necessary to stay on track to meet 2°C.**
  With current policies, global emissions are expected to increase between 53.9 to 54.3 $GtCO_2e$ by 2020 and 58.6 to 60.1 $GtCO_2e$ by 2030. With the nine policy areas we have analysed, implementation of good practice policies is projected to stabilise GHG emissions by 2020 at 49.2 to 49.7 $GtCO_2e$ and decrease to 43.7 to 47.4 $GtCO_2e$ by 2030, which would be close to the 2°C range (UNEP, 2014). The emissions range that reflects scenarios compatible with holding temperature increase below 2°C is between 30 to 44 $GtCO_2e$ in 2030 in the UNEP Emissions Gap Report 2014, with the median of all of those scenarios being 42 $GtCO_2e$ (UNEP, 2014).

  These good practice policies were implemented in sectors representing 65% of global emissions, no additional policies were analysed in the remaining sectors.

- **Replicating good practices policies across many different sectors would deliver most significant reductions.**
  Most emission reductions in our study result from increasing support for electricity generation from renewable energy (3.7 to 6.0 $GtCO_2e$ reduction in 2030). The range is due to different assumptions that can be made for current trends after 2020 for which often no specific renewable policies are yet in place, and different assumptions for the implementation of good practice policies (see Section 3.1.1).

  Many countries see these technologies in the electricity sector as an important opportunity to develop a cleaner energy system and are already implementing policies. The good practice policies can build on those efforts.

Good practice policies in energy efficiency can also lead to emission reductions. Implementing efficiency measures in the transport, appliances and industry sectors could avoid 2.9 to 5.1 $GtCO_2e$/a in 2030. Most countries already have efficiency standards in place that limit the energy consumption of technologies. These standards could be extended in scope, enhanced in terms of ambition and their enforcement strengthened. Good practice policies for reducing deforestation could imply emission reductions of 1.5 $GtCO_2e$ below scenarios with implemented policies.

- **Direct replication of good practice policies is projected to halt emission growth in most regions significantly before 2030**
  For all countries analysed, the good practice policies can lead to significant emission reductions. In most countries, implementation of these policies halts emission growth at today's level or decreases emissions from this point. An exception is India, where current activity levels are extremely low and further development will still slightly increase emissions until 2030, even with the implementation of good practice policies.

  Depending on country circumstances, the size of absolute reductions differs. Of course, the overall size of the country has an impact, but other factors also matter: countries with high economic growth and fast-changing technology react stronger to technology changes induced by policies (e.g. car fuel efficiency standards). Also, for example a strong increase of electricity demand together with implementation of a high target for the share of renewable electricity has a strong impact on absolute emissions. A difference between the countries also emerges from the choice of sectors and good practice policies. If a country has a particularly large share of emissions of the uncovered sectors (e.g. agriculture), the reductions in our scenario are likely smaller.

- **In the sectors analysed, replicating good practice policies can decrease the energy and carbon intensity to levels required for 2°C, at the same time as increasing the level of economic activities in these sectors.**
  This analysis shows that good practice policies such as decarbonising the energy supply and improving energy efficiency in the demand sectors can significantly reduce the impact that an increase in activity can have on greenhouse gas emissions, such as an increase of floor space, improved access to electrification, and enhanced mobility.

- **The implementation of good practice policies identified in our analysis brings global emission levels close to the range consistent with the 2°C warming limit. On average, our study shows that in the electricity generation, transport, and buildings sectors, these policies are in line with this target.**
  The impact of good practice policies on a sectoral level is compared, using sectoral indicators, to global scenarios compatible with 2°C from the IPCC Fifth Assessment Report. The emission intensity of the electricity sector and the per capita energy consumption in the building sector are in line with the 2°C compatible scenarios for 2030. The same is valid for the reduction of F-gases and the transport sector. For the land use, land use change and forestry (LULUCF) sector, 2°C scenarios indicate emission levels around zero, some even result in negative emissions from this sector already by 2030 (IPCC, 2014). In our assessment, the total emissions for the good practice scenario in the LULUCF sector by 2030 are low but do not go to zero.

- **With current policies, global emissions including LULUCF are expected to increase by 10% to 11% between 2010 and 2020 and 20% to 23% between 2010 and 2030 leading to emission levels of 53.9 to 54.3 $GtCO_2e$ in 2020 and 58.6 to 60.1 $GtCO_2e$ in 2030.** If good practice policies were implemented in the nine policy areas (see Summary Table 1) included in our assessment, emissions could almost remain stable at current levels until 2020 (49.2 to 49.7 $GtCO_2e$ in 2020) and decrease thereafter to 43.7 to 47.4 $GtCO_2e$ by 2030 (see Figure 20). The result is a decrease of global emissions from approximately 59 $GtCO_2e$ in the current policies scenario by 2030 (grey range in Figure 1) to approximately 45 $GtCO_2e$ in the good practice policies scenario by 2030 (dark green range in Figure 1). Around 20 $GtCO_2e$ emissions are not covered by good practice policies. This would bring GHG emissions close to the level necessary to stay on track to hold warming below 2°C. Implementation of good practice policies in the sectors not covered in our analysis could close the remaining emissions gap (as in(UNEP, 2014)). Emission reductions could also be achieved by other measures in the electricity sector such as nuclear or CCS (Carbon Capture Storage).

The policy area which has the highest impact on global emissions in this analysis is the strengthened support for electricity generation through renewable energy sources. Implementation of good practice policies in this area could reduce emissions between 3.7 to 6.0 $GtCO_2e$ in 2030. This number goes beyond the potential indicated in the UNEP Emissions Gap Report 2014 of 5 $GtCO_2e$. That report bases its estimates on the 2°C scenario of the Energy Technology Perspectives report that assumes a less aggressive deployment of renewable energy (IEA, 2014b). Note that implementation of this ambitious renewable policy could bring along high implementation costs, which are not analysed in our study.

Other areas with significant reductions from implementing good practice policies are the reduction of fluorinated gases (‘f-gases’), the promoting of fuel efficiency standards of light duty vehicles and an increase in the efficiency of industrial processes. The area producing the lowest reductions in 2030 are electric cars. The main reason is that this technology is just starting to develop in our scenario: it will have little impact on the short-term but possibly has a high potential to reduce emissions beyond 2030. Further, the reduction indicated is additional to the effect of efficiency in the transport sector. If no fuel efficiency measures were taken, electric cars would have a stronger impact on emissions.

Only relatively small emission reductions can be achieved in the LULUCF[2] sector through the implementation of good practice policies. The main reason for this limited potential is that there is already a strong trend of reduction of deforestation in the baseline development, leading to a total reduction of LULUCF emissions in the range of 3 $GtCO_2e$ in 2030 compared to 2010.

[2] LULUCF = emissions and removals from activities relating to land use, land-use change and forestry

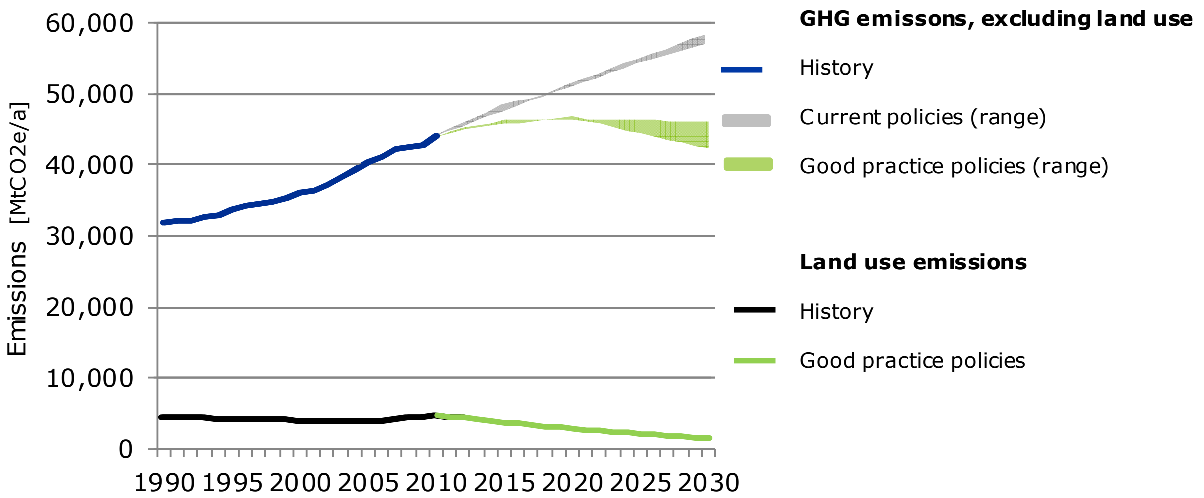

Figure 1. Global greenhouse gas emissions under current policies scenario and implementation of good practice policies in all countries excl. LULUCF and only LULUCF. Note: emissions in 2010 are 48.8 GtCO2e, and thus slightly lower than other sources (e.g. (UNEP, 2014)).

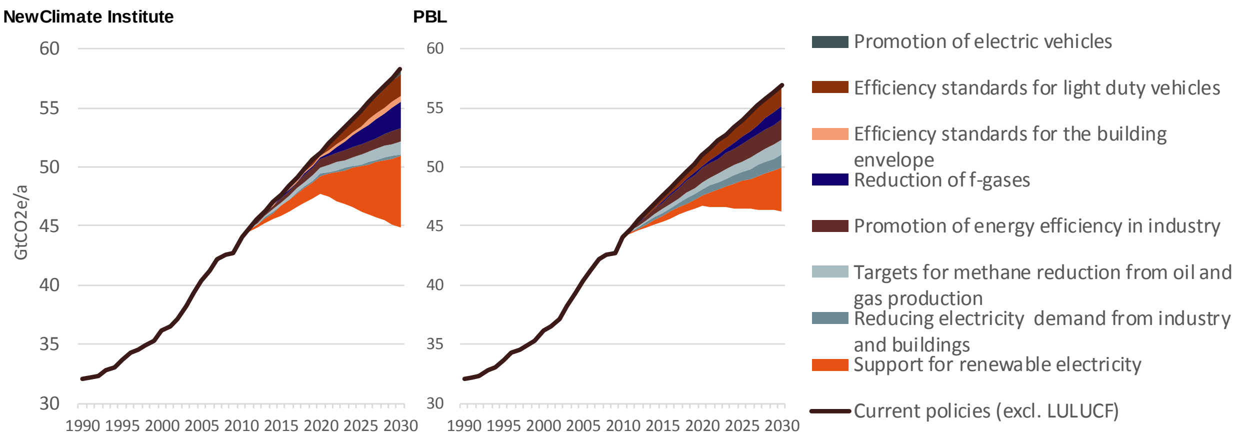

Figure 2: Reductions below the implemented policies for each of the nine policy areas covered, based on two methods from NewClimate Institute and PBL. Source: Authors

All the results above are based on the assumption that the good practice policies can be technically implemented on a global level. We have not considered country specific circumstances beyond energy and emission data, and sometimes projections of activities. In our calculations, we did not take into account cost estimates or the effect of other benefits. On a local scale and/or concerning specific technologies, however, technological and financial barriers might constrain their mitigation potential (IPCC, 2014).

Summary - Table 1 illustrates the approach in each policy area. For all of the policy areas, there is a wide range of good practice policies, spread across all regions of the world. Chapter 4 illustrates those examples and includes further detail on the approach in each sector.

Summary - Table 1: Overview of good practice policies and indicators for quantification

Policy area and policy action	Indicator	Good practice value
Increase renewable share in electricity through country dependent policy mix	Share of renewable energy of electricity generation	+1.35% growth in share of RE generation per year and replace coal before other energy carriers
Emission reductions from production of fossil fuels	Emissions of CH4 and CO_2 per unit of produced for oil & gas (associated gas and flaring/venting of gas)	Move from today to good practice values in 2030: Oil and gas: 77.4 $ktCO_2e$/Mtoe
Promotion of industrial energy efficiency through country specific policy instruments	Additional annual reduction of energy use in industry over current trend	1% better than development under current efforts
HFC and other F-gas emission reductions	Reductions below base year	Reductions below baseline for target years: 2018: 10% 2022: 35% 2029: 70% 2033: 85%
Standards for efficiency of appliances and lighting	Annual improvement in appliance efficiency	Average efficiency improvement of 1.8% per year
Energy efficiency of the building envelope (heating/cooling)	KWh/m2 (energy consumption) for new buildings	Starting value for first year: Current standard for new buildings in kWh/m² Moving linearly to 0 kWh/m² in 2030
Fuel efficiency / emission standards light duty vehicles	Light duty vehicles fuel efficiency km/l for new registrations	Linear development from today's level towards a fuel economy standard of 47.5 km/l in 2030
Support Electric cars driven by renewable electricity	Share of electric cars for new registrations	Starting from today's share per country increasing to 10% of new vehicles in 2020, 20% in 2030
Emission reduction from deforestation	Yearly deforested area	Based an average 2010 deforestation rate, decreasing deforestation with 22% in 2020, and 44% in 2030.

1.2 Main findings for the sectoral level

1.2.1 Electricity from renewable energy sources

The good practice policy for renewable electricity generation that was selected, is an increase of the share of renewables of 1.35 percentage points per year. Implementation of this policy results in a significantly faster development of renewable energy compared to current policies, especially after 2020. Such good practice policies are projected to decrease emissions on a global level by 0.9 to 1.7 $GtCO_2e$ in 2020 and 3.7 to 6.0 $GtCO_2e$ in 2030.

Under the current policies scenario, the share of renewable electricity generation moves between 10% and 30% for most countries, with the world average being around 30% in 2030. Under the good practice policy scenario, the shares move up to roughly 40% to 55% in 2030. With its large hydro electricity generation capacity, Brazil's share is already significantly above the average and remains as high in the good practice scenario.

The contribution of additional renewable energy also significantly decreases the emissions intensity of electricity generation. Especially in coal intensive countries like India and China, the increased share of renewable energy implied by the good practice policies significantly drives down the emission intensity.

The emission intensity of electricity supply after implementation of these good practice policies is within the range of what scenarios indicate would be required to hold temperature increase below 2°C above pre-industrial levels. IPCC AR4 WG3 indicates a 25^{th} to 75^{th} percentile range of 164 to 350 g/kWh in 2030 for the global average. Most countries are within that range in the good practice scenarios. However those with a currently very high intensity will require more time to achieve those levels.

The World Bank Report “Decarbonising development: 3 steps to a zero carbon future” mentions that at least 30% of electricity should be generated through renewable energy sources by 2025 (Fay et al., 2015). The IPCC says that in 2030, the share should be at around 35% (the median of all scenarios). The results of the good practice scenario exceed these values for all countries analysed.

Both reports say the electricity sector should be completely decarbonised around the middle of this century. This means the development the good practice policies imply needs to continue, and, in many regions, at an even faster pace. From a climate perspective, implementation of nuclear or CCS could result in similar emission reductions.

1.2.2 Reducing methane emissions from oil and gas production

Another potential area of improvement analysed in this report is the emission intensity of oil and gas production. In most countries, this is expected to increase or roughly stabilise in the next two decades. With aggressive reduction targets as for example foreseen in this sector in the United States, about 0.5 $GtCO_2e$ could be globally reduced in 2020, and up to 1.3 $GtCO_2e$ in 2030.

A major share of those emission reductions come from major oil-producing countries not covered in detail in this report. Of the countries covered, employing a strong methane reduction target for Russia would lead to the most reductions, given its high production volumes. For Japan, this sector is largely irrelevant, as it imports almost all of its oil and gas. For China, the effect is small as emissions in the sector are not high and the intensity already improves under projections of current policies. For India, the effect is larger than for China although it produces less gas and oil, as the emission intensity of the process is at a significantly high level today and projected to stay high.

1.2.3 Efficiency of industrial processes

If countries worldwide were to implement good practice policies for efficiency in industry, global emissions could decrease by 1.2 $GtCO_2e$ in 2020 and 1.8 $GtCO_2e$ in 2030. The major share of those projected reductions comes from China and India. China has the world’s largest industry emissions in both 2020 and 2030, especially for cement and steel. The analysis shows that it could strengthen or expand existing programmes to tap into significant mitigation potential. Efficiency measure in India’s industry sector were projected to have the largest impact because it has relatively large energy savings potential when compared to good practice (Dasgupta, Roy, Bera, Sharma, & Pandey, 2012). Implementing good practice efficiency policies could decrease GHG emissions by 29% in 2030 compared to current policies emission levels.

1.2.4 Reductions of fluorinated gases

Good practice policies implemented in the area of industrial F-gases could achieve high additional emission reductions to current policies. If the North American Montreal Protocol Amendment Proposal were to be implemented and extended to PFC’s and SF6, global emissions could decrease by 0.1 to 0.2 $GtCO_2$ in 2020 and by 1.1 to 2.2 $GtCO_2e$ in 2030, relative to the current policies scenario. With currently implemented policies, the increase can be as high as 300% to 400% above 2010 levels with currently implemented policies, especially in countries with certain developing industrial sectors (e.g. car industry, or refrigerants). With good practice policies, global emissions decrease by 70%-80% below the current policies scenario

Global F-gas emissions in the good practice policy scenario decrease to a level of 60% to 65% of 2010 levels. According to Labat et al. (2015) a global mitigation scenario illustrating how all countries can set milestones for action by 2030 - in relation to the common goal of holding global warming below 2°C and integrating national circumstances - would go deeper, to around 70% F-gas reductions compared to 2010 by 2030.

1.2.5 Efficiency of building envelopes and appliances

Implementation of good practice policies in the residential sector could lead to a decrease of electricity consumption of 0.9 TWh and reductions of GHG emissions of up to 1.8 GtCO_2e in 2030. Implementation of good practice policies on efficiency for appliances leads to indirect GHG emission reductions of 1.3 GtCO_2 by 2030, while the impact on direct emissions is negligible. Efficiency measures implemented when constructing new buildings can reduce emissions by 0.2 GtCO_2e in 2020 and 0.5 GtCO_2e in 2030 in those countries covered in this sectoral analysis (China, US, India, Russia, Japan)[3]. The results show the per capita demand in countries with high per capita consumption in this sector decreases the most with the implementation of the good practice policies compared with a scenario with currently implemented policies. In countries where per capita energy consumption is still increasing to provide basic services to the population, the policy will imply less direct short term changes.

The IPCC scenarios compatible with 2°C illustrate different values for the five regions for 2050. Comparing the country results to their particular regions shows that the results of good practice policies are roughly in line with the efforts needed for 2°C in the building sector. Thereby, some trade-offs between countries may be necessary: while the US even is significantly below the average value for the OECD-1990 region, Russia is - even with good practice policies - still above the threshold. Japan, China and India are close to the value indicated for their region in 2030.

1.2.6 Efficiency of light duty vehicles and electric cars

In the transport sector, strong fuel energy efficiency standards for new light duty vehicles and supporting electric vehicles could reduce emissions by 0.3 to 0.9 GtCO_2 in 2020 and 1.9 GtCO_2e in 2030 (see Table 21). Already under the current policy scenario, fuel efficiency of light duty vehicles increases as most countries already have car efficiency policies in place. Good practice fuel efficiency standards for new light-duty vehicles are more ambitious and could accelerate this trend significantly and speed up efficiency improvements of the entire car fleet. These good practice standards are based on an extrapolation of proposed 2025 EU car standards to 2030. The standards are comparable to the standards in the 2°C scenario from the Technology Roadmap (IEA, 2012) which are based on estimates of good achievable levels in terms of technology potential and also include changed sales expectations. If these additional standards were implemented, it would lead to 50%-70% global emission reductions for light-duty vehicles compared to current policies scenario.

Similarly, fuel efficiency and a greater share of electric vehicles in the car stock, further decrease the emissions intensity of the distance driven of this sub-sector. The emissions intensity already decreases under current policies, but the rate of improvement are much higher with global good practice action.

IPCC does not break down requirements for the transport sector to light duty vehicles in the illustration of what is compatible with 2°C, but shows that, in 2020, electric mobility should hold a share of approximately 1%, and 9% in 2050 (Sims et al., 2014). With the good practice policies, these shares

[3] For the other countries and the rest of the world, the analysis was not possible due to data gaps

would be achieved for light duty vehicles. The IPCC also shows that absolute emissions of the sector should roughly stabilize at current levels throughout 2050 and decrease thereafter, while activity strongly increases. For the light duty vehicles considered in this report, this is the case. We even see a reduction in emissions from this segment after 2020.

1.3 Main findings for example countries

In addition to the sectoral results, we provide an estimate of the potential impact of good practice policies globally. With this aim in mind, we also illustrate the potential that replicating those policies has on each country. For all regions, this report finds substantial reductions resulting from the replication of good practice policies.

The extent to which the chosen policies reduce emissions varies between countries, depending on how important the chosen policy areas are in terms of emissions, to what extent countries are already implementing climate action and other country specific circumstances. Our approach assumes that the good practice policies can be implemented with the same effectiveness. When these policies would be actually implemented in these countries, there could be important differences between the countries. The results shown here are only illustrative and serve to give an indication of the potential impact of certain policies, rather than real emission reductions in a particular country.

We compare the good practice scenarios to the current policy projections from (den Elzen et al., 2015). We use these projections as reference, while acknowledging that the literature provides a range of alternative estimates for the countries considered.

1.3.1 China

In the projections used in this study, current implemented policies in China lead to approximately 13 $GtCO_2e$ in 2020 and 15 $GtCO_2e$ in 2030. This is an increase of approximately 30% above 2010 levels by 2020, and approximately 50% by 2030. With these emission levels, our projections suggest that China will likely achieve their pledge for 2020 emissions (see Figure 3). When we project that "good practices policies" are replicated in all sectors we find that this translate to peaking emissions in China around 2020 and at a level below 12 $GtCO_2e$. In addition, replicating the “good practice” policies translates to driving China’s emissions to below current levels by 2030.

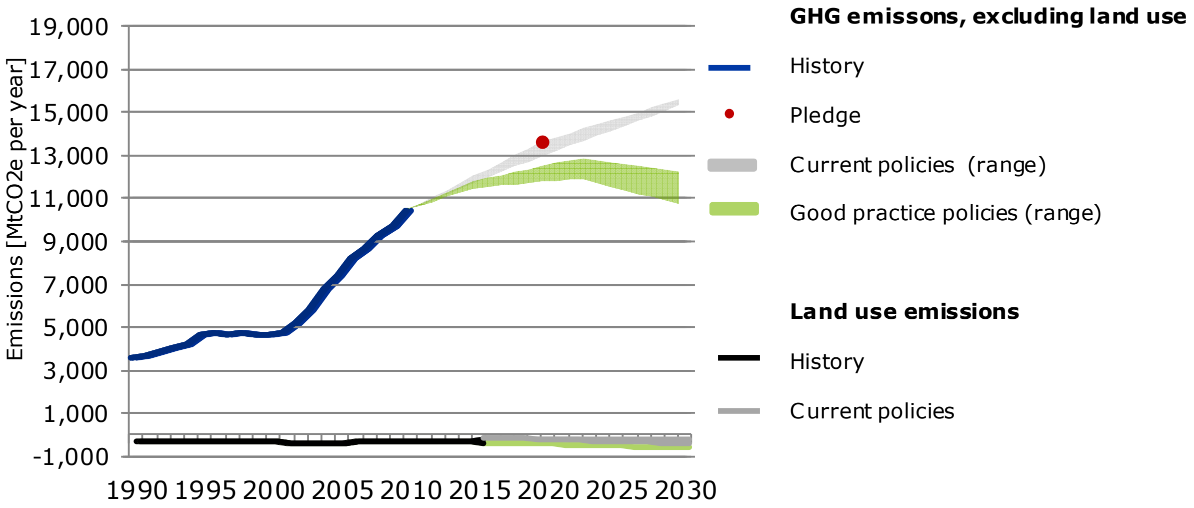

Figure 3: Impact of climate policies on greenhouse gas emissions in China.

Historical greenhouse gas emissions are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT).

1.3.2 United States

In the projections used in this study, currently implemented policies in the United States lead to approximately 5.4 to 6.2 $GtCO_2e$ in 2020 and 5.3 to 6.5 $GtCO_2e$ in 2030. This projected trend would maintain emissions approximately at today's level. With the emission levels resulting from our projections, the US would likely not achieve their 2020 pledge. However, the country has a number of administrative actions close to implementation which, if fully implemented, could lead to it achieving the target (compare (den Elzen et al., 2015). Replicating "good practice" policies in all sectors analysed in this study, the results indicate that the US could achieve emission reductions of 15% to 37% below current levels by 2030, according to our projections (see Figure 4).

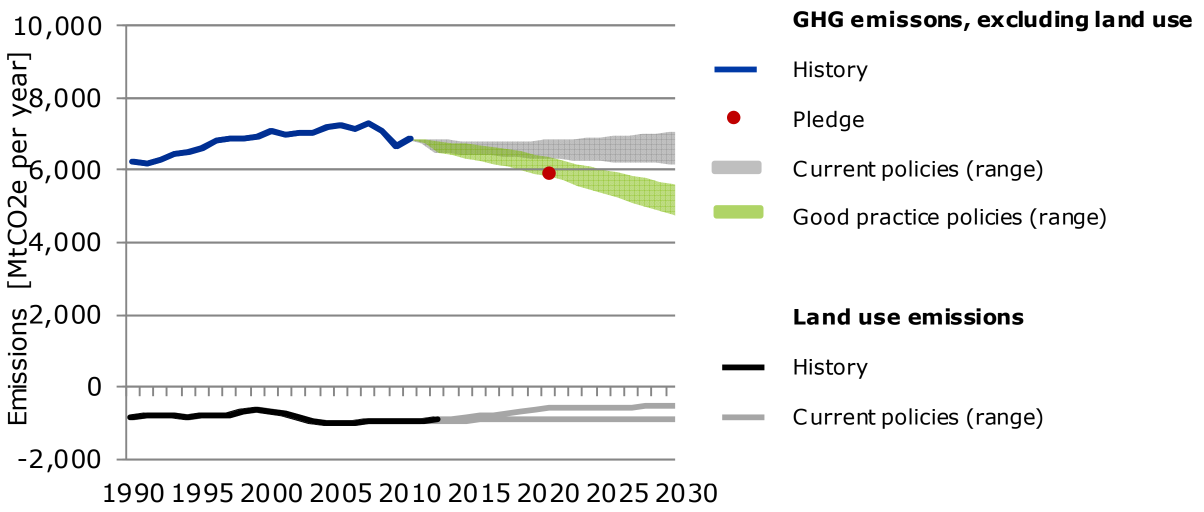

Figure 4: Impact of climate policies on greenhouse gas emissions in the United States.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC, and LULUCF emissions from the Sixth National Communication of the United States of America (United States, 2014).

1.3.3 India

In the projections used in this study, current implemented policies in India lead to 3.5 to 4.0 GtCO2e in 2020 and 4.8 to 5.5 GtCO2e in 2030. This is an increase of 50% to 67% above 2010 levels by 2020, and more than double by 2030. With the emission levels resulting from these projections, India will likely achieve their pledge for 2020 emissions (see Figure 5). Replicating "good practice" policies in all sectors, emissions in India are projected to be at 3.0 to 3.5 $GtCO_2e$ in 2020 and at 3.4 to 4.1 $GtCO_2e$ in 2030.

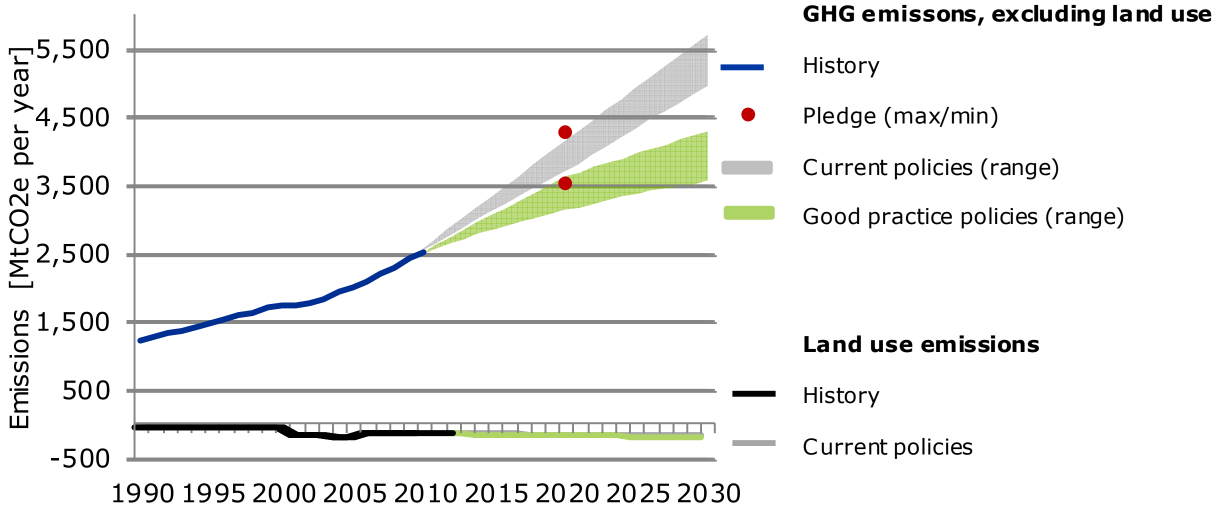

Figure 5: Impact of climate policies on greenhouse gas emissions in India.

Historical greenhouse gas emissions are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT).

1.3.4 Brazil

In the projections used in this study, current policies in Brazil lead to 1.5 $GtCO_2e$ emissions by both 2020 and 2030, including land use. Brazil has already implemented deforestation policies, especially in the Cerrado region which lead to important reductions from today's levels, according to our assessment. Therefore the focus in this report is on all other sectors. Excluding land use, current policies projections in this report in Brazil are expected to grow and lead to 1.0 to 1.1 $GtCO_2$ by 2020 and 1.1 to 1.2 $GtCO_2e$ by 2030 (see Figure 6). Replicating the "good practice" policies, our study projects emissions of roughly 1 $GtCO_2e$ in 2030.

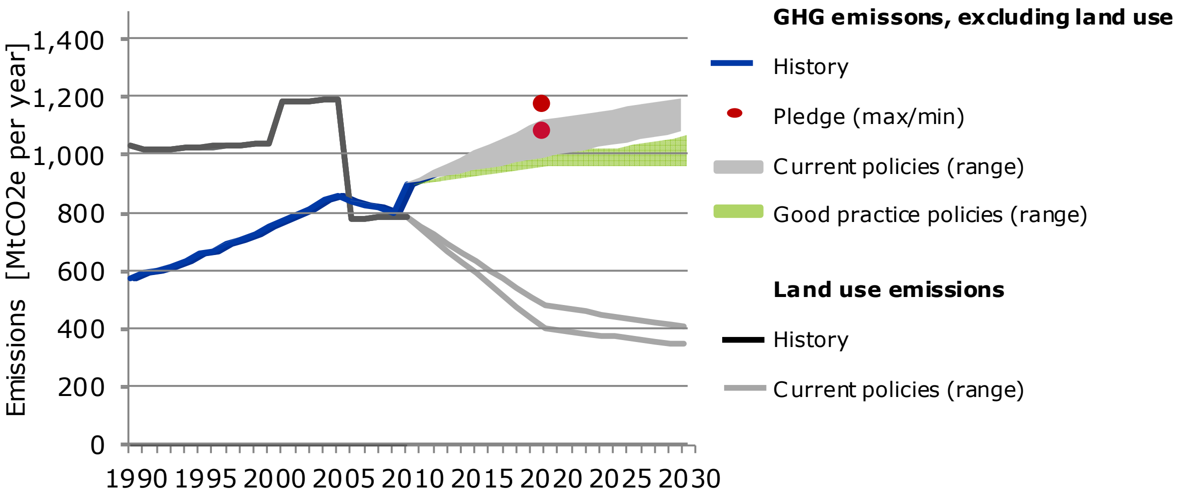

Figure 6: Impact of climate policies on greenhouse gas emissions in Brazil.

Historical greenhouse gas emissions (excluding LULUCF) are based on inventory data submitted to the UNFCCC (until 2005), energy-related CO_2 emissions from IEA (2013a), non-energy-related emissions from EDGAR 4.2 (JRC and PBL, 2012) and LULUCF emissions from FAOSTAT data (http://faostat3.fao.org/faostat-gateway).

1.3.5 Russian Federation

In the projections used in this study, current policies in Russia lead to 2.3 to 2.4 $GtCO_2e$ in 2020 and 2.2 to 2.8 $GtCO_2e$ by 2030 (excl. LULUCF). The emission levels calculated here indicate an achievement of Russia's pledge for 2020 emissions. Replicating "good practice" policies decreases projected emission levels from 2015 onwards and leads to levels of 2 $GtCO_2e$ or below by 2030 (see Figure 7).

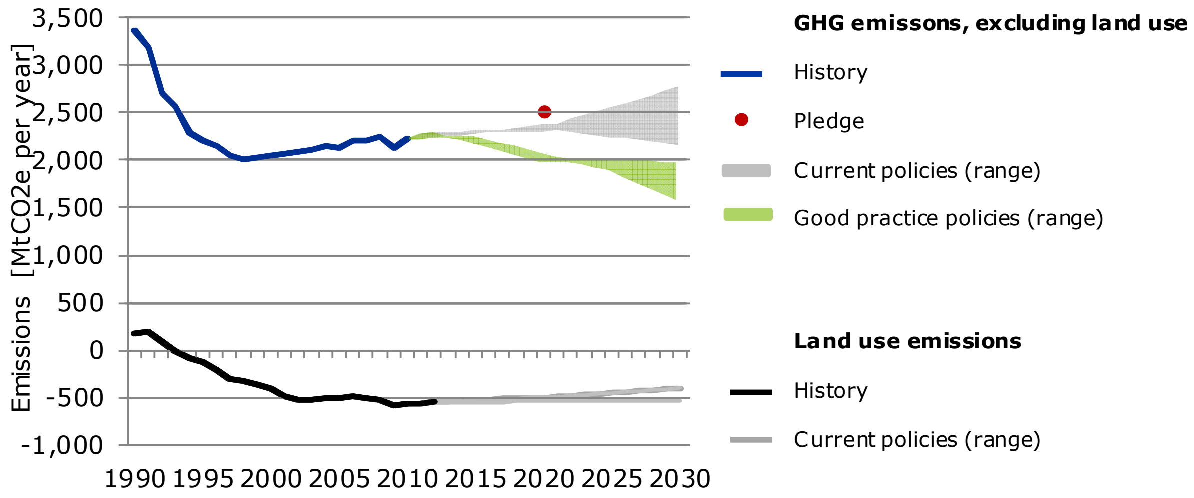

Figure 7: Impact of climate policies on greenhouse gas emissions in the Russian Federation.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC, and forestry emissions from the Sixth National Communication (Russian Federation, 2013)

1.3.6 Japan

In the projections used in this study, emissions after implementation of current policies in Japan remain at around 2010 levels by 2020 and decrease by 5% to 17% by 2030 (see Figure 8). This reflects emission levels of 1.1 to 1.3 $GtCO_2e$ by 2020 and 1.0 to 1.2 $GtCO_2e$ by 2030. The wide range can be explained by the uncertainty about the phase-out of nuclear energy, as it is not clear whether this will occur and which energy carriers would replace nuclear energy. With these projections, meeting the 2020 pledge could be challenging for Japan. Replicating "good practice" policies translates to projected emission levels of 0.5 to 0.9 $GtCO_2e$ in 2030.

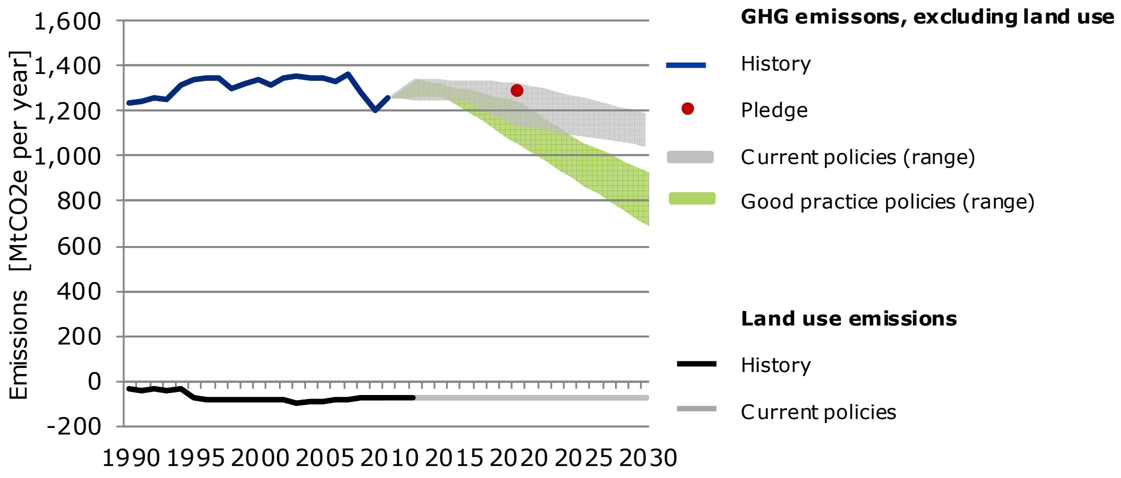

Figure 8: Impact of climate policies on greenhouse gas emissions in Japan.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC.

1.3.7 Rest of world

The previous sections showed the results of implementation of "good practice" policies for six example countries. Replication of "good practice" policies for the rest of the world lead to 5% above 2010 emission levels by 2020 and around 2010 levels by 2030, according to our projections (see Figure 9).

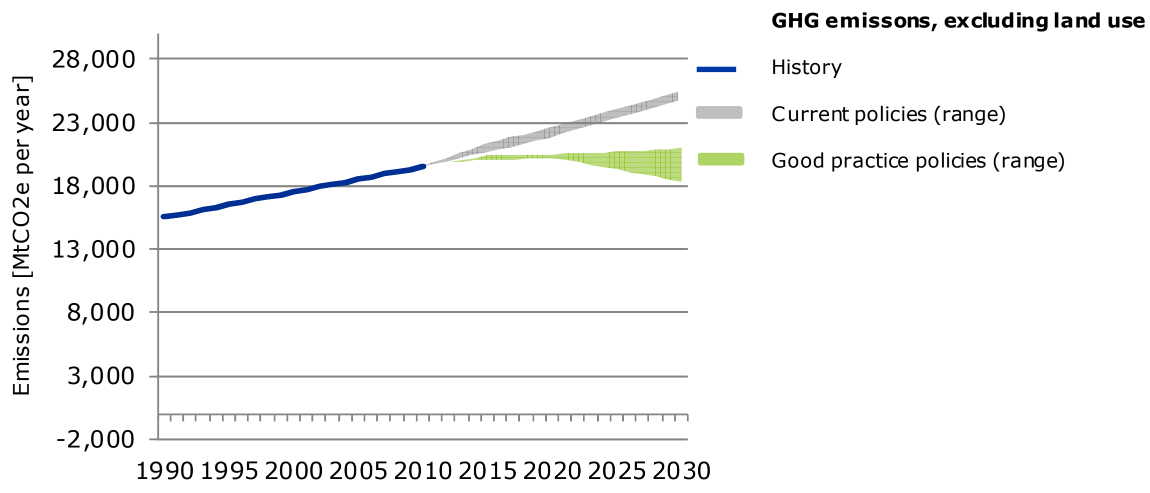

Figure 9: Impact of climate policies on greenhouse gas emissions in "Rest of the World"

1 Introduction

An earlier study (den Elzen et al., 2015) analysed the impact enhanced policies could have on greenhouse gas emission reductions in the 13 largest emitting countries/regions (Australia, Brazil, Canada, China, the European Union, India, Indonesia, Japan, Mexico, the Russian Federation, South Korea, Turkey, and the United States) compared to the emission trajectories based on the most efficient current and planned climate policies.

The research question of that study was to find out how far countries could reduce emissions with three to five selected most efficient enhanced mitigation measures related to different areas of climate policy in each country, which are related to current national priorities. These areas include support for renewable energy, fuel efficiency in passenger transport, or a phase-down of fluorinated gases. The mitigation measures in this report all relate to the up-scaling of low-carbon energy supply, improvements in energy efficiency, and the adoption of low-emission technologies in all sectors.

The analysis in this report extends the scope in three ways:

- It covers more policy areas and enhanced mitigation measures for each country, to illustrate a comprehensive picture of how emissions could develop under the application of existing “good practice” policies.
- It scales up the analysis to the global level, to illustrate how global emissions would develop if all countries would implement good practice policies.
- It assesses the impact of GHG reductions on a sectoral level using sector specific indicators.

Another difference to the previous study is a focus on six example countries + rest of the world, rather than looking at a larger number of countries but neglecting the rest of the world.

Good practice policies are climate- and energy policies that have been, or are being implemented in specific countries and have resulted in significant deviation from business-as-usual emission development in specific (sub-)sectors. These policies show that it is technically possible to implement such policies in one country.

We translate this into global implementation to illustrate the impact of replicating very ambitious climate policies and try to learn how far it could bring the world towards holding temperature increase below 2°C. Further, we give an indication of what these good practice policies mean for the decarbonisation of various sectors. Note that, although we show results for six large emitting example countries, the approach does not give a recipe for these specific countries on how to implement ambitious climate policies. It merely inspires to show the possibilities of some chosen standard measures. Actual implementation should consider local circumstances and criteria that go further than mere emission reduction. Other measures might be more appropriate based on these considerations.

This report identifies and describes good practice policies, and develops methods to calculate the impact of these policies on GHG emissions projections of six large emitters (China, United States, India, Brazil, the Russian Federation and Japan) [4] and on a global level. Together, these countries emitted around 55% of global anthropogenic greenhouse gas emissions in 2012 (Joint Research Centre & PBL Netherlands Environmental Assessment Agency, 2014). The results for each country serve to identify policies that could be implemented to raise ambition and have significant co-benefits.

[4] We do not consider the European Union separately, but refer to other studies which have analysed the impact of enhanced policies on its emissions (compare e.g. (Bossman et al., 2012; Greenpeace, 2012; Labat et al., 2015)). For more detail, see (den Elzen et al., 2015)

Further, one can compare future emission reduction targets and policies of that country to a good practice scenario.

2 Approach

The method applied consists of the following steps:

- Identify good practice policy areas
- Define indicators for quantification of policies
- Determine impact of good practice policies on countries
- Aggregate the global total

The next paragraphs describe these steps further illustrating the approach for fuel efficiency standards for cars.

2.1 Identify good practice policy areas

Starting from the enhanced policies implemented in our previous study (den Elzen et al., 2015), we identify a number of "good practice policies" that could be implemented by all countries. For areas not covered in that report, we consider good practice polices that are currently being implemented or proposed by specific countries.

Additionally to the earlier analysed enhanced policies, existing reports could point to potentially innovative, high impact policies. For example, technical papers from the UNFCCC on mitigation benefits of actions, initiatives and options to enhance mitigation ambition give insights in successful policy making, based on submissions from countries and observers (UNFCCC, 2014)(UNFCCC, 2013b). We also consider specifically innovative or ambitious actions. Criteria for the overall list are a coverage of all important sectors, global applicability of policies and data availability.

The selected policies describe specific good practice policies that go beyond current polices in specific (sub)sectors, but do not necessary cover the total technical mitigation potential in this (sub)sector. For example a question could be what the impact of efficiency standards for cars implemented globally is if the most stringent level currently applied by one country is used for all countries, not what the mitigation potential from more efficient cars is.

To provide a comprehensive global picture and reflect different national priorities of countries in terms of the sectoral focus, it is essential to cover all greenhouse gases and sectors in a balanced manner. Within the scope of this report we cover nine good practice policy areas, which represent roughly 65% of global emissions in 2030 (see Section 3.3).

2.2 Define indicators for the quantification of the policies

To make sure that climate policies will result in emission reductions for different countries, it is necessary to define a method for each policy, which is applicable independently of the countries' diverse national circumstances as good as possible. Factors which can influence the results are for example the country's population and density trends, the expected growth of the complete economy or specific sectors, the current status of sectoral structure of the economy (sectoral emission break-up), current status of existing policies, energy production and consumption. It is thus important to find indicators that directly link to the identified climate policies, and which are independent of these country specific factors or can build on them.

As example, the indicator "fuel efficiency of new cars" is independent of starting point and overall energy consumption and activity level of a country, as opposed to the indicator "absolute energy consumption reductions of cars", which does depends on those.

2.3 Determine impact on countries and globally

For each good practice policy, this report elaborates an adequate indicator to express the improvement caused by this policy (e.g. fuel efficiency of new cars in km/l). The good practice case or a combination of different good practice examples then provides the exemplary value for this indicator (e.g. moving towards a fuel efficiency of new cars of 47.5 km/l in 2030, based on the development in a specific country after implementation of policies). The targeted indicator value under good practice policies is the same for all countries. Where adequate, the analysis includes the delay from a decision of the policy to its implementation and impact.

These targets are implemented into energy and land use models to quantify the impact on GHG emissions in 2020 and 2030. Two methods are used to estimate this impact: (i) the PBL FAIR policy model (den Elzen et al., 2014) together with the TIMER energy model (Van Vuuren et al., 2014), and (ii) bottom-up spreadsheet calculations by NewClimate Institute, which are based on existing scenarios from national and international studies (e.g. IEA´s World Energy Outlook 2014), as well as own calculations of the impact of individual policies in various subsectors. Both methods were supplemented with emission projections for land-use policies using IIASA's global land-use model GLOBIOM (Havlík et al., 2014) and global forest model G4M (Gusti, 2010). For most sectors, both approaches analyse the impact in parallel, and the illustrated results compare the outcomes of the two models. Both methods were also used for the calculation of the impact of the most effective current and planned policies on greenhouse gas emissions, as described in detail in den Elzen et al.(2015). The selection of current and planned policies was based on literature research and expert knowledge.

For the analysis of the good practice policies the PBL FAIR policy model and the TIMER energy model allows to account for the impact of possible overlaps between good practice policies. Such overlap could be efficiency targets that lead to lower energy levels and which would have an impact on the results of implementing renewable energy targets, or change in fossil fuel prices could change due to simultaneous implementation of all policies. NewClimate approaches the policy areas in a stepwise integrated way, meaning that for example the model considers first a change in the carbon intensity of the electricity supply, and then reductions in electricity consumption. The model does not consider overlaps between reductions of fossil fuels and emissions from fossil fuel production.

The analysis focuses on the global level an on the six largest emitting countries. The remaining countries are summarised to one additional region (which also includes the EU member states). Reviewing large emitters in detail allows an accurate consideration of country specific differences for a great part of emissions. It provides additional insight in how different policy areas can impact sectoral and total emissions of those countries.

The remaining countries ("rest of world") are treated as one region, to which both methods apply the same good practice policies. NewClimate Institute sums up all emissions and activity data outside the countries covered in detail and applies the same indicators to this aggregate. PBL calculates the impact of the policies for the individual remaining countries or regions as used with the FAIR policy and TIMER energy models, and then aggregates these to the "rest of world". Carefully choosing the methods for quantification and using indicators applicable to different circumstances makes it possible to use aggregated data from these countries. For the Land Use, Land Use Change and Forestry sector, this report takes a different approach: it looks at countries with important forest areas individually and then aggregates them to a global value.

This analysis covers nine policy areas in detail, covering approximately 65% of emissions in in 2030 (see Figure 10). For the areas not covered, substantial mitigation options are possibly available, but not considered quantitatively in this report. Sectors, which are not included in our analysis are agriculture, parts of the transport and industrial sector, waste, and bunkers.

For a few policy areas, the analysis was only possible with one of the approaches, given complexity of the calculations or data availability. In those cases, the results of one modelling team are transferred to the other model and adjusted where necessary. This is the case for energy efficiency in industry and appliances, where PBL conducted a detailed analysis and NewClimate Institute integrated those results in their framework. For efficiency of the building envelope and the increase of the share of electric cars it is the other way round and NewClimate Institute follows a detailed approach. Thereby, a careful consideration of overlaps is necessary. For example if one of the models estimates reductions for electricity consumption in the building sector due to the implementation of building standards, these reductions need to be reflected as a decrease in emissions of the power sector in the other model and vice versa.

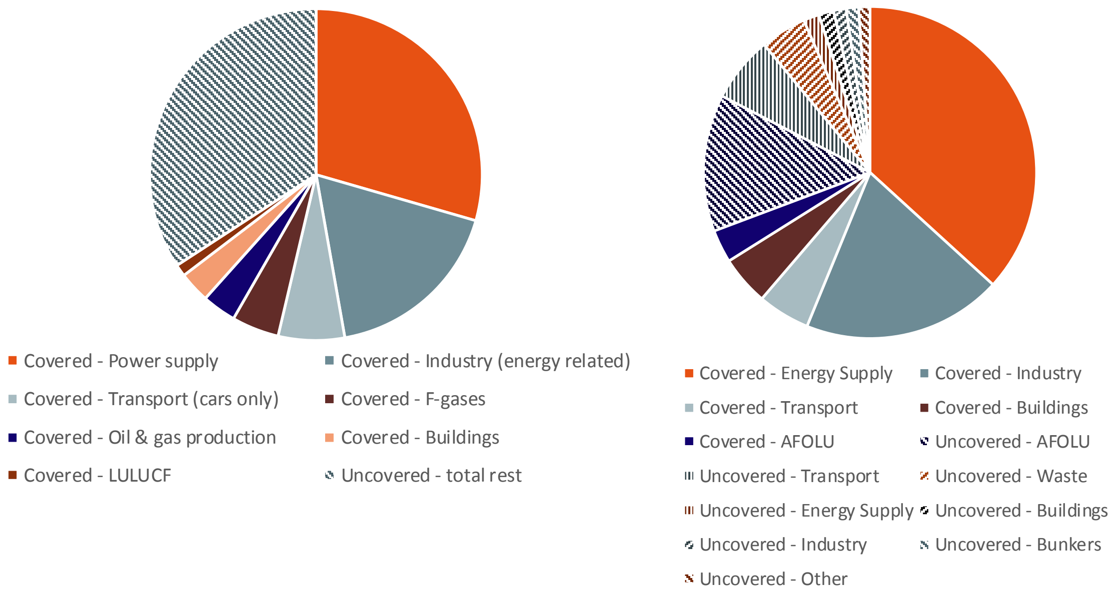

Figure 10 Covered GHG emissions (incl LULUCF) in assessment of good practice policies. The shares indicate % of 2030 emissions under the current policy scenarios for PBL and New Climate insitute

After calculating the emissions of individual countries and the “rest of world”, this last step aggregates the results on a global level.

2.4 Comparing the results to scenarios compatible with 2°C

To conclude, it was assessed whether the globally applied good practice policies are sufficient to hold global temperature increase below 2°C above pre-industrial levels, taken into account that our analysis only account for 65% of global emissions by 2030. Two options give an indication to answer this question in this report:

- On global level, compare overall global emission levels after implementation of good practice policies up to 2030 with global emission projection compatible with meeting the 2°C target with a likely chance, as assessed by UNEP (2014).
- On sectoral level, compare intensity indicators with those in scenarios compatible with 2°C levels (mainly from UNEP (2014), and partly based on the IPCC AR5, Working Group III)

3 Selection of good practice policies and accompanying indicators

This chapter describes the selection of good practice policies for all sectors. The text and tables illustrate and explain the indicators chosen and how the past or current impacts of existing policies on greenhouse gas emissions translate into good practice values. Further, for each policy area, the text describes how the level of the chosen indicator is translated to emission reductions.

3.1 Energy supply sector

For the energy supply sector, we consider two areas: power generation and the production of fossil fuels.

For increasing the deployment of renewable energy technologies, the mitigation potential is high (5 $GtCO_2e$ in 2030 (UNEP, 2014)), and immediate implementation of such policies can lead to long-term transformational effects, as GHG emissions from this sector are avoided.

During the production of fossil fuels, a high amount of energy is wasted through flaring or venting of methane emissions, or leakage during the transport of the fuels. Although measures can be cost-effective as the captured methane can be used as an energy sources, only few countries have policies in place to control this sector (Braun et al., 2014). The potential of this sector is also significant (2 $GtCO_2e$ in 2030 (UNEP, 2014)).

3.1.1 Renewable energy in electricity generation

More and more countries are already starting to implement policies supporting renewable energy technologies. Over 140 countries have renewable energy targets and many of those are supported by economic incentives or regulatory instruments (REN21, 2014). In this section, we describe exemplary policy activities in Uruguay, Costa Rica, the Pacific Islands and the Dominican Republic, developing countries with specifically ambitious target and comprehensive supportive policies. We also include the UK and Germany, countries which have implemented RE policies for long time periods already. As an example from the African continent, the section describes RE policies in Morocco also. Other good practice examples – not further described in this report – are the RE policy frameworks of Kenya and Philippines (UNFCCC, 2014). For countries, where renewable energy policies have existed for a certain period of time, we compare historic trends of the share of renewables, for countries which are just starting to develop such frameworks, we focus on the targets to compare their ambition.

As an example, Uruguay has enacted several laws that constitute the basis of their ambitious renewable energy target. Uruguay has set a target of 90% share of the power generation from RE by 2015 (REN21, 2014). Furthermore, the different policies on biofuels, solar power, and wind power also support achieving this target. Innovative promotion schemes have been developed, granting industries up to 80% tax reductions on the investment in renewable energy generation (MIEM, 2014). According to Montano (2014) this successful model has been taken as a reference and is being currently imitated by other countries. Uruguay is among the “top countries for investment in new renewable power” (REN21, 2014) and by 2011 its share for RE of electricity generation was at approximately 72% (IEA, 2013a). Uruguay is especially investing in wind power to hedge their hydropower risk and has installed the largest per capita capacity during 2014. For achieving the target, the annual percentage point increase of the share of RE electricity generation would need to be 4.5 percentage point. It is worth noting the main drivers of Uruguay’s ambitious RE target are the lack of gas and oil resources in the country and the fact that almost all their hydroelectric potential has being used (Montano, 2014).

Likewise, Costa Rica and the Dominican Republic have enacted targets and supporting policies on RE, which include tax exemptions, tendering and technology specific targets. Costa Rica aims to achieve a 100% of RE by 2021 (REN21, 2014). In 2011 91% of electricity came from renewable energy IEA (2013) and are 93% are expected for 2015, leading to more modest growth rates of the share of RE of 0.9 percentage point on average per year. The Dominican Republic aims at achieving 20% renewable electricity by 2020, their share of RE by 2011 was 12% (IEA, 2013a) (0.9 percentage point annual increase of the share).

Other ambitious RE policy examples include Morocco, which has in place various targets for renewable capacity, as well as support policies for promoting the development of such technologies. Morocco is considered among the most ambitious countries in terms of renewable energy within the African continent (Braun et al., 2014). According to IEA (2014c) Morocco's energy strategy and RE targets are on track and it "has made important advances in wind and solar energy, and fuel subsidy reform". The capacity target of the country aims to increase 6 GW in wind, solar and hydro power by 2020 (2 GW each) (IEA, 2014c).

The Pacific Islands, through their Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP) have also set targets for power generation from RE. The PIGGAREP is being implemented by the UNDP and funded by the GEF (SPREP, 2014). Furthermore, the PIGGAREP has set RE as "a priority issue at the national level and has been mainstreamed in national and sectoral policies, strategies, plans and/or roadmaps in most countries" (SPREP, 2014). Some small islands states have the most ambitious target among the Pacific Islands such as Tuvalu and Niue whit a 100% target of RE by 2020.

Various countries have had policies in place for longer time periods in the past. For example, UK implemented the Renewable Obligation in 2002, a system requiring energy suppliers to fulfil a certain quota of RE, either through own installations or through the purchase of certificates. Germany has in place the Renewable Energy Act (Erneuerbaren Energien Gesetz (EEG)), with a feed-in tariff as the main instrument incentivising investments in RE since 2000. Both policies have boosted renewable energy deployment in the electricity sector (Braun et al., 2014). On average, the share of renewable electricity has increased by 1.35 percentage points per year in the two countries since 2002 (Own calculations based on IEA Energy Balances (IEA, 2014a)).

Table 1: Annual increase in renewable electricity share as the result of exemplary good practice policies in the energy supply sector

Country	Indicator value: annual required increase in renewable energy share of electricity in percentage points to meet target	Description of policy
Uruguay	4.5[5]	RE target 90% in 2015 Tax exemptions for RE investments Increase renewable share in electricity through country dependent policy mix
Costa Rica	0.9[6]	RE target 100% in 2021 Diversification of the energy matrix

[5] According to IEA (2013b) the RE share by 2011 was approximately 72%. Taking into account the RE target by 2015, thus the increase per year is of 4.5 percentage point.
[6] Costa Rica´s RE share by 2011 was 91%. Therefore, the increase per year is 0.9 percentage point (IEA, 2013b).

Country	Indicator value: annual required increase in renewable energy share of electricity in percentage points to meet target	Description of policy
		Increased of alternative and more stable renewable sources, through their V and VI National Energy Plans
Tuvalu	NA[7]	RE target 100% in 2020 Greenhouse gas abatement through increase share of RE The Master Plan for Renewable Electricity and Energy Efficiency in Tuvalu and support by the Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP) for the Pacific Islands
Dominican Republic	0.9[8]	RE target 20% in 2020 Development of renewable sources of Energy Incentives (e.g. tax exemptions) through Law No. 57-07 for the development of renewable energy sources
Morocco	3.5[9]	No specific % target for the share of RE Capacity Target: 2 GW of wind, 2 GW of solar and a 2 GW increase in hydropower capacity by 2020 Upscaling approach : 42% in 2020 Support schemes for RES-E 2009 National Energy Strategy, which sets objectives in the areas of electricity fuel mix and its optimization, and the development of renewable energy source

Source: REN21 (2014).

According to the Global Status Report (REN21, 2014), China, the US, Brazil, Canada and Germany are the top five countries in terms of total installed renewable power capacity as of end-2013 and investment in 2013, including hydro power. If hydroelectricity is not accounted Spain, Italy and India are incorporated in the top countries with the highest RE power capacity for the same year. Uruguay and Costa Rica invested the largest share of their GDP in RE in 2013. Other countries with a high share of electricity generation by 2013 include Morocco, Japan, Canada and Norway.

Note that from the climate standpoint implementation of nuclear energy would also have the same mitigation impact on greenhouse gas emissions, but in this analyses we have focused on implementation of renewable energy.

[7] Specific data on RE share for this country is not available

[8] The RE share by 2011 for the Dominican Republic was 12%. Therefore, the increase per year is 0,9 percentage point (IEA, 2013b).

[9] While the share of RE electricity output in 2010 was approximately 17%, by 2011 it decreased to 10%, due to a strong decreased of hydropower generation.

Table 2: Topmost countries for RE power capacity and investments by 2013

Total installed renewable power capacity by 2013 (incl. hydro)	Total installed renewable power capacity by 2013 (excl. hydro)	Investment in 2013	Share of GDP invested in 2013
China	China	China	Uruguay
US	US	US	Mauritius
Brazil	Germany	Japan	Costa Rica
Canada	Spain/Italy	UK	South Africa
Germany	India	Germany	Nicaragua

Source: REN21 (2014).

For the calculation of good practice policies, we have assumed an increase of the share of renewable electricity of 1.35 percentage points per year. As most countries discussed above have specific circumstances (e.g. hydro potential), we have based our good practice policy on average growth rates of renewable energy in UK and in Germany, after the implementation of strong RE policies. The analysis relies on these countries as they were among the first countries to implement a comprehensive renewable energy policy framework, and the actual impact of this can be already observed. Other countries anticipate even stronger growth rates (up to 4.5 percentage points). While there are individual countries with even higher growth rates, the achievement of those targets relies on very country specific circumstances, therefore global application of growth rates higher than 1.35 percentage points is too optimistic. Also, these higher growth rates would be based on targets, rather than what has already been successfully implemented.

To estimate the impact on emissions of a good practice policy in the area of renewable energy electricity generation, the base year share of each country is increased by 1.35 percentage points per year until 2030. The resulting share of RE in those years is then compared to the current policy trajectory (compare section 4.1.1). The NewClimate calculations assume that all non-renewable energy carriers are decreased with the same amount. Mostly, coal is affected here. Then total emissions for both the current policy scenario and good practice scenario are calculated by multiplying country specific emission factors of the different electricity generation technologies with final energy use per energy carrier. In the PBL TIMER energy model, the annual 1.35 percentage points increase in RE was translated into a RE share target in 2030 for each country, which was implemented in the TIMER energy supply model, resulting in a deviation from the current policies scenario. The share of renewable technologies in the good practice policy scenario is calculated by extrapolation of current policy trends and accounting for country specific circumstances, e.g. maximum potential for specific renewable technologies. Investments in non-renewable technologies are determined by applying a multinomial equation. In TIMER we use multinomial logit equations to determine market shares based on costs, while maintaining some heterogeneity.

3.1.2 Methane reduction from fossil fuel production

Economies based on the oil & gas sector face several challenges for controlling methane leakage, as Larsen et al., (2015) pointed out in their report *Untapped Potential*. Nevertheless, within this sector low-cost GHG abatement opportunities could deliver significant emissions reductions. They further asserted that “If only the top 30 oil and gas methane emitting countries were to reduce those emissions 50% below 2012 levels by 2030, this would prevent the loss of 1.8 trillion cubic feet of natural gas supply worldwide.” (Larsen et al., 2015). This section focuses on exemplary policies in the oil & gas sector in Russia, Norway and United States, all countries with an important share of extraction of oil and gas and policies in place to limit emissions from those activities. It further describes some activities in Trinidad and Tobago, a developing country with an extremely high dependence on fossil fuel exports.

Russia is known for producing, transporting and exporting the largest share of the world's natural gas (Lechtenböhmer et al., 2007). According to Carbon limits AS (2013) the country has so far been inefficient in reducing the flaring of methane within the last decade and "remains at 24-25% of total associated gas production". Therefore, it has been estimated that the methane related emissions from this sector have the highest reduction potential for the country, especially the emissions resulting from their natural gas transmission network (IEA, 2006; cited Lechtenböhmer et al., 2007). Furthermore, there is also an increasing interest in applying "more efficient pricing and sustainable production of natural gas" since Russian key producing fields are declining over time (IEA, 2006). The difficulty for reducing methane flaring levels from the oil & gas sector is partly due to the propagation of new production sites in Eastern Siberia (Carbon Limits AS, 2013). These concerns drove the government back in 2007 to aim for a better use of the associated petroleum gas (APG) and in consequence various policies have been developed for supporting this endeavour and make it a national priority (Carbon Limits AS, 2013). Among the policies, the most prominent one is related to establishing a target to reduce methane flaring to 5%, thus the remaining 95% should be utilized. The policy is coupled to preferential market access for companies complying with the target and non-compliance penalties (Carbon Limits AS, 2013; Roelfsema et al., 2013).

The oil & gas sector in Norway has the largest share of the country's GDP with 22% as stated by IEA (2011) in its energy policies review on Norway. Likewise, oil & gas represent close to 47% of total exports and is globally ranked on third place after Russia and South Arabia for exports (IEA, 2011). Therefore, the significant amount of fugitive emissions that arise from this sector constitutes both a challenge and a source of innovation for Norway's policy-making, which has established a taxation system for oil & gas activities back since 1991 (IEA, 2011). The tax is "helping to push the industry to seek technological solutions and to investigate storage solutions (…) and has also helped to introduce more efficient solutions for power supply from offshore installations." (IEA, 2011). By 2011 Norway achieved "the world's highest recovery rate for its offshore oil resources" and according to IEA (2011) the country has characterized for developing the sector in an environmental-friendly manner as well as for providing energy security.

The United States Environmental Protection Agency in January 2015 introduced a target to reduce methane emissions from oil and gas production by 40% to 45% by 2025 below 2012 levels and outlined a set of actions to achieve this target building on prior activities by the Administration (US EPA, 2015). This is a significant change in trends in comparison to the last two decades, where emissions from this sector have only decreased little (from 192 MtCO_2e in 1990 to 161 MtCO_2e in 2012[10]).

Trinidad & Tobago is a carbon intensive economy. According to UNEP Risoe (2013) *Emissions Reduction Profile for Trinidad & Tobago*, the country is amongst the highest per capita GHG emissions in the world, with approximately 37 tCO_2e per year, in spite of its status as an developing country. With an economy based mainly on energy, the country has significant exports of oil, gas and other energy products. Moreover, today it is "ranked as the number one single site exporter of methanol and ammonia in the world" (UNEP Risoe, 2013). Furthermore, the reports points out that the country has a leading role for the exports of LNG, iron and steel. To date there is not a clear policy framework for controlling GHG emissions from the oil & gas, and chemicals sectors. Nevertheless, the government is preparing to implement an energy management program for petrochemical plants and an energy efficiency policy framework is in preparation (UNEP Risoe, 2013). Furthermore, they had developed a

[10] National inventory data retrieved from http://unfccc.int/di/DetailedByParty/Event.do?event=go

Programme of Activities (PoA), which aims to avoid methane emissions resulting from venting and flaring of associated gases from producing oil fields (UNFCCC, 2012).

Table 3: Exemplary good practice policies in the energy supply sector (policy area: reduce methane emissions from oil and gas production)

Country	Indicator value	Description of policy
United States	77.4 ktCO_2e/Mtoe oil and gas produced	US methane target as passed in January 2015 aims at 40-45% reduction below 2012 by 2025
Russia	n.a.	Target to reduce flaring to 5% = 95% utilization target coupled with increased penalties for non-compliance Non-compliance penalties: different payments apply for different types of pollutants relevant to APG Incentives to reduce flaring: market liberalization and preferential market access Regulatory reform for clustering projects with supplies of associated gas from multiple fields
Norway	n.a.	Taxation of oil and gas activities Operation of the carbon capture and storage (CCS)
Trinidad and Tobago	n.a.	PoA 9358 : Petrotrin Oil Fields Associated Gas Recovery and Utilization PoA Energy management program for petrochemical plants and policy framework for energy efficiency in preparation

Source: UNEP Risoe (2013), Roelfsema et al. (2013), Carbon Limits AS (2013), IEA (2011)

The calculations of emissions from the upstream energy sector rely on the target of the US to reduce methane emissions from oil and gas production by 40% to 45% below 2012 levels by 2025. To take into account the shift to flaring of gas causing other emissions, we include other gases (mainly CO_2) additionally to methane. With the development in production of oil and gas as projected in the Annual Energy Outlook 2014 (US EPA, 2014a), this would mean 77.4 ktCO_2e per Mtoe fuel produced in 2025. Countries which already are below these values remain at their current levels.

We consider this policy to be good practice as it covers the complete sector and implies reductions which diverge significantly from the historic trend: from 1990 to 2012, emissions in the oil and gas sector in the US only decreased by 15% (UNFCCC, 2013a), in spite of a longer time period.

To estimate the impact of the good practice indicator on emissions, NewClimate applies the good practice target for 2030 in terms of emissions intensity to the projected oil and gas production of each country and compares the results with the current policy projections for this sector. PBL applied the same methodology.

Table 4: Overview quantification approaches for the energy supply sector

Policy	Indicator	Good practice value	Explanation
Increase renewable share in electricity through country dependent policy mix	Share of renewable energy of electricity generation	+1.35% growth in share of RE generation per year and replace coal before other energy carriers.	Combines growth rates various countries after implementation of strong RE policies.
Emission reductions from production of fossil fuels	Emissions of CH4 and CO_2 per unit of energy produced for oil & gas	Move from today to good practice values in 2030: Oil and gas: 77.4 ktCO_2e/Mtoe	US methane target as passed in January 2015 aims at 40-45% reduction below 2012 by 2025

3.2 Industry

Energy efficiency is regarded as an effective way for reduction in GHG emissions from fossil fuels (Tanaka, 2011). Additionally, also reverting the increasing emission trend for HFC emissions considered an effective mitigation policy. The total industry sector has an emission reduction potential of 4.5 GtCO_2e in 2030 (UNEP, 2014). Of this, 1.5 GtCO_2e relates to process emissions, and 3 GtCO_2e to energy efficiency and renewable energy measures. The UNEP emissions gap report indicates that co-benefits can be particularly high for efficiency measures in the industrial sector.

3.2.1 Energy efficiency of industrial processes

The selection of good practice policies for industry was done by highlighting ambitious policies that are being implemented by various countries. Several Indian policies support the goal of improving energy efficiency in the industry sector. The Energy Conservation Act was established back in 2001, which included energy consumption labels and performance standards actions targeted to large energy consumers (ABB, 2013; Tanaka, 2011). Later in 2008 the country adopted the National Plan on Climate Change (NAPCC) that includes a National Mission for Enhanced Energy Efficiency. This mission incorporated targets, annual fuel savings and emission reductions (ABB, 2013). Furthermore, it includes a market-based component – called the Perform, Achieve and Trade (PAT) Scheme - for energy efficiency improvement targets, where tradable Energy Savings Certificates (ESCerts) are assigned to energy intensive industries according to the amount of energy saved (ABB, 2013). Thus, firms that do not meet the targets are able to buy ESCerts from less energy-intensive companies.

China's largest industry energy efficiency program is the *Top 1000/10000 program*, which consists of a "negotiated agreement between the government and the private sector to reduce energy consumption" (Tanaka, 2011). The Top 1000 program was established during the 11Th Five-year plan (FYP) targeted to the largest 1000 firms in China and it was progressively extended to cover smaller firms within the 12th FYP at the local level back in 2011 until 2015 (IEPD, 2013). Thus, the Top 10,000 Program aimed "to cover two thirds of China's total energy consumption" (IEPD, 2013). As Tanaka (2011) points out, the policy is characterized for its penalties and rewards scheme that recompenses efficient practices and imposes fines to the inefficient ones by implementing energy management programs and the local energy conservation authorities are responsible for evaluating. The targeted sectors are mainly the metallurgical, petrochemical and chemical industries, nevertheless, large transport companies, public buildings, hotels and commercial firms "using more than 5,000 tce per year" are also considered (IEPD, 2013; Tanaka, 2011).

In South Korea, industry is the largest sector in terms of energy consumption. This sector accounted for 55% of total GHG emissions by 2009, including non-energy uses (ABB, 2011). The Ministry of Knowledge Economy established a voluntary agreement starting in 1998, where firms present concrete action plans. These firms specify voluntary reduction targets for energy consumption and will be offered low-interest loans and technical support by the government (Tanaka, 2011). Later in 2008

South Korea initiated the National Energy Basic Plan (2008 – 2030) in which aims at reducing energy intensity to 0.185 TPES/GDP (tonnes of oil equivalent per thousand USD) in 2030 from 0.341 TPES/GDP in 2006, equivalent to an annual improvement of 2% on average (ABB, 2011).

In Japan the energy consumption for industrial purposes has significantly decreased since 1990 (Reinaud & Goldberg, (2012). This has been achieved through diverse measures that have contributed to enhance energy efficiency in the industry. The main policies that were establish with the aim of encouraging energy efficiency are the Keidanren Voluntary Action Plan (VAP), a voluntary emissions trading scheme (JVETS), and most recently, a mandatory benchmarking policy introduced in 2010. The Keidanren VAP "was considered key pillar in Japan's industrial energy and emissions policy" started in 1997 and each of the sectors within the industry selected its own targets (Reinaud & Goldberg, 2012). Thus, with the VAP there was no arrangement with the State for assuring compliance, which led to questioning its transparency and ambition levels (Reinaud & Goldberg, 2012). The JVETS, likewise, is a voluntary cap-and-trade scheme first introduced in 2005 targeted to the firms not covered by the Keidanren VAP. The government gives Japanese Emission Allowances (JPAs) to the JVETS industry participants when they "adopt absolute emissions reduction targets" instead of intensity targets (IIP, 2012b). In contrast, the Benchmarking policy has a mandatory component. The targets are based on "top-of-the-world efficiency levels" benchmarks and it "introduced a 1% annual energy efficiency improvement obligation" (Reinaud & Goldberg, 2012). In addition to sectoral studies the benchmarks are defined upon negotiation processes between the government and the industry.

Within the Energy Efficiency Opportunities Act of 2006 Australia introduced the Energy Efficiency Opportunities (EEO) program (EEX, 2015). The EEO program was compulsory and it encouraged large energy-using firms that had an annual energy consumption above 0.5 PJ to identify, evaluate and make public cost-effective energy saving opportunities (IIP, 2012a). The program targeted mining, manufacturing, commercial, services, transport and electricity firms around the country, thus covering approximately "56% of Australia's total energy use" (EEX, 2015). The implementation component of the EEO was not mandatory, however, disclosing the results of the assessments on energy efficiency opportunity was (IIP, 2012a). Tanaka (2011) affirms that revealing such information to the public can be a "highly motivating" practice for industry and the results of the program confirmed that statement. For instance, the Energy Efficiency Exchange (2015) showed that the opportunities adopted within the EEO program accounted for savings up to 89 PJ, while emissions reductions amounted close to 1.5% Australian GHG emissions (8.2 $MtCO_2e$) during the first five years of the program. The EEO program was closed down in June 2014 by the government due to their "commitment to reduce costs for business and its deregulation agenda" (EEX, 2015).

In Ireland, the Sustainable Energy Authority of Ireland (SEAI) established energy agreements with companies or institutions, aiming for a decrease of the growth of energy consumption by 1% (in comparison to a reference scenario) (Tanaka, 2011). The SEAI backs the agreements through financial support, creating opportunities for networking and provision of information (Sustainable Energy Authority of Ireland, 2015).

Table 5: Exemplary good practice policies in the industrial sector (policy area: promotion of energy efficiency)

Country	Indicator value	Description of policy
China		Top 1000/10000 Programme
India		Energy Conservation Act 2001 Mission for Enhanced Energy Efficiency 2008 - PAT scheme
Ireland	Annual energy efficiency improvement of 1% beyond autonomous improvement	Energy agreements
South Korea		National Energy Basic Plan (2008 – 2030): voluntary energy efficiency targets from participating firms
Japan		The Act on the Rational Use of Energy[11] The Keidanren Voluntary Action Plan (VAP) – targets set by industry Voluntary emissions trading scheme (JVETS) – cap and trade scheme Mandatory benchmarking policy – EE targets based on benchmarks
Australia		Energy Efficiency Opportunities Act (2006) - the Energy Efficiency Opportunities (EEO) program (2006 – 2014)

Source: Tanaka (2011), ABB (2013), ABB (2011), Reinaud & Goldberg (2012), EEX (2015)

The approach for choosing an overall target relies on an exemplary policy in Ireland. Therefore, the overall target of annual 1% energy efficiency improvement is implemented in the PBL TIMER industry model which consists of a cement, steel and other industry model. It is difficult to introduce an indicator which can cover all subsectors, independently of their composition and current energy intensity because large differences in energy use are observed within different industry sub-sectors and between countries. Energy intensity per physical output would be preferable, but because of the inhomogeneity across sub-sectors and availability of data, this is not an option. These considerations result in the choice of energy intensity of Industry Value Added in constant US$2005 that can provide a common basis across sub-sectors. The largest drawback of this indicators is that it is influenced by structural economic effects, so this indicator must be seen as a first assessment of energy efficiency in the industry sector.

The overall efficiency improvement is implemented in the model by assuming implementation of specific measures for several different industrial processes in the industry sub-models aiming at this same improvement. These efficiencies can be considered very ambitious, specifically in countries with an old industry stock, and a low replacement rate of new (more efficient) factories. For example, the annual efficiency improvements in terms of physical units used in Deetman et al (2012) are 0.2-0.5% for cement, 0.5%-0.9% for steel and 0.5%-0.9% for other industry based on a gradual adoption of good housekeeping measures between 2015 and 2030, as found in the literature. In the cement model of TIMER a gradual phase-out of inefficient cement plants is implemented between 2015 and 2030, by only allowing more advanced cement plants to be built. Steel production from scrap metal in electric-arc furnaces (currently considered to be the most energy-efficient option) is limited by the availability of scrap metal (Neelis & Patel, 2006). Thus, we enforce all newly built steel furnaces to be of the most efficient steel blast furnaces type (with or without CCS) from 2015 onwards. Measures in the

[3] http://iepd.iipnetwork.org/policy/mandatory-energy-efficiency-benchmarking-industry

remaining industry sub-sectors, such as using efficient lighting and lighting management, more efficient and flexibly adjustable motors, optimized compressed air systems (Kaya, Phelan, Chau, & Sarac, 2002), and more preventive maintenance are implemented in the general TIMER industry. In this study, we simulate the effect of a gradual adoption of such good housekeeping measures in the other industry sector between 2015 and 2030.The New Climate Institute calculations used the final energy reductions from the PBL calculations to which they apply their own emission factors per kWh final energy use to determine the total GHG emission reductions for the industry sector.

3.2.2 Reductions of fluorinated gases

F-gases are used in the industry sector, but also in the buildings sector, and are powerful greenhouse gas emissions. These emissions have increased in the last decades specifically in the refrigerants industry and the car industry, where they are used to replace ozone depleting substances. In the absence of additional policies, they are expected to increase further in the future, however, environmentally friendly alternatives are already available for most sectors, as indicated by UNEP (2011), and explored in more detail in the UNEP report of the technology and economic assessment panel (UNEP Technology and Economic Assessment Panel, 2014). A number of countries are currently discussing measures to reduce future emissions of F-gases:

China has developed HFC phase-down programmes, including capacity-building, collection and reporting of HFC emissions data; mobilization of financial resources for further actions to phase-down HFCs; research, development and deployment of environmentally sound, effective and safe alternatives and technologies; and multilateral agreements to phase down HFCs (UNFCCC, 2014).

United States of America promotes safer low-GWP alternatives to HFCs; providing funding opportunities for HFC alternatives and banning some HFCs (ibid.).

The EU has started to implement new policies which strengthens the existing measures and introduce a number of far-reaching changes. By 2030 it will cut the EU's F-gas emissions by two-thirds compared with 2014 levels (European Commission, 2014). The expected *cumulative* emission savings for the EU are 1.5 $GtCO_2e$ by 2030 and 5 $GtCO_2e$ by 2050. The new legislation will stimulate innovation and green growth and jobs by encouraging the use of green technologies based on less climate-harmful alternatives. It should also improve prospects for a future global agreement to phase down the use of F-gases under the Montreal Protocol on the protection of the ozone layer. Scenarios of F-gas emission reductions for the EU is analysed by Schwarz et al. (2011).

The EU further submitted a proposal in 2015 to phase-down global HFC emissions: In this proposal, non-Article 5 countries should reduce HFC consumption to levels that are 15% below the baseline in 2019, 40% in 2023, 70% in 2028 and 85% in 2034. The baseline for developed (non-Article 5) countries is calculated as 100% of average HFC consumption and production and 45% of average HCFC consumption and production in the years 2009 to 2012, expressed in CO_2equivalents. Article-5[12] Parties are required to freeze the production of HFCs in 2019, and reach a long-term reduction target by 2040. The baseline includes a share of HCFC production acknowledging that during and after the chosen reference period (2009-2012) a conversion from HCFC to HFCs production may have taken place. A long-term phase down schedule for this combined HFC/HCFC consumption should be agreed by 2020, including the date for the last phase-down step (UNEP, 2015b).

The 2014 North American Amendment Proposal to the Montreal Protocol, a joint initiative of Canada, US and Mexico (US EPA, 2014b), introduces similar reduction targets for all countries. In this proposal non-Article 5 countries should reduce HFC consumption to levels that are 10% below the baseline in

[12] http://ozone.unep.org/new_site/en/parties_under_article5_para1.php

2018, 35% in 2023, 70% in 2029 and 85% in 2035. The baseline for non-Article 5 countries is calculated as 100% of average HFC consumption and production and 40% of average HCFC consumption and production in 2011-2012. Similar as for the proposal of the EU, the reduction targets for Article-5 countries consider longer time periods, but are already included in this proposal.[13]

Table 6: Exemplary good practice policies in the industrial sector for reduction of F-gases

Policy area	Country	Indicator value	Description of policy
HFC and other F-gas emission reductions	USA, Mexico, Canada	F-gas emissions reduction relative to the year 2010	North American Proposal 2014 HFC submissions to the Montreal Protocol: Proposal to decrease HFC emissions by 70% relative to baseline in 2030 for non-Article 5 countries and 60% relative to baseline for Article 5 countries. The full reduction schedule continues until 2045.
	EU		Reduction of F-gas emissions by two-thirds compared to 2014 levels.[1)]
	EU		Proposed amendment to the Montreal Protocol. Proposal to decrease HFC emissions by 70% relative to baseline in 2030 for non-Article 5 countries and 85% in 2034; and 85% relative to baseline for Article 5 countries in 2040.
	China		HFC phase-down programmes[2)]
	United States		Promotion of alternative substances[2)]

Sources: 1) Schwarz et al. (2011), 2) UNFCCC (2014)

This report uses the proposed emission reductions for non-Article 5 countries from the North American Amendment Protocol for all countries. While reduction rates are slightly faster in early years in the European proposal, the baseline is a little bit more ambitious in the North American Amendment Protocol (40% of HCFCs rather than 45%). Whether the difference in the years over which the average for the baseline is taken will depend on the development of the emissions in the country over the last years. In addition, we upscale the emission reductions for all fluorinated gas emissions (including PFC and SF6), by a full implementation of the new regulation of the EU.

To estimate the emission reductions of good practice policies, the TIMER as well as the bottom-up calculations of NewClimate Institute take a similar approach. Both compare the current policy projections to the emission levels resulting from the indicated reductions below the “baseline” for each region and for all fluorinated gas emissions. To determine the baseline, historic HCFC emissions are needed, additional to HFC emissions. These are available from the Ozone Secretariat at UNEP (UNEP, 2015a), however only as aggregate by country, including all gases. This makes it impossible to determine the global warming effect of the HCFCs, as the individual gases have distinct Global Warming Potentials (GWP). To be able to proceed with the calculations, this report assumes an average GWP of 1810, using HCFC-22, a substance commonly used as refrigerant as a reference (compare (Solomon et al., 2007)).

[13] During the negotiation process for the Montreal Protocol, also India has submitted a proposal. This is not mentioned in more detail here as it targets a lower level of ambition.

Table 7: Overview of quantification approaches for the industrial sector

Policy	Indicator	Good practice value	Sources
Promotion of energy efficiency through country specific policy instruments	Additional annual reduction of energy use in industry over current trend	1% better than development under current efforts	Energy Agreements with the Sustainable Energy Authority of Ireland support reductions of energy consumption of 1% per year compared to BAU (Tanaka, 2011)
HFC and other F-gas emission reductions	Reductions below base year	Reductions below baseline for target years: 2018: 10% 2022: 35% 2029: 70% 2033: 85%	North American Amendment Proposal to the Montreal Protocol (US EPA, 2014b) for HFCs, in combination a full implementation of the new regulation of the EU, which strengthens the existing measures and introduces a number of far-reaching changes. By 2030 it will cut the EU's F-gas emissions by two-thirds compared with 2014 levels (see: (European Commission, 2014)).

3.3 Buildings

Energy use in buildings account for 19% of global GHG emissions (Lucon, Ürge-Vorsatz, et al., 2014), including indirect emissions. This energy is used for electricity consumption for appliances and energy consumption for thermal comfort. The UNEP Emissions Gap report 2014 presents mitigation potential of roughly 2 $GtCO_2e$ in 2030, with very high potential for co-benefits (UNEP, 2014).

3.3.1 Efficiency of the building envelope of new buildings

For buildings, it is important to start implementing sustainable standards very soon to avoid locking in inefficient building structures. Countries such as Mexico, Tunisia, Japan, and EU have in place ambitious energy efficiency policies in the buildings sector.

In Mexico the residential sector accounts for approximately 16% of total energy use in the country and 26% of total electricity use (IDB, 2012). The IDB (2012) estimated that an average house in Mexico consumes close to 71 kWh/m^2, while a "poorly designed house in a hot climate may use an additional 1,000 kWh per year". The high share of energy use from housing was one of the main drivers for the government to establish policies for promoting energy efficiency in this sector. In 2008 the Mexican government enacted the Law for the Sustainable Use of Energy, as well as the National Program for Sustainable Use of Energy (PRONASE), which addresses, inter alia, lighting, electronic appliances, new buildings and retrofits in buildings for reducing energy usage in the country. This situation let to the design and implementation of two programs on housing called *Ecocasa*[14] and *Ecocasa 2*[15], which have been developed through the Nationally Appropriate Mitigation Actions (NAMAs) framework. The Ecocasa programs aim to integrate technologies such as insulation, efficient gas heaters and efficient refrigeration, among others, for reducing GHG emissions in comparison to conventional houses (IDB, 2015). By 2014 the *Ecocasa* program had already achieved a 35% (9,754 houses) construction progress for accomplishing the 27,600 eco-houses goal in 2020 and it was appointed by the UNFCCC in the COP 19 as a global example for its "lighthouse activities" (IDB, 2015; SLF, 2014). For *Ecocasa 2* the program is projected to continue for five years (2014-2019) and it includes "efficiency benchmarks

[14] NAMA for sustainable housing in Mexico. This NAMA is implemented by the Ecocasa program and is a "is a joint initiative of SHF, the Inter-American Development Bank (**IDB**) and the German Development Bank KfW**"** (NAMA Database, 2015d).

[15] NAMA for new residential buildings in Mexico. This NAMA is implemented by the Ecocasa 2 program and obtained funding from GIZ through the NAMA facility (NAMA Database, 2015c)

are set for total primary energy demand based on building type and climate" (NAMA Database, 2015c).

Likewise, Tunisia started implementing a NAMA on Energy conservation in the building sector (2015 – 2020). It includes actions and programs for promoting efficient lighting, household appliances and efficient buildings. Given that implementation started recently there is no available information on its progress yet.

Japan, China and Germany are examples of countries, which have had building codes in place for a decade or even more. Germany has mandatory standards for new buildings and requirements for refurbishment of existing buildings (Bundesgesetzblatt, 2013). Economic incentives exist to go beyond the minimum requirements: For new buildings constructed today consuming not more than 40 kWh/m²/a of primary energy demand for new buildings German legislation provides additional financial support. Further, European law requires member states to assure that in 2020, all new buildings are nearly zero-energy buildings (European Parliament, 2010). China has a Mandatory Performance Standard in place since 1995, which affects new and refurbished buildings in urban areas. It sets minimum requirements for the heat coefficient of building envelope elements and the design of the building (e.g. its orientation) (BigEE, 2011). The building standard of Japan falls under the Energy Conservation Law. This law was first adopted in 1979 and has been revised various times. For residential buildings, the law foresees minimum requirements for the heat coefficient, as well as maximum final energy demand per building area. Both for China and Japan, the requirements vary for different climatic zones. Germany does not make this differentiation.

Table 8: Exemplary good practice policies for efficiency of the building envelope (Policy area: Energy efficiency of the building envelope (heating/cooling))

Country	Indicator value	Description of policy
Mexico	n.a.	Housing NAMAs: Ecocasa 1 & Ecocasa 2 Programs[1)]
Germany	40 kWh/m² primary energy 15 kWh/m² final energy	Financial support for new and refurbished buildings with a certain efficiency standard from KfW [2)]
China	n.a.	Regulations for Energy efficiency of building design and operation in new and refurbished buildings in urban areas: Requirements for heat transfer coefficient of building envelope elements and design of building (e.g. orientation)[3)]
Japan	108 kWh/m² final energy*	Design and Construction Guidelines on the Rationalization of Energy Use for Houses: heat coefficient requirements for building envelope and other elements, differentiated by climate zone [4)]
EU	Nearly zero kWh/m² in 2020	Directive on new buildings

Source: 1) NAMA Database (2015d), 2) (KfW, 2014), 3) (BigEE, 2011) 4) (Asian Business Council, 2010). *Using the median value of various climate zones based on own calculations

Energy consumption per square meter for newly constructed buildings serves as an indicator for energy efficiency of the building envelope.

The low energy building codes currently implemented in Germany provide guidance on the good practice value: For new buildings constructed today, consuming not more than 40 kWh/m²/a, German legislation provides financial support. Further, European law requires member states to assure that in 2020, all new buildings are nearly zero-energy buildings (European Parliament, 2010).

The analysis for efficiency of the building envelope is difficult because of heterogeneity user behaviour and climate zones. We will conduct the analysis for the six major emitters, but take a simplified approach for the "rest of world", where we include the sector in the "others" category, where we apply the average reduction factor. The impact of buildings envelope policies for the PBL calculations is based on the emissions reductions from the NewClimate calculations for the six major emitters.

3.3.2 Efficiency of appliances

Specifically for appliances, there is substantial room for increasing ambition already before 2020 given the high rates of renovation and rapidly increasing demand (Braun et al., 2014). We can find good practice policies on efficiency of appliances in Japan and the EU.

To enhance energy efficiency of appliances, Japan adopted the Top Runner Program for promoting energy conservation in appliances in 1998. The programme is targeted at manufactures, who are required to comply with efficiency level targets for the production of appliances according to “the best performance of current technologies” (Braun et al., 2014). Therefore, it follows a benchmarking approach based on strict criteria that include large domestic shipment products, high-energy consumption products in its use phase, and products with a considerable potential for energy efficiency improvement. There is a stakeholder consultation process in place for deciding the standards and target years that manufacturers must follow based on the most energy efficient products available in the market, also called ‘top runners’. Furthermore, the producers are also required to disclose complete information “on their sales and the energy efficiency of their products, which is the basis for an evaluation on their compliance with the Top Runner Program” (Braun et al., 2014), (also compare (UNFCCC, 2013b)).

Table 9: Exemplary good practice policies for efficiency of appliances

Policy area	Country	Indicator value	Description of policy
Standards for efficiency of appliances and lighting	Japan	N.a.	Top-runner programme[1)]

Source: 1) Braun et al., (2014),

The good practice policy that is chosen in this report for improvements of efficiency of appliances, relies on the progress that is made in various EU member states. These states showed an annual improvement of appliance efficiency of 1.8% between 2001 and 2012. These member states have implemented successful energy efficiency measures for appliances before 2005 (UK, Sweden, Netherlands, France, Slovakia, Finland, Czech Republic, Latvia) according to the MURE database (ISIS, 2014). The historic energy efficiency progress of these measures is represented by the ODEX index (Enerdata, 2010) which is a weighted average of sub-sectoral indices. These sub-sectoral indices are calculated from different energy consumption indicators and measured in physical units (e.g. kWh/appliance).

The historic annual improvement of 1.8% of the EU member states was implemented in the TIMER residential model and was applied to all new residential appliances[16] for all six large emitting countries and the rest of the world, between 2015 and 2030. The efficiency improvement for lightning was based on the EU policy between 2009 and 2012 that endorsed phase-out of all incandescent light-bulbs (European Commission, 2009). The New Climate Institute calculations used the energy reductions from the PBL calculations to which they applied their own emission factors.

To compare the sectoral results to scenarios compatible with 2°C, we convert the numbers to energy consumption per capita.

[16] Refrigerator, Microwave, Washing Machine, Clothes Dryer, Dish Washer, TV, DVD-VCR, PC

Table 10: Overview of quantification approaches for the buildings sector

Policy	Indicator	Good practice value	Explanation
Standards for efficiency of appliances and lighting	Annual improvement in appliance efficiency	Average efficiency improvement of 1.8% per year	Average improvement of appliance efficiency between 2001 and 2012 of EU member states with successful efficiency policies implemented before 2005. Odyssee-Mure 2014, Energy Efficiency Key Indicators. Available from http://www.indicators.odyssee-mure.eu/online-indicators.html
Energy efficiency of the building envelope (heating/cooling)	kWh/m2 (energy consumption) for new buildings	Starting value for first year: Current standard for new buildings in kWh/m² Moving linearly to 0 kWh/m² in 2030	Value from EU directive on energy performance of buildings suggests near 0 energy buildings in 2020, we set this for 2030 to provide sufficient time

3.4 Transport

For the transport sector, this report focuses on the areas of efficiency of light duty vehicles, and the support of electric cars. The first area is one where many countries are active already (ICCT, 2014)). A number of countries has implemented efficiency standards or emission intensity targets for new cars. The exact design of the policy and the ambition of the targets varies (see Table 11). Many countries regularly revise the targets over time and increase their stringency (e.g. EU, Japan, China, and USA).

Electric mobility is only starting to develop, but at a sometimes surprisingly quick pace (Hare et al., 2014). As examples, both Colombia and India have NAMA’s under development on introducing electric cars. Colombia intends to reach a 20% penetration of electric cars, but they did not specify the period for attaining this target (NAMA Database, 2015b). Chile intends to introduce 70,000 electric vehicles in 2020, including cars, taxis, mini buses and fleet vehicles which is 1% of the total fleet (NAMA Database, 2015a).

Within the National Electric Mobility Mission 2020, India introduced a goal of 21% penetration of electric cars (hybrid, plug-in hybrid and electric). This plans also includes targets for buses, two- and three- wheel drives and light commercial vehicles (Government of India, 2012).

Norway provides significant tax exemptions for electric vehicles, allows electric cars in bus lanes, waives road tolls and parking fees and has put in place a great number of free charging stations (The Guardian, 2014). For various months, this reflected in a percentage of 10% of vehicle sales.

Table 11: Exemplary good practice policies in the transport sector

Policy area	Country	Indicator value	Description of policy
Efficiency / emission standards light duty vehicles [1]	China	14.5 km/l in 2015. 20 km/l in 2020	Fuel efficiency standard for light duty vehicles
	South Korea	24,1 km/l in 2020	Fuel efficiency standard for light duty vehicles
	Japan	19,5 km/l in 2020	Fuel efficiency standard for light duty vehicles
	US & Canada	23,4 km/l in 2025	Fuel efficiency standard for light duty vehicles
	EU	17.9 km/l in 2015, 24,4 km/l in 2021, , 7)	Fuel efficiency standard for light duty vehicles
	Brazil	17.4 km/l in 2017	Fuel efficiency standard for light duty vehicles
	Mexico	14,9 km/l in 2016	Fuel efficiency standard for light duty vehicles
	India	21.0 km/l in 2021	Fuel efficiency standard for light duty vehicles
Support Electric cars driven by renewable electricity	Norway	6% of new vehicles in 2013[2]	Incentives for the purchase of electric vehicles include: Economic incentives through tax levies, preference parking and driving lanes, investments in charging infrastructure[3],
	Colombia	20%, no year specified	Electric Vehicles NAMA 20% penetration for passenger transport [4],
	India	6% in 2020 for BEV 11% in 2020 for HEV 4% in 2020 for PHEV	National Electric Mobility Mission 20205)
	Chile		E-mobility readiness plan[5] 70,000 electric vehicles in 2020, (1% of total fleet on the road (cars, taxis, mini buses, fleet vehicles)

Sources: 1) (ICCT, 2014); 2) (Shahan, 2014); 3) (The Guardian, 2014); 4) (NAMA Database, 2015b); 5) (Government of India, 2012); 6) (NAMA Database, 2015a); 7) (European Commission, 2015)

To assess the impact of improved efficiency of light duty vehicles, this study builds on the fuel economy and emission standards of the European Union. It assumes a linear development from the current level towards a fuel economy standard of 47.5 km/l in 2030. This is an extrapolation of EU standards for 2025. The standards are comparable to the standards in the 2°C scenario from the Technology Roadmap (IEA, 2012) which are based on estimates of best achievable levels in terms of technology potential and also include changed sales expectations

For the calculations on electric mobility, Norway's support for electric cars serves as a good example: for various months, electric vehicles reflected in a percentage of more than 10% of vehicle sales. We assume that this share could be achieved as a minimum by 2020 in all countries, and continue to increase further to 20% in 2030.

As the emissions from electric transport depend on the emission intensity of the electricity generation, renewable energies ideally fuel this additional electricity demand. This study assumes that this is the case and that this renewable energy is additional to the good practice renewable energy policies in the power sector. This is possible if electric cars support a higher share of renewables by creating additional demand and serving as a buffer for peaks in supply through their battery systems.

Exceptions for certain countries may be necessary so that the total renewable energy share does not exceed the potential of renewable energy generation.

To calculate emission reductions from the efficiency standards and the increase share of electric vehicles, the models rely on the renovation of the car stock. NewClimate calculations assume an average life expectancy of 15 years and add new cars according to the standards, using a linear interpolation between current levels of efficiency and share of electric cars towards the targets. The new composition of the car stock leads to lower emissions in comparison to the current policy scenario. For PBL, the efficiency standards are implemented in the TIMER transport model (Girod, Van Vuuren, & Deetman, 2011) where all light-duty efficiencies for new non-electric cars, with average lifetime of 10 years, are set equal to the good practice policy targets and costs are adjusted for these efficiency levels.

The two indicators can be combined to calculate the average emission intensity per kilometre for passenger cars, to represent the carbon intensity of this transport sector segment.

Table 12: Overview of quantification approaches for the transport sector

Policy	Indicator	Good practice value	Sources
Efficiency / emission standards light duty vehicles	Light duty vehicles fuel efficiency km/l for new registrations	Linear development from today’s level towards a fuel economy standard of 47.5 km/l in 2030	Light duty fuel economy and emission standards of the European Union, linear extension to 2030 beyond 2020.
Support Electric cars driven by renewable electricity	Share of electric cars for new registrations	Starting from today’s share per country increasing to 10% of new vehicles in 2020, 20% in 2030	Support for electric cars in Norway

3.5 LULUCF

For the LULUCF sector, the main focus is that of halting deforestation and thereby reducing emissions. For deforestation, a number of countries have already shown that they are able to reduce their national deforestation rates. A number of international initiatives such REDD+ have also mobilized the international community to address the issue of deforestation and support countries in their efforts to reduce emissions from deforestation and forest degradation.

An example of a country that has been able to lower its deforestation level is that of Brazil. Brazil has implemented a number of national actions plans to reduce LULUCF emissions, and particularly to lower the deforestation in the areas of the country with the highest deforestation rates. Two examples of such plans are the Action Plan for Deforestation Prevention and Control in the Legal Amazon (PPCDAm), and the Action Plan for Deforestation Prevention and Control in the Cerrado region (PPCerrado). The PPCDAm calls for an 80% reduction of the annually deforested area in the Amazon by 2020, compared to an official historical average deforestation from 1996 - 2005 of 1.95 Mha/year. In a similar manner, the PPCerrado calls for a 40% reduction of emission from deforestation in the Cerrado by 2020, compared to an official historical deforestation rate of 1.95 Mha/year. Since its establishment in early 2004, the PPCDAm action plan has been very successful at decreasing the deforestation rate through a combination of forest cover monitoring, land use planning, enforcement, and promotion of sustainable use of resources. Based on these actions, PRODES[17] have estimated that the deforestation in the Legal Amazon has from the 1996 - 2005 average of 1.95 Mha/year, decreases to an average of 0.58 Mha/year for the period of 2010 - 2014. This corresponds to an overall 71% decrease of the deforestation rate.

The PPCerrado action plan, on the other hand, has only been established as of 2010 and only recently forest monitoring systems outside that of the Legal Amazon have started to be developed. With the latest Brazilian reporting of the Forest reference emission levels[18], the Brazilian government have recognizes the problem of data accuracy concerning deforestation in the Cerrado biome. Though a downward trend of vegetation loss has been noted in individual data since that of 2008, this data is still highly uncertain.

Table 13: Overview of good practice policies and quantification approaches for LULUCF

Policy	Indicator	Good practice value	Sources
Emission reduction from deforestation	Yearly deforested area	Based an average 2010 deforestation rate, decreasing deforestation with 22% in 2020, and 44% in 2030.	FAO STAT and FAO FRA

The approach chosen here is that of estimating the emission reduction potential of the good practice policy through the use of an indicative percentage decrease of the national annual deforestation rate. Based on the case of Brazil and on official FAO estimates and national reporting to FAO FRA of the annual deforestation rates as of 2010, it is assumed that the national deforestation rate could be decreased by 44% as of 2030. This percentage is estimated based on that Brazil would reach its target of 80% reduction in the Amazon, while keeping the deforestation rate in the other parts of the country stable over time. While steps can be taken to decrease the total nation deforestation in Brazil even more that the indicative percentage as here given, this has as of yet not been successfully implemented.

For the LULUCF sector it is as such assumed that countries, by implementing the good practice policy, could reduce their deforestation rate from their 2010 levels by 22% as of 2020, and 44% as of 2030. Some countries have the potential to decrease their deforestation rates even further then the good practice policy we have defined. Particularly countries with relatively small deforestations rates and without large pressures on the forest sector are likely to do this. Still, the 44% reduction of deforestation would be a considerable challenge for a number of countries. The approach of only considering the current deforestation rate and not taking the historical trend into account is likely to put higher institutional pressures on countries with historical low deforestation than that of countries with long historical trends as they are likely to already have undergone structural socio-economic developments that help to decrease the pressure of certain deforestation drivers.

The reduction in deforestation will be estimated for 2020 and 2030, where the 2020 emissions are based on a linear extrapolation of the target from that of 2015 to 2030. That is, the calculation of the emission reduction of the good practice policy is estimated based on that the policy is implemented as of 2015, and that the 44% reduction of national deforestation is fulfilled by 2030. Countries that in their

[17] The PRODES (Gross Deforestation Monitoring Program in Amazonia) is a national program that provides annual rated of gross deforestation in the Legal Amazonia. It is carried out by the National Institute for Space Research (INPE, Instituto Nacional de Pesquisas Espaciais).

[18] Brazil's submission of a forest reference emission level for deforestation in the Amazonia biome for results-based payments for REDD+ under the UNFCCC.

baseline development are estimated to reduce their deforestation rate more than that of the development for the good practice policy are assumed to keep to their baseline development. In other words, implementation of the good practice policy is assumed to reduce deforestation in comparison to a baseline development, not to increase deforestation in comparison to the baseline development. In terms of emission reduction related to implementation of the good practice and reduction of deforestation, the related emission reduction is estimated based on an average above ground and below ground biomass emission factor per hectares of forest in each respective country and each respective year. Implementation of the good practice as such provides an emission reduction based on the reduction of deforestation in hectares from the baseline deforestation rate and an average emissions factor based on the areas that are being deforested in that year. The response of emissions from soil and dead organic matter to a reduction of deforestation is not taken into account as to the implementation of the good practice policy, thereby providing a conservative estimate of the emission reduction potential.

4 Results of good practice by sectors and countries

4.1 Sectoral results of good practice policies

The paragraphs in this section illustrate the results of implementation of good practice policies by sector. For each policy area analysed in detail, we illustrate one or two indicators under the current policies scenario and the good practice policies scenario. This shows, how these sectoral indicators change with the implementation of good practice policies. Further, we illustrate the absolute emissions reductions in each policy area, and the relative reductions in comparison to the current policy scenario for the policy area.

For the intensity indicators, the graphs show the average of results of the calculations of PBL and NewClimate Institute. Emissions reductions are illustrated in tables in which ranges reflect the maximum and minimum values of two calculation methods used in our assessment.

4.1.1 Electricity from renewable energy sources

The good practice policy for renewable electricity generation that was selected is an increase of the share of renewables of 1.35 percentage points per year. Implementation of this policy results in a significantly faster development of renewable energy compared to current policies, especially after 2020. Such good practice policies are projected to decrease emissions on a global level by 0.9 to 1.7 $GtCO_2e$ in 2020 and 3.7 to 6.0 $GtCO_2e$ in 2030.

The reductions calculated by NewClimate Institute are in general higher than those resulting from PBL for three reasons:

1. The renewable share in the PBL current policies scenario is in most cases higher than the NewClimate scenario, which is based on the World Energy Outlook Current Policies scenario, showing a stabilisation trend in renewable energy. The renewable share after 2020 increases in the PBL TIMER energy model due to the assumed ongoing investments in renewable energy, and also due to the increased rate of technology development resulting from the increased installed renewable capacity.
2. NewClimate assumes that renewable energy first replaces coal, while PBL assumes that all energy carriers are reduced equally, taking into renewable potential and national circumstances.
3. NewClimate first calculates the impact of the support policies for renewable energy, without any changes to energy efficiency. PBL includes all good practice policies in one scenario, therefore assessing both renewable electricity and efficiency measures at the same time

Under the current policies scenario, the share of renewable electricity generation moves between 10% and 30% for most countries, with the world average being around 30% in 2030 (Figure 11). With its large hydro electricity generation capacity, Brazil's share is significantly above the average. The share of renewable energy in Brazil is however expected to stabilise or even decrease in the next decades under current policies in our projections. For some countries, the growth of the share of renewable energy is projected to be faster between 2010 and 2020 than in the decade after 2020. One reason for this is, that only current policies are reflected and many policy targets currently do not exceed 2020. Another reason is, that electricity consumption is still expected to increase strongly beyond 2020, and even with a strong increase in RE capacity, the share decreases.

Under the good practice policy scenario, the shares move up to roughly 40% to 55% in 2030.

Also in terms of the emissions intensity of the electricity generation, the contribution of additional renewable energy reflects in the results (Figure 12). The intensity already decreases in the current policy scenario in all countries (except for Brazil in the scenario of NewClimate). Besides renewable energy, further increase of electricity generation from gas plays a role here. Especially in coal intensive countries like India and China, the increased share of renewable energy implied by the good practice policies drives down the emission intensity significantly.

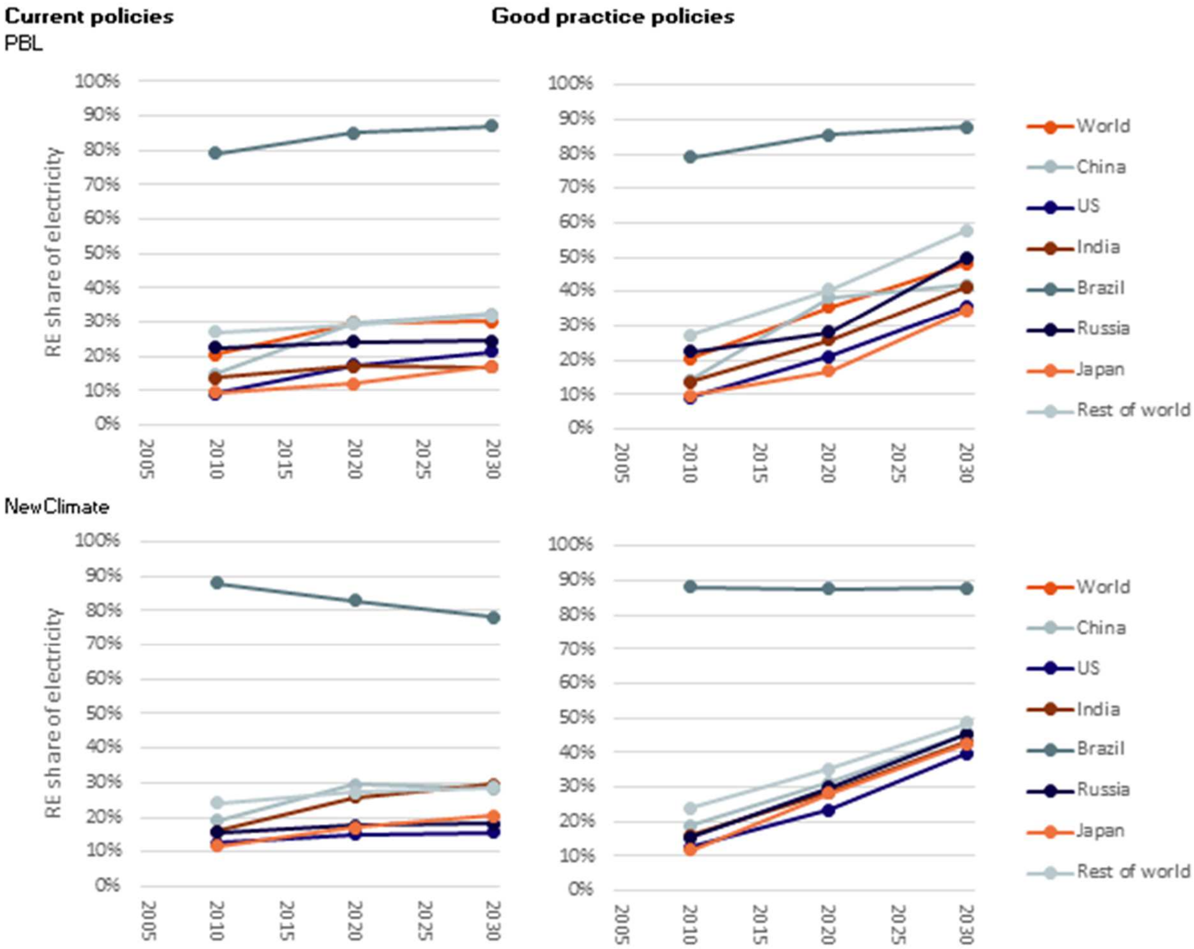

Figure 11: Share of renewable energy electricity generation under current and good practice policy scenarios for the PBL (upper graphs) and NewClimate (lower graphs)

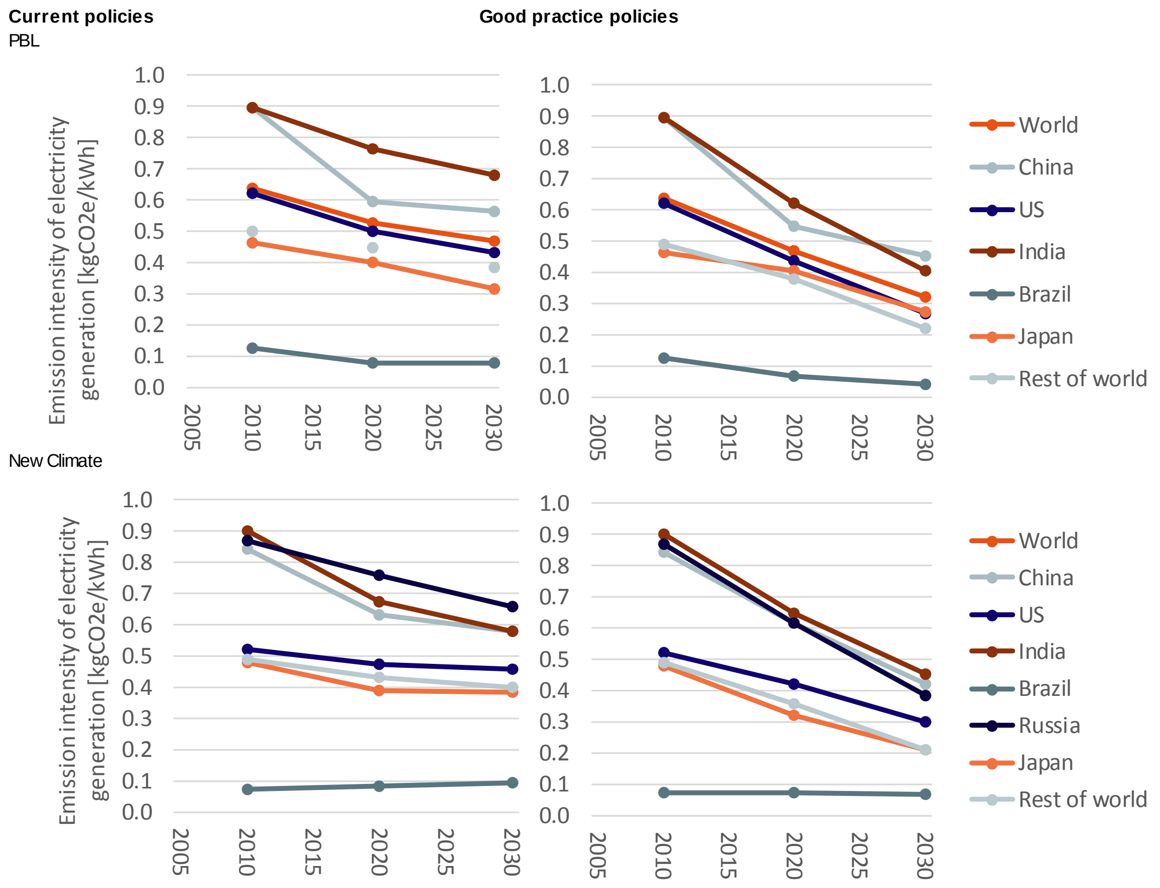

Figure 12: Emissions intensity of electricity generation under current and good practice policy scenarios

Table 14: Absolute and relative reductions of emissions through increasing renewable energy in the electricity generation sector

Country	Absolute reductions [$MtCO_2e/a$ below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World	[875; 1540]	[3695; 5965]	[6%; 11%]	[21%; 35%]
China	[0; 130]	[1015; 1650]	[0%; 3%]	[16%; 28%]
US	[105; 235]	[435; 750]	[4%; 11%]	[20%; 34%]
India	[40; 145]	[340; 530]	[3%; 10%]	[21%; 26%]
Brazil	[0; 5]	[0; 25]	[2%; 12%]	[0%; 25%]
Russia	[20; 165]	[75; 390]	[2%; 19%]	[9%; 42%]
Japan	[0; 75]	[20; 150]	[0%; 16%]	[6%; 31%]
Rest of world	[640; 890]	[1625; 2660]	[13%; 18%]	[30%; 47%]

The emission intensity of electricity supply after implementation of these good practice policies is within the range of what scenarios indicate would be required to hold temperature increase below 2°C above pre-industrial levels. IPCC AR4 WG3 indicates a 25th to 75th percentile range of 164 to 350 g/kWh in 2030 for the global average. Most countries are within that range in the good practice scenarios, however those with a currently very high intensity will require more time to get to those levels.

The World Bank Report "Decarbonising development: 3 steps to a zero carbon future" mentions that at least 30% of electricity should be generated through renewable energy sources by 2025. The IPCC says that in 2030, the share should be at around 35% (the median of all scenarios). The results of the good practice scenario exceed these values for all countries analysed.

Both reports say the electricity sector should be completely decarbonised around the middle of this century. This means the development the good practice policies imply needs to continue, and, in many regions, at an even faster pace. From a climate perspective, implementation of nuclear or CCS could result in similar emission reductions.

4.1.2 Reducing methane emissions from oil and gas production

Another potential area of improvement analysed in this report is the emission intensity of oil and gas production. In most countries, this is expected to increase or roughly stabilise in the next two decades. With aggressive reduction targets as for example foreseen in this sector in the United States, about 0.5 $GtCO_2e$ could be globally avoided in 2020, and up to 1.3 $GtCO_2e$ in 2030.

A major share of those emission reductions come from major oil-producing countries not covered in detail in this report. Of the countries covered, employing a strong methane reduction target for Russia would lead to the most reductions, given its high production volumes. For Japan, this sector is largely irrelevant, as it imports almost all of its oil and gas. For China, the effect is small as emissions in the sector are not high and the intensity already improves under projections of current policies in this report. For India, the effect is larger than for China although it produces less gas and oil, as the emission intensity of the process is at a significantly high level today and projected to stay high.

Figure 13 illustrates the development of the intensity of oil and gas production under the two cases. The good practice policy of improving the intensity by 4.7% per year already has a substantial impact by 2020 and continues this way to 2030.

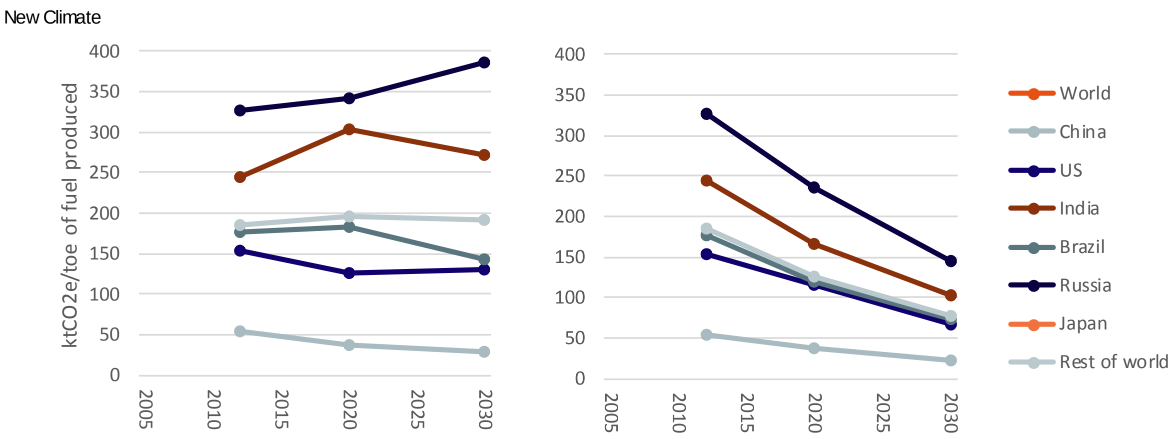

Figure 13: Emissions intensity of oil and gas production under current and good practice policy scenarios

Table 15: Absolute and relative reductions of emissions through improving emission intensity of the oil and gas production

Country	Absolute reductions [$MtCO_2e/a$ below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World	[540; 580]	[1100; 1250]	[30%;35%]	[55%; 65%]
China	0	15	0%	15%
US	15	[90; 100]	10%	[50%; 55%]
India	12	20	45%	60%
Brazil	15	25	35%	50%
Russia	125	275	30%	60%
Japan	0	0	0%	0%
Rest of world	370	680	35%	60%

4.1.3 Efficiency of industrial processes

If countries worldwide were to implement good practice policies for efficiency in industry, global emissions could decrease by 1.2 $GtCO_2e$ in 2020 and 1.8 $GtCO_2e$ in 2030. The major share of those projected reductions comes from China and India. China has the world's largest industry emissions in both 2020 and 2030, especially for cement and steel. The analysis shows that it could strengthen or expand existing programmes to tap into significant mitigation potential. Efficiency measure in India's industry sector were projected to have the largest impact because it has relatively large energy savings potential when compared to good practice (Dasgupta et al., 2012). Implementing good practice efficiency policies could decrease GHG emissions by 29% in 2030 compared to current policies emission levels (see Table 16).

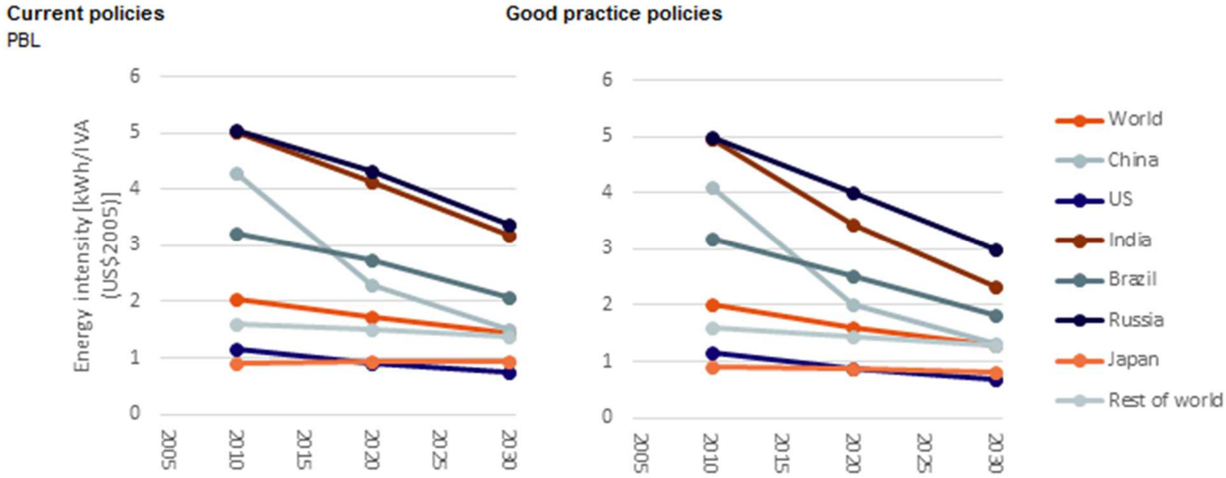

Figure 14: Energy intensity of the industrial sector under current and good practice policy scenarios

Table 16: Absolute and relative reductions of emissions from energy efficiency in the industrial sector

Country	Absolute reductions [$MtCO_2e$/a below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World	[966; 1210]	[1051; 1753]	[13%; 16%]	[17%; 22%]
China	[480, 590]	[600, 650]	[17%, 20%]	[20%, 25%]
US	[30, 45]	[65, 110]	[4%, 4%]	[10%, 10%]
India	[95, 175]	[205, 350]	[21, 21%]	[29%, 29%]
Brazil	[25, 40]	[35, 50]	[16%, 16%]	[19%, 19%]
Russia	[45, 75]	[70, 115]	[17%, 17%]	[24%, 24%]
Japan	[15, 35]	[30, 75]	[10%, 10%]	[18%, 19%]
Rest of world	260	450	8%	11%

Note: NewClimate uses PBL's reduction below reference for energy consumption in industry

To what extend these good practice policies are on track to meet the 2°C target is difficult to establish as there are no studies presenting indicators on the level of the total industry sector, but only on sub-sector level such as cement, iron and steel and paper.

4.1.4 Reductions of fluorinated gases

Good practice policies implemented in the area of industrial F-gases could achieve high additional emission reductions to current policies. If the North American Montreal Protocol Amendment Proposal were to be implemented and extended to PFC's and SF6, global emissions could decrease by 0.1 to 0.2 $GtCO_2$ in 2020 and by 1.1 to 2.2 $GtCO_2e$ in 2030, relative to the current policies scenario. The reductions in 2020 are small because the baseline included in the proposal is relatively high as it recognizes that HFCs are alternatives in some existing HCFC applications, so baseline levels are set to accommodate some level of transition from HCFCs to HFCs. The range of global emission reductions relative to current policies scenario in 2030 is large because of the uncertainty in F-gas projections represented by the large difference in emission projections (See Figure 15). With currently implemented policies, the increase can be as high as 300% to 400% above 2010 levels with currently implemented policies, especially in countries with certain developing industrial sectors (e.g. car industry, or refrigerants). With good practice policies, global emissions by 70%-80% below current policies scenario (see Table 17), resulting in an emission level close or below the 2010 F-gas emission level (see Figure 15).These reductions are in line with the global mitigation potential at €20/MtonCO_2eq presented in (Schwarz et al., 2011).

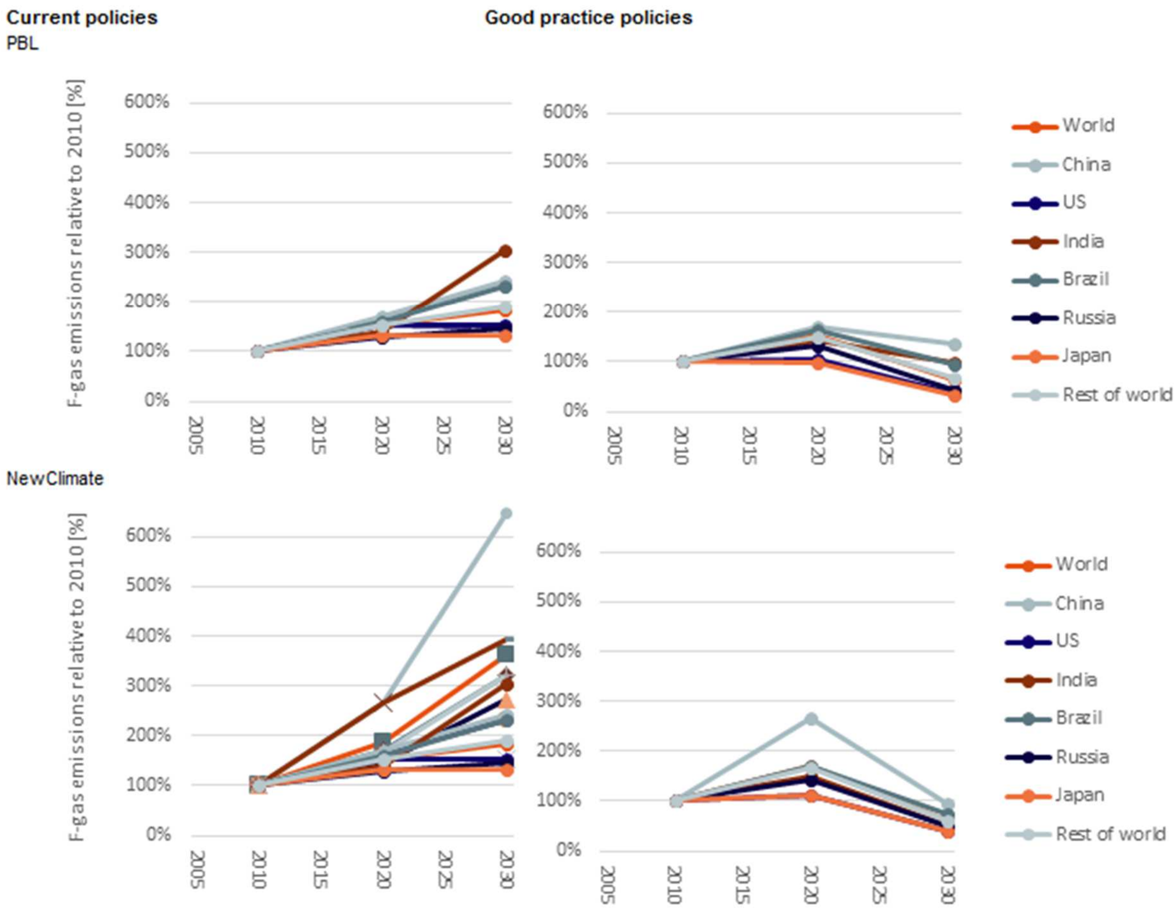

Figure 15: F-gas emissions relative to 2010 under current and good practice policy scenarios

Table 17: Absolute and relative reductions of emissions from accelerated phase out of F-gases

Country	Absolute reductions [MtCO_2e/a below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World	[125; 180]	[1085; 2210]	[9%; 13%]	[65%; 83%]
China	0;	[160; 765]	0%	[45%; 85%]
US	[70; 155]	[265; 365]	[31%; 32%]	[77%; 83%]
India	[0; 40]	[40; 125]	[0%; 43%]	[68%; 87%]
Brazil	0	[20; 30]	[0%; 1%]	[60%; 77%]
Russia	[0; 1]	[30; 40]	[1%; 3%]	[70%; 82%]
Japan	[10; 25]	[25; 70]	[26%; 28%]	[74%; 75%]
Rest of world	[0; 5]	[390; 965]	0%	[65%; 81%]

Global F-gas emissions in the good practice policy scenario decrease to a level of 60% to 65% of 2010 levels. According to Labat et al. (2015) a global mitigation scenario illustrating how all countries can set milestones for action by 2030 - in relation to the common goal of holding global warming below 2°C and integrating national circumstances - would go deeper, to around 70% F-gas reductions compared to 2010 by 2030.

4.1.5 Efficiency of building envelopes and appliances

Implementation of good practice policies in the residential sector could lead to a decrease of electricity consumption of 0.9 TWh (see Table 18) and reductions of GHG emissions of up to 1.8 $GtCO_2e$ in 2030.

Implementation of good practice policies on efficiency for appliances leads to indirect GHG emission reductions of 1.3 $GtCO_2$ by 2030, while the impact on direct emissions is negligible. Although the relative reductions are high, the total reductions are not as the residential sector only represents around 5% of global emissions. The impact of these policies on per capita electricity consumption, as shown in Figure 16, is small because of the relative small size of the residential sector. Nonetheless, the largest reduction of per capita electricity consumption relative to current policies was found in Brazil and China.

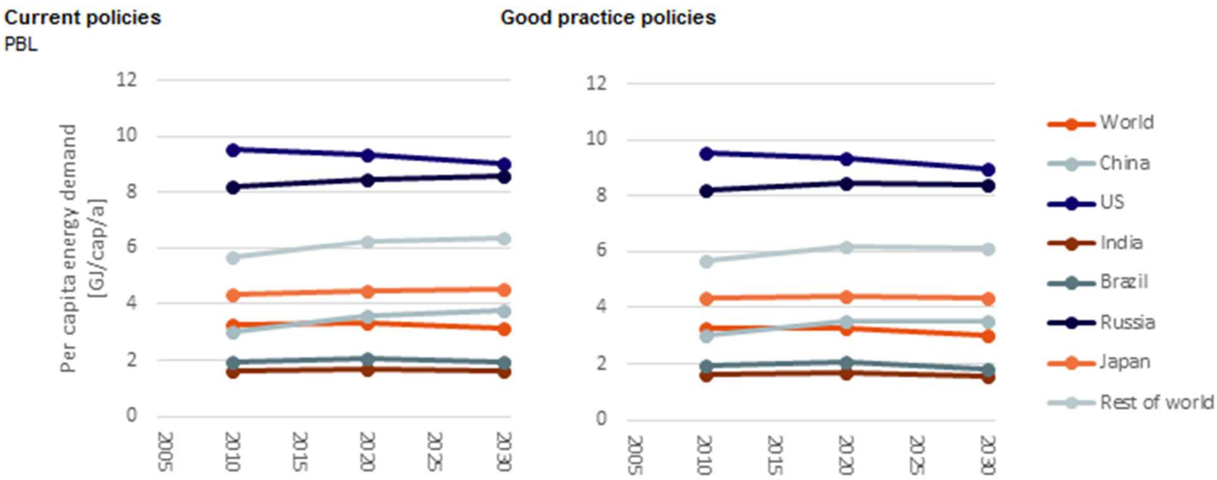

Figure 16 Per capita electricity consumption in the building sector (appliances) under current and good practice policy scenarios

Table 18: Reduction of electricity consumption in TWh per year

Country	Absolute reductions [TWh/a below current policies scenario] 2020	2030
World	215	930
China	65	310
US	15	65
India	15	80
Brazil	5	30
Russia	5	25
Japan	5	20
Rest of world	100	405

Efficiency measures implemented when constructing new buildings can reduce emissions by 0.2 $GtCO_2e$ in 2020 and 0.5 $GtCO_2e$ in 2030 in those countries covered in this sectoral analysis (China, US, India, Russia, Japan)[19].

The results show, that the per capita demand in countries with currently high per capita consumption in this sector decreases strongest with the implementation of the good practice policies in comparison to a scenario with current policies. In countries, where per capita energy consumption still increases to provide basic services to the population, the policy will imply less direct short term changes.

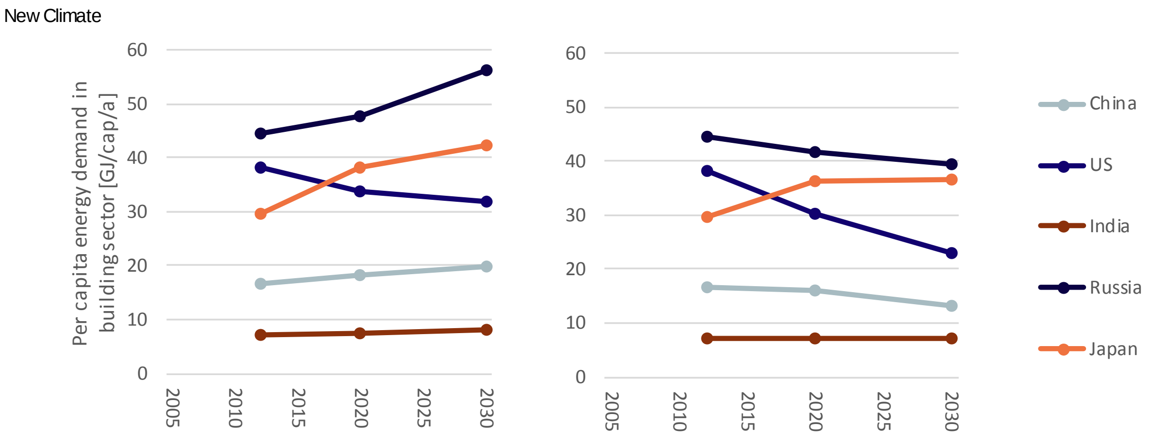

Figure 17: Per capita energy consumption in the building sector (incl. electricity) under current and good practice efficiency standard of new buildings (Brazil, rest of the world and world not available)

Table 19: Absolute and relative reductions of emissions through improving efficiency of building envelopes

Country	Absolute reductions [$MtCO_2e$/a below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World[20]	[175, 280]	[525, 690]	[12%, 12%]	[30%, 30%]
China	[95, 230]	[285, 530]	[20%, 20%]	[54%, 54%]
US	[5, 25]	[15, 55]	[12%, 12%]	[31%, 31%]
India	[10, 20]	[50, 80]	[4%, 4%]	[11%, 11%]
Brazil	n.a.	n.a.	n.a.	n.a.
Russia	[20, 25]	[60, 60]	[16%, 16%]	[37%, 37%]
Japan	[15, 15]	[40, 40]	[10%, 10%]	[29%, 29%]
Rest of world	n.a.	n.a.	n.a.	n.a.

The IPCC scenarios compatible with 2°C illustrate different values for the five regions for 2050. Comparing the country results to their particular regions shows that the results of good practice policies are roughly in line with the efforts needed for 2°C in the building sector. Thereby, some trade-offs between countries may be necessary: while the US even is significantly below the average value for the OECD-1990 region, Russia is - even with good practice policies - still above the threshold. Japan, China and India are close to the value indicated for their region in 2030.

[19] For the other countries and the rest of the world, the analysis was not possible due to data gaps

[20] Only China, US, India, Russian and Japan are included in this number, all other countries are excluded due to data limitations

Table 20: Per capita energy demand in buildings according to scenarios compatible with 2°C

Region	2010	2050	2030 (interpolated)
OECD-1990	50.3	37.2	43.8
EIT	35.6	31.6	33.6
LAM	9.2	11.8	10.5
MAF	12.2	10.3	11.3
ASIA	11.0	11.6	11.3

Source: (Lucon, Ürge-Vorsat, et al., 2014)

4.1.6 Efficiency of light duty vehicles and electric cars

In the transport sector, strong fuel efficiency standards for new light duty vehicles and supporting electric vehicles could reduce emissions by 0.3 to 0.9 $GtCO_2$ in 2020 and 1.9 $GtCO_2e$ in 2030 (see Table 21). Already under the current policy scenario, fuel efficiency of light duty vehicles increases (see Figure 18) as most countries already have car efficiency policies in place. Good practice energy efficiency standards for new light-duty vehicles could accelerate this trend significantly and speed up efficiency improvements of the entire car fleet. These good practice standards are based on an extrapolation of proposed 2025 EU car standards to 2030. The standards are comparable to the standards in the 2°C scenario from the Technology Roadmap (IEA, 2012) which are based on estimates of good achievable levels in terms of technology potential and also include changed sales expectations. If these additional standards are implemented, this would lead to 50%-70% global emission reductions compared to current policies scenario.

Similarly, fuel efficiency and a greater share of electric vehicles in the car stock, further decrease the emissions intensity of the distance driven of this sub-sector. The emissions intensity already decreases under current policies, but the rate of improvement are much higher with global good practice action (compare Figure 19).

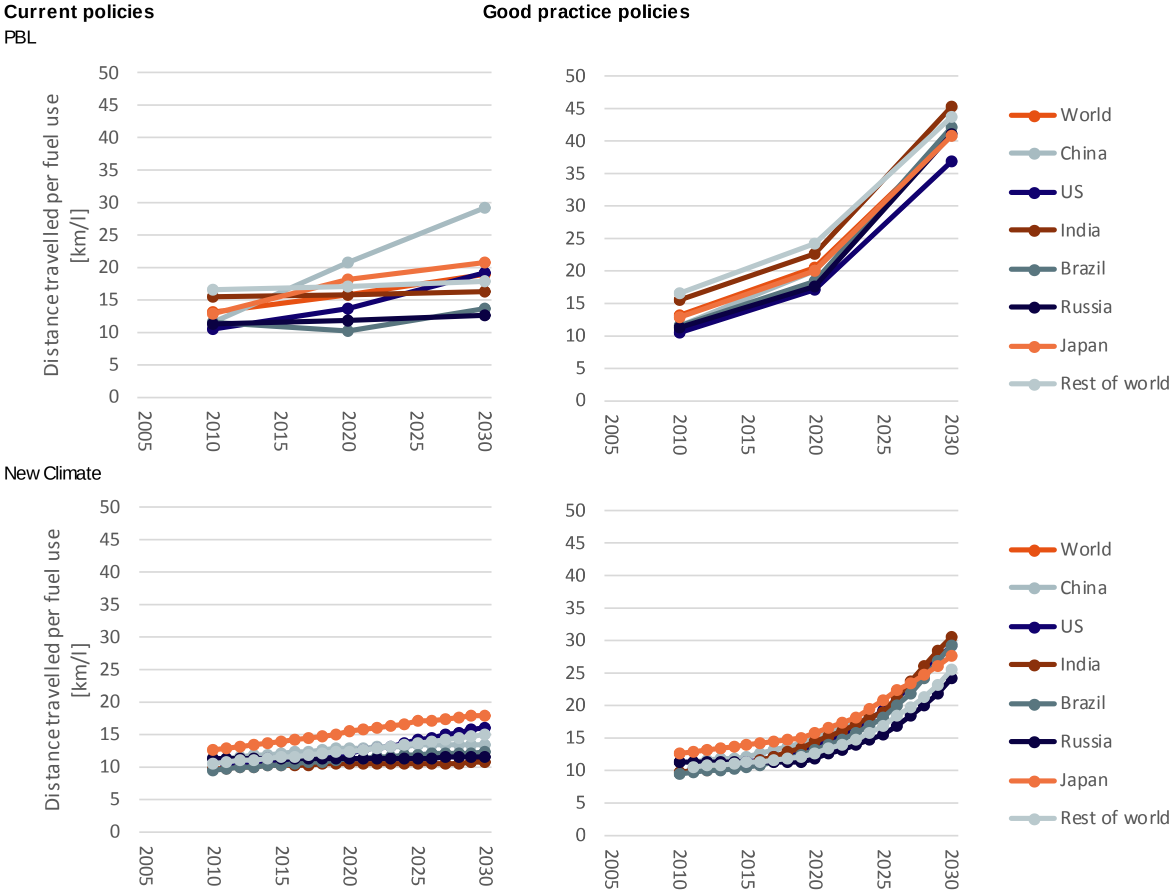

Figure 18: Fuel efficiency of light duty vehicles under current and good practice policy scenarios

Table 21: Absolute and relative reductions of emissions through improved efficiency of light duty vehicles

Country	Absolute reductions [MtCO_2e/a below current policies scenario]		Relative reductions [% below current policies scenario]	
	2020	2030	2020	2030
World	[275; 885]	[1875; 1915]	[9%; 34%]	[52%; 70%]
China	[25; 65]	[105; 360]	[13%;14%]	54%
US	[70; 205]	[250; 355]	[8%; 25%]	[37%; 58%]
India	[35; 60]	[145; 180]	[27%; 54%]	[65%; 84%]
Brazil	[20; 65]	[80; 95]	[14%; 51%]	[58%; 79%]
Russia	[5; 25]	[50; 110]	[5%; 45%]	[53%; 83%]
Japan	[0; 25]	[30; 70]	[2%; 23%]	[35%; 65%]
Rest of world	[75; 490]	[895; 1060]	[5%; 41%]	[54%; 75%]

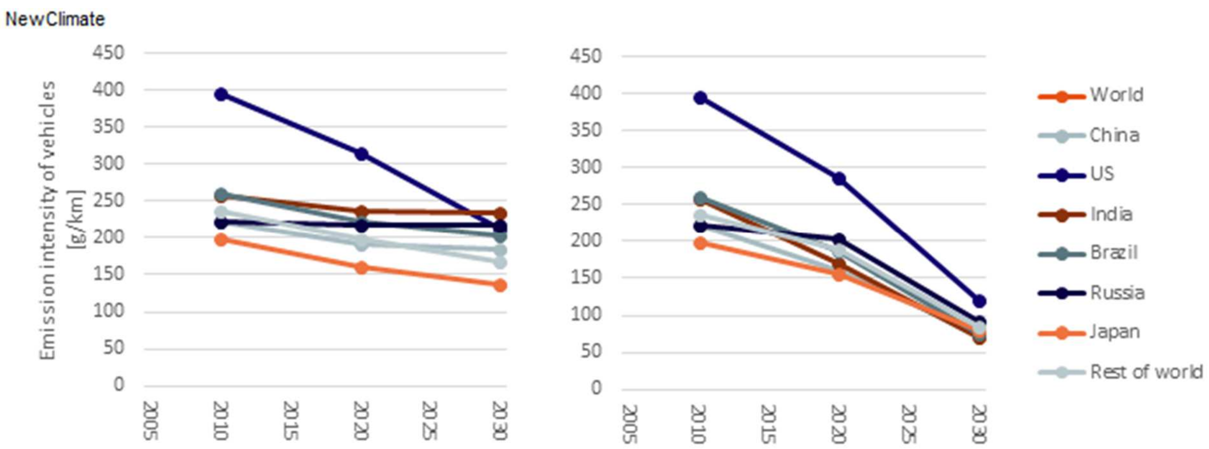

Figure 19: Emission intensity of light duty vehicles under current and good practice policy scenarios

Table 22: Absolute and relative reductions of emissions through increasing the share of electric cars (fuelled with electricity generated by renewable energy)

Country	Absolute reductions [$MtCO_2e/a$ additional reduction below scenario including good practice efficiency]		Relative reductions [% additional reduction below scenario including good practice efficiency]	
	2020	2030	2020	2030
World	85	325	2%	10%
China	10	35	2%	10%
US	10	50	2%	10%
India	0	10	2%	10%
Brazil	0	5	2%	10%
Russia	5	10	2%	10%
Japan	5	5	2%	10%
Rest of world	60	210	2%	10%

The IPCC does not break down requirements for the transport sector to light duty vehicles in the illustration of what is compatible with 2°C, but shows that, in 2020, electric mobility should hold a share of approximately 1%, and 9% in 2050 (Sims et al., 2014). With the good practice policies, these shares would be achieved for light duty vehicles. The IPCC also shows that absolute emissions of the sector should roughly stabilize at current levels throughout 2050 and decrease thereafter, while activity strongly increases. For the light duty vehicles considered in this report, this is the case. We even see a reduction in emissions from this segment after 2020.

4.2 Total economy wide emissions with good practice policies

4.2.1 World

With current policies, global emissions, including LULUCF, are expected to increase by 10% to 11% between 2010 and 2020 and 20% to 23% between 2010 and 2030 leading to emission levels of 53.9 to 54.3 $GtCO_2e$ in 2020 and 58.6 to 60.1 $GtCO_2e$ in 2030 (see Table 23). If good practice policies were implemented in the nine policy areas (see Summary Table 1) included in our assessment, emissions could almost remain stable at current levels until 2020 (49.2 to 49.7 $GtCO_2e$ in 2020) and decrease thereafter to 43.7 to 47.4 $GtCO_2e$ by 2030 (see Figure 20). The result is a decrease of global emissions from approximately 59$GtCO_2e$ in the current policies scenario by 2030 (grey range in Figure 20) to approximately 45 $GtCO_2e$ in the good practice policies scenario by 2030 (dark green range in Figure 20). This would bring GHG emissions close to the level necessary to stay on track to hold warming below 2°C. Implementation of good practice policies in the sectors not covered in our analysis could close the remaining emissions gap (as in(UNEP, 2014)).

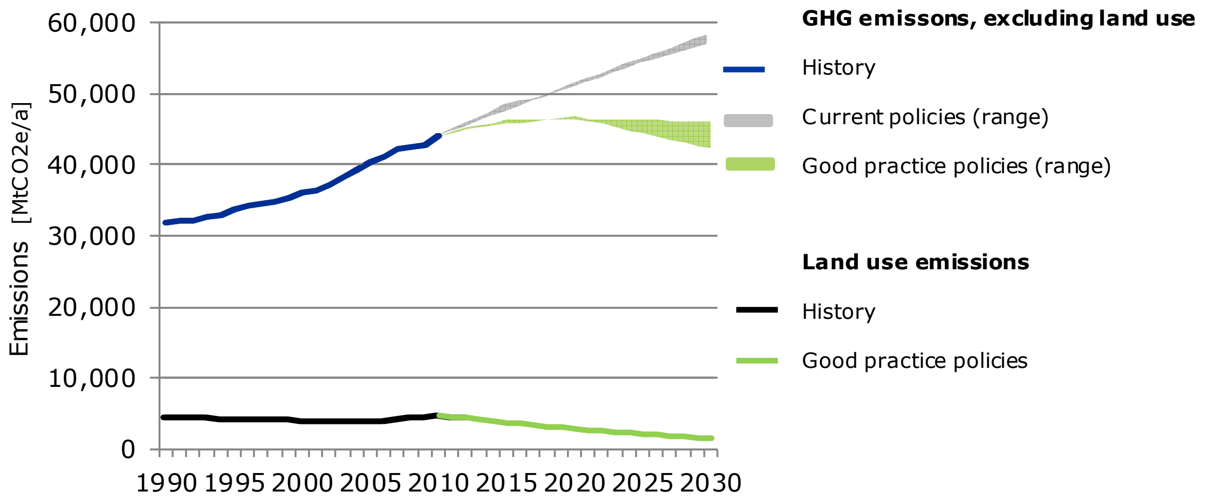

Figure 20. Global greenhouse gas emissions under different scenarios.

The light green area are remaining emissions after the implementation of good practice policies of the areas covered in the analysis. The brown area are the remaining emissions of the areas which are not covered. Note: emissions in 2010 from the two methods are at 48.8 GtCO2e, and thus slightly lower than other sources (e.g. (UNEP, 2014)).

Table 23: Global greenhouse gas emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	Absolute 2020	[GtCO$_2$e/a] 2030	Relative to 2010 2020	2030
Including LULUCF				
Pledge[1)]	[52.0; 55.0]		[12%, 18%]	
Current policies	[53.9, 54.3]	[58.6, 60.1]	[10%, 11%]	[20%, 23%]
Good practice policies	[49.2, 49.7]	[43.7, 47.4]	[1%, 2%]	[-11%, -3%]

Sources: 1) UNEP Gap report 2014. The range is based on conditionality of the pledges, and different accounting rules for implementation of pledges. The central estimates of PBL are consistent with this range.

The policy area which has the highest impact on global emissions in this analysis is the strengthened support for electricity generation through renewable energy sources. This area alone could reduce emissions between 3.7 to 6.0 GtCO$_2$e in 2030. This number goes beyond the potential indicated in the UNEP Emissions Gap Report 2014 of 5 GtCO$_2$e. That report bases its estimates on the 2°C scenario of the Energy Technology Perspectives report that assumes a less aggressive deployment of renewable energy (IEA, 2014b). Note that implementation of this ambitious renewable policy could bring along high implementation costs, which are not analysed in our study.

Other areas with significant reductions from implementing good practice policies are the reduction of fluorinated gases ('f-gases'), the promoting of fuel efficiency standards of light duty vehicles and an increase in the efficiency of industrial processes. The area producing the lowest reductions in 2030 are electric cars. The main reason is that this technology is just starting to develop in our scenario: it will have little impact on the short-term but possibly has a high potential to reduce emissions beyond 2030. Further, the reduction indicated is additional to the effect of efficiency in the transport sector. If no fuel efficiency measures were taken, electric cars would have a stronger impact on emissions.

Only relatively small emission reductions can be achieved in the LULUCF sector through the implementation of good practice policies. The main reason for this limited potential is that there is already a strong trend of reduction of deforestation in the baseline development, leading to a total reduction of LULUCF emissions in the range of 3 $GtCO_2e$ in 2030 compared to 2010.

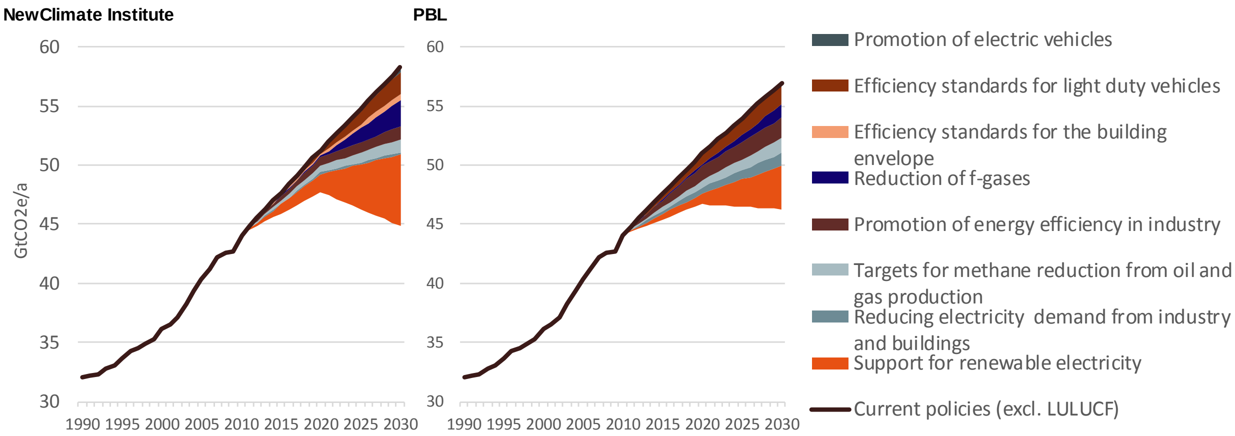

Figure 21: Reductions below the current policies projection per policy area covered in detail

Table 24: Absolute and relative reductions below implemented policies projections per policy area for the world

Policy area	Absolute reductions below current policies [$GtCO_2e/a$]		Relative reduction below implemented policies	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	[1.4; 1.7]	[4.7; 6.2]	[10%; 12%]	[27%; 36%]
Support for renewable electricity	[0.9; 1.5]	[3.7; 6.0]	[6%; 11%]	[21%; 35%]
Reducing electricity demand from industry and buildings	[0.1; 0.6]	[0.2; 1.0]	[0%; 4%]	[0%; 6%]
Targets for methane reduction from oil and gas production	[0.5; 0.6]	[1.1; 1.2]	[31%; 33%]	[57%; 63%]
Promotion of energy efficiency in industry[1)]	1.2	1.8	13%	17%
Reduction of F-gases	[0.13; 0.18]	[1.1; 2.2]	[10%; 15%]	[65%; 85%]
Efficiency standards for the building envelope[*4)]	[175, 280]	[525, 690]	[12%, 12%]	[30%, 30%]
Efficiency standards for light duty vehicles	[0.3; 0. 9]	[1.9; 1.9]	[9%; 34%]	[52%; 70%]
Promotion of electric vehicles[2)]	0.0	0.3	2%	11%
Decrease deforestation[3)]	0.95	0.28	5%	4%

Sources: 1) only PBL calculations; 2) only NewClimate calculations; 3) only IIASA calculations. 4) Global total only includes China, India, USA, Russia and Japan

4.2.2 China

In the projections used in this study, current implemented policies in China lead to approximately 13 $GtCO_2e$ in 2020 and 15 $GtCO_2e$ in 2030. This is an increase of approximately 30% above 2010 levels by 2020, and approximately 50% by 2030. With these emission levels, our projections suggest that China will likely achieve their pledge for 2020 emissions (see Figure 22). When we project that "good practices policies" are replicated in all sectors we find that this translate to peaking emissions in China around 2020 and at a level below 12 $GtCO_2e$. In addition, replicating the “good practice” policies translates to driving China’s emissions to below current levels by 2030.

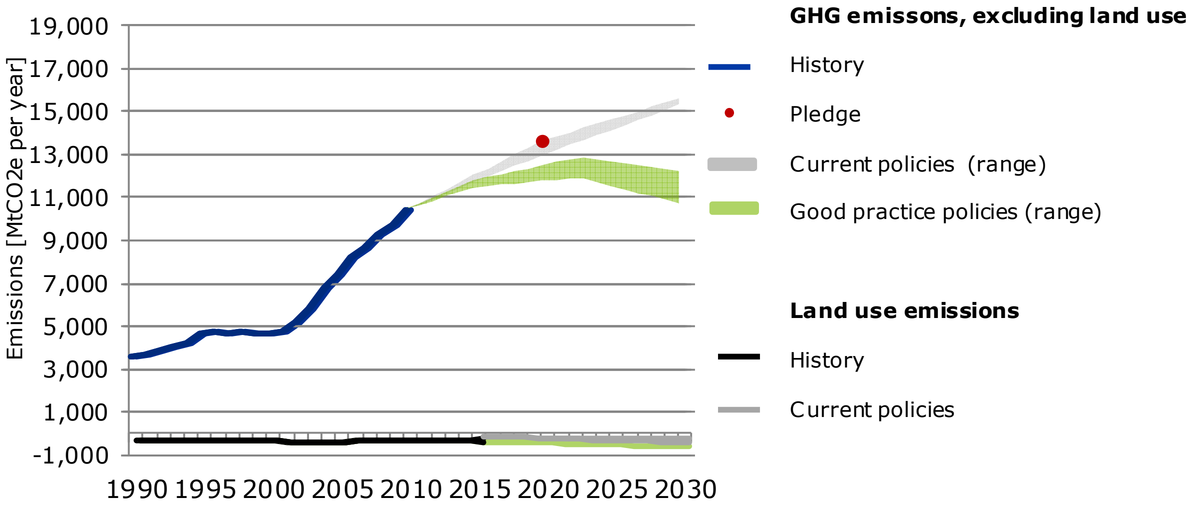

Figure 22: Impact of climate policies on greenhouse gas emissions in China.

Historical greenhouse gas emissions are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT).

Table 25: Greenhouse gas emissions for China including LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	**Absolute 2020**	**[GtCO$_2$e/a] 2030**	**Relative to 2010 2020**	**2030**
Including LULUCF				
Pledge*	[13.5]		[33%]	
Current policies*	[12.5, 13.4]	[14.7, 15.4]	[24%, 32%]	[45%, 52%]
Enhanced policies	[12.1, 12.9]	[13.1, 13.7]	[20%, 28%]	[30%, 35%]
Good practice policies	[11.3, 12.1]	[10.5, 11.6]	[12%, 20%]	[4%, 14%]

The implemented policy scenario, as calculated for and described in more detail in (den Elzen et al., 2015), contains policies and targets as described in the 12th Five Year Plan. This also includes updated targets for renewable energy capacity. Den Elzen et al. also calculated the impact of various selected enhanced policy actions, in the area of afforestation, even stronger RE development, improving building standards and a reduction of HFC consumption and production. This scenario led to emissions of 12.1 to 12.9 GtCO$_2$e in 2020, and 13.1 to 13.7 GtCO$_2$e in 2030. The implementation of good practice analysed in this report could decreases emissions to between 11.3 and 12.1 GtCO$_2$e in 2020 and 10.5 to 11.6 GtCO$_2$e in 2030.CO$_2$

The good practice policies in the sectors energy supply, industry, buildings, transport and the remaining areas thus lead to reductions of up to 1.2 to 1.3 GtCO$_2$e in 2020 and 3.1 to 4.6 GtCO$_2$e in 2030 below the scenario with current policies. For China, most reductions beyond current policy projections come from the increased deployment of renewable energy according to this assessment. This action alone would reduce emissions by 0.1 GtCO$_2$e in 2020 and 1.0 to 1.7 GtCO$_2$e in 2030. Further, limiting the consumption of F-gases can lead to reductions of 0.2 to 0.8 GtCO$_2$e in 2030. China is currently developing policies in both these areas: announced post 2020 contribution includes an increase of the renewable energy share (Xinhua, 2014), and China is working on improving the policy framework for F-gases (UNFCCC, 2014). Table 26 illustrates projected reductions from all analysed policy areas under the good practice scenario.

Table 26: Absolute and relative reductions below current policies projections per policy area for China

Policy area	Absolute reductions below current policies [$MtCO_2e/a$]		Relative reduction below current policies	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	[0; 180]	[1 035; 1 785]	[0%; 4%]	[16%; 30%]
Support for renewable electricity	[0; 100]	[1 015; 1 650]	[0%; 3%]	[16%; 28%]
Reducing electricity demand from industry and buildings	*[30,50]*	*[20,135]*	[1%, 1%]	[0%,2%]
Targets for methane reduction from oil and gas production	0	15	0%	17%
Promotion of energy efficiency in industry[1)]	[480, 590]	[600, 650]	[17%, 20%]	]20%, 25%]
Reduction of F-gases	0	[160; 765]	[0%; 0%]	[45%; 85%]
Efficiency standards for the building envelope[2)]	[95; 230]	[285; 528]	[20%, 20%]	[54%, 54%]
Efficiency standards for light duty vehicles	[25; 65]	[105; 360]	[13%; 14%]	[54%; 54%]
Promotion of electric vehicles[2)]	10	35	2%	11%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations

Note: The scope of the individual emission reductions in Table 26 is limited to the emissions the policy area affects. E.g. for the efficiency standard for light duty vehicles, only emissions from light duty vehicles are considered to compare with reduction estimates.

The good practice scenario in this report also leads to stronger reductions than the enhanced policy scenario from den Elzen et al. The additional reductions result mainly from the extended scope. A second reason is the strengthening of the additional policies: the efficiency of the building standard for new buildings develops from 40 kWh/m² today towards 0 kWh/m² in 2020 for new buildings in the good practice scenario. In the enhanced scenario, it remains at the initial value of 40 kWh/m². The reductions of F-gases are also stronger in the good practice scenario, as these actions cover all F-gases here, while they are limited to HFCs in the enhanced scenario.

4.2.3 United States

In the projections used in this study, currently implemented policies in the United States lead to approximately 5.4 to 6.2 $GtCO_2e$ in 2020 and 5.3 to 6.5 $GtCO_2e$ in 2030. This projected trend would maintain emissions approximately at today's level. With the emission levels resulting from our projections, the US would likely not achieve their 2020 pledge. However, the country has a number of administrative actions close to implementation which, if fully implemented, could lead to it achieving the target (compare (den Elzen et al., 2015). Replicating "good practice" policies in all sectors analysed in this study, the results indicate that the US could achieve emission reductions of 15% to 37% below current levels by 2030, according to our projections (see Figure 23).

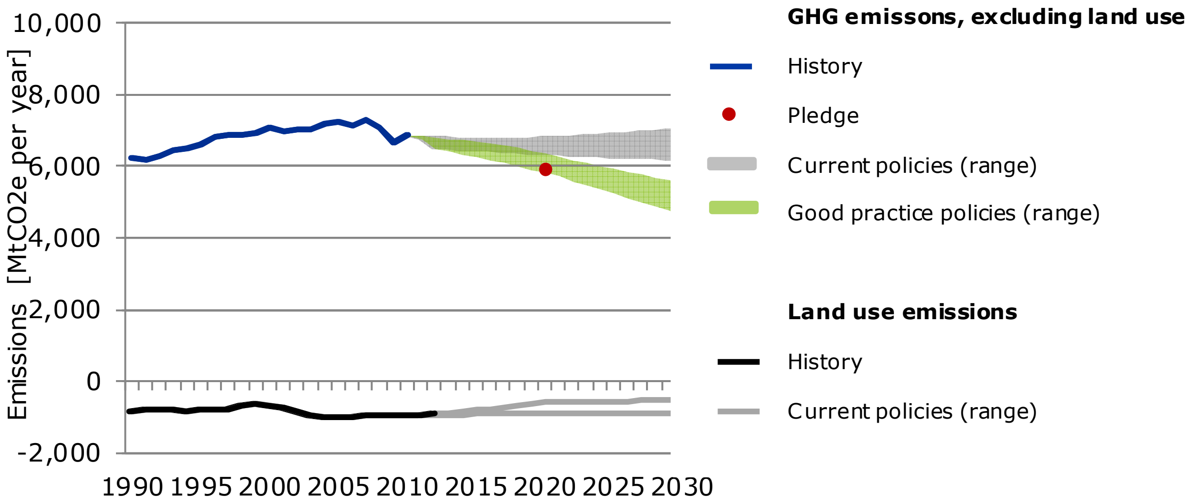

Figure 23: Impact of climate policies on greenhouse gas emissions in the United States.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC, and LULUCF emissions from the Sixth National Communication of the United States of America (United States, 2014).

Table 27: Greenhouse gas emissions for USA including LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	Absolute 2020	[GtCO$_2$e/a] 2030	Relative to 2010 2020	 2030
Including LULUCF				
Pledge*	5.1		-13%	
Implemented policies*	[5.4, 6.2]	[5.3, 6.5]	[-8%, 4%]	[-11%, 9%]
Planned policies	[4.7, 5.9]	[4.3, 5.7]	[-20%, 0%]	[-27%, -4%]
Enhanced policies	[4.4, 5.6]	[3.7, 4.9]	[-26%, -6%]	[-38%, -17%]
Good practice policies	[5.0, 5.8]	[3.7, 5.0]	[-16%, -3%]	[-37%, -15%]

The implemented policy scenario, as calculated for and described in more detail in (den Elzen et al., 2015), contains all policies implemented until November 2014. For the United States, Den Elzen et al. also calculated the impact of a number of policies which were categorises as “planned”. Most important to mention here are the Clean Power Plan, reductions of methane emissions from oil and gas production, and the renewable energy and energy productivity targets from the President’s Climate Action Plan (Executive Office of the President, 2013). Den Elzen et al. further analysed various selected enhanced policy actions for the United States: Enhancing the planned power plant standard, reducing energy efficiency on the industrial sector, strengthen existing car standards and phasing down HFCs. This scenario led to emissions of 4.4 to 5.6 GtCO$_2$e in 2020, and 3.7 to 4.9 GtCO$_2$e in 2030. The implementation of good practice policies would decrease emissions to 5.0 to 5.8 GtCO$_2$e in 2020 and 3.7 to 5.0 GtCO$_2$e in 2030. CO$_2$

The good practice policies in the sectors energy supply, industry, buildings and transport lead to reductions of up to 0.4 to 1.2 GtCO$_2$e in 2020 and 1.0 to 2.7 GtCO$_2$e in 2030 below the scenario with current policies. For the United States, most reductions beyond current policy projections come from the increased deployment of renewable energy, from reducing F-gases and from strengthening efficiency standards for light duty vehicles, according to our analysis. Applying good practice policies in the area of renewable energy alone would already reduce emissions by 0.1 to 0.2 GtCO$_2$e in 2020 and by 0.4 to 0.8 GtCO$_2$e in 2030. The policy areas with most impact here also are an important pillar of current actions by the Obama administration: Via the Clean Power Plan, the United States are tackling emissions from the power sector, and with the North American Amendment Proposal, the country is supporting the decrease of HFCs. Table 28 illustrates projected reductions from all analysed policy areas under the good practice scenario.

Table 28: Absolute and relative reductions below current policies projections per policy area for the US

Policy area	Absolute reductions below current policies [$MtCO_2e/a$]		Relative reduction below current policies	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	[255; 340]	[770; 960]	[12%; 14%]	[35%; 44%]
Support for renewable electricity	[105; 235]	[435; 750]	[4%; 11%]	[20%; 34%]
Reducing electricity demand from industry and buildings	*[23,235]*	*[20, 527]*	[1%, 10%]	[1%, 24%]
Targets for methane reduction from oil and gas production	15	[90; 100]	[9%; 9%]	[49%; 53%]
Promotion of energy efficiency in industry1)	[30, 45]	[65, 100]	[4%, 4%]	[10%,10%]
Reduction of F-gases	[70; 155]	[265; 365]	[31%; 32%]	[77%; 83%]
Efficiency standards for the building envelope2)	25	55	12%	31%
Efficiency standards for light duty vehicles	[70; 200]	[250; 355]	[8%; 25%]	[37%; 59%]
Promotion of electric vehicles2)	10	50	1%	11%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations

For 2020, the selected enhanced measures in Den Elzen et al. led to stronger reductions in 2020 than the good practice policies in this report. More policy areas are considered here, however the relatively drastic reductions implied through the enhanced actions in the power sector and the industrial sector are more aggressive in the short term than the good practice policies

4.2.4 India

In the projections used in this study, current implemented policies in India lead to 3.5 to 4.0 GtCO2e in 2020 and 4.8 to 5.5 GtCO2e in 2030. This is an increase of 50% to 67% above 2010 levels by 2020, and more than double by 2030. With the emission levels resulting from these projections, India will likely achieve their pledge for 2020 emissions (see Figure 24Figure 5). Replicating "good practice" policies in all sectors, emissions in India are projected to be at 3.0 to 3.5 $GtCO_2e$ in 2020 and at 3.4 to 4.1 $GtCO_2e$ in 2030.

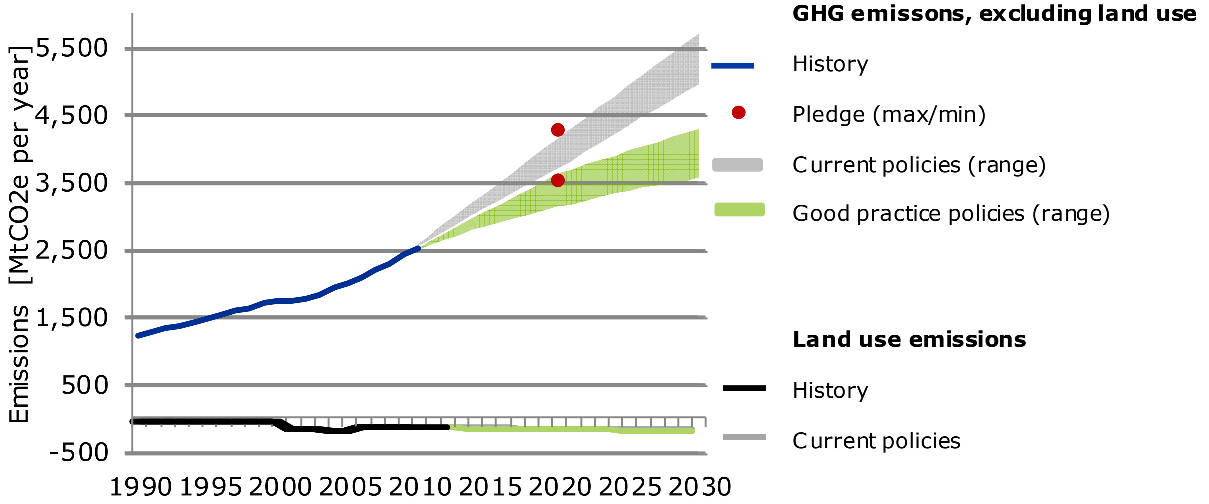

Figure 24: Impact of climate policies on greenhouse gas emissions in India.

Historical greenhouse gas emissions are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT).

Table 29: Greenhouse gas emissions for India including LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	**Absolute 2020**	**[GtCO₂e/a] 2030**	**Relative to 2010 2020**	**2030**
Including LULUCF				
Pledge*	[3.4; 4.1]		[65%; 70%]	
Current policies*	[3.5, 4.0]	[4.8, 5.5]	[49%, 66%]	[102%, 132%]
Planned policies	3.9	5.3	62%	121%
Enhanced policies	[3.3, 3.7]	[4.5, 4.8]	[38%, 54%]	[80%, 101%]
Good practice policies	[3.0, 3.5]	[3.4, 4.1]	[26%, 47%]	[44%, 74%]

The implemented policy scenario, as calculated for and described in more detail in (den Elzen et al., 2015), contains important mitigation actions India's renewable energy targets and energy efficiency measures in the industrial sector. Further, Den Elzen et al. calculated a scenario under planned policies that includes announced targets for wind and solar capacities beyond current legislation. Den Elzen et al. also calculated the impact of various selected enhanced policy actions: Increasing the forest cover, granting access to electricity through solar PV, efficiency standards for light duty vehicles and building envelopes, efficiency increase of appliances, and phasing down HFCs. This scenario led to emissions of 3.3 to 3.7 $GtCO_2e$ in 2020, and 4.5 to 4.8 $GtCO_2e$ in 2030. The implementation of good practice analysed in this report decreases emissions to 3.0 to 3.5 $GtCO_2e$ in 2020 and 3.4 to 4.1 CO_2GtCO_2e in 2030CO_2.

The good practice policies in the sectors energy supply, industry, buildings, transport and the remaining areas thus lead to reductions of up to 0.5 $GtCO_2e$ in 2020 and 1.4 $GtCO_2e$ in 2030 below the scenario with implemented policies. For India, most reductions beyond current policy projections come from the increased deployment of renewable energy. This action alone would reduce emissions by 0.3 to 0.5 $GtCO_2e$ in 2030, according to our assessment. Further, energy efficiency improvements in the industrial sector and transport has great potential to reduce emissions via good practice policies. With the Perform, Achieve and Trade Scheme, India is already targeting efficiency in industrial companies. This programme could be a basis for further action. Similarly, existing car standards could be strengthened. Table 30 illustrates projected reductions from all analysed policy areas under the good practice scenario.

Table 30: Absolute and relative reductions below current policies projections per policy area for India

Policy area	Absolute reductions below current policies [$MtCO_2e/a$]		Relative reduction below current policies	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	*[55; 395]*	*[315; 915]*	*[5%; 27%]*	*[19%; 45%]*
Support for renewable electricity	*[40; 150]*	*[340; 530]*	*[3%; 10%]*	*[21%; 26%]*
Reducing electricity demand from industry and buildings	*[15,250]*	*[-25, 385]*	*[1%, 17%]*	*[-1%, 19%]*
Targets for methane reduction from oil and gas production	10	20	45%	62%
Promotion of energy efficiency in industry[1)]	[95, 175]	[200, 3550]	[21%, 21%]	[29%, 29%]
Reduction of F-gases	[0; 40]	[40; 125]	[0%; 43%]	[68%; 87%]
Efficiency standards for the building envelope[2)]	20	80	4%	11%
Efficiency standards for light duty vehicles	[35; 55]	[145; 180]	[27%; 53%]	[65%; 84%]
Promotion of electric vehicles[2)]	0	10	2%	12%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations

The good practice scenario also leads to stronger reductions compared to the enhanced policy scenario from Den Elzen et al. (2015) The additional reductions result mainly from increasing the ambition level of the policies. For example, the reductions of F-gases in this report represents an increase in ambition level in terms of reductions and coverage of emissions. Further, the renewable energy expansion is broader in this report. Den Elzen et al focused on the share of the population which does not yet have access to electricity. This report significantly increases the share of total electricity generation.

4.2.5 Brazil

In the projections used in this study, current policies in Brazil lead to 1.5 $GtCO_2e$ emissions by both 2020 and 2030, including land use. Brazil has already implemented deforestation policies, especially in the Cerrado region which lead to important reductions from today's levels, according to our assessment. Therefore the focus in this report is on all other sectors. Excluding land use, current policies projections in this report in Brazil are expected to grow and lead to 1.0 to 1.1 $GtCO_2$ by 2020 and 1.1 to 1.2 $GtCO_2e$ by 2030 (see Figure 25). Replicating the “good practice” policies, our study projects emissions of roughly 1 $GtCO_2e$ in 2030.

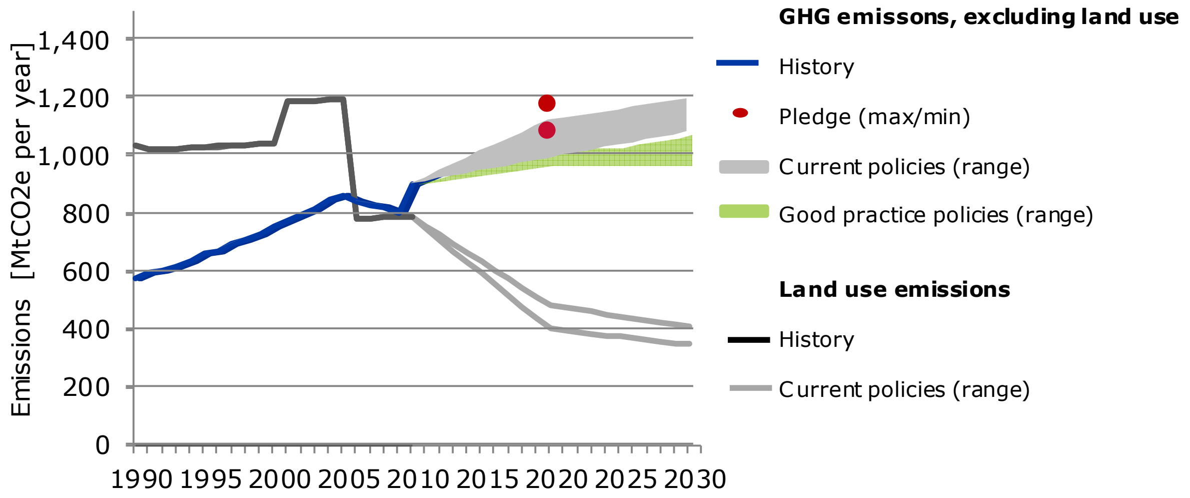

Figure 25: Impact of climate policies on greenhouse gas emissions in Brazil.

Historical greenhouse gas emissions (excluding LULUCF) are based on inventory data submitted to the UNFCCC (until 2005), energy-related CO_2 emissions from IEA (2013a), non-energy-related emissions from EDGAR 4.2 (JRC and PBL, 2012) and LULUCF emissions from FAOSTAT data (http://faostat3.fao.org/faostat-gateway).

Table 31: Greenhouse gas emissions for Brazil including and excluding LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	**Absolute 2020**	**[GtCO₂e/a] 2030**	**Relative to 2010 2020**	**2030**
Including LULUCF				
Pledge*	[2.0; 2.1]		[17%; 22%]	
Current policies*	[1.5, 1.5]	[1.5, 1.5]	[-13%, -10%]	[-12%, -9%]
Enhanced policies	[1.3, 1.4]	[1.3, 1.4]	[-15%, -22%]	[-15%, -26%]
Good practice policies	[1.3, 1.4]	[1.3, 1.4]	[-21%, -16%]	[-25%, -16%]
Excluding LULUCF				
Pledge*	[1.1;1.2]		[20%, 30%]	
Current policies*	[1.0, 1.1]	[1.1, 1.2]	[10%, 24%]	[20%, 32%]
Enhanced policies	[1.0, 1.0]	[1.0, 1.1]	[8%, 21%]	[7%, 27%]
Good practice policies	[1.0, 1.0]	[1.0, 1.1]	[8%, 13%]	[7%, 19%]

* The LULUCF emission projections are based on calculations by IIASA

The current policies scenario as described in Den Elzen et al. (2015), includes besides land use policies, renewable energy targets from the ten year National Energy Expansion Plan and vehicle efficiency standards from the National Plan on Climate Change. Excluding land use, the enhanced policy scenario in this report led to an emission level of 1.0 $GtCO_2e$ in 2020 and 1.0 to 1.1 $GtCO_2e$ in 2030 as the result of avoiding decarbonisation in the electricity sector and implementation of improved vehicle efficiency standards and phase-down of hydrofluorocarbons.

Good practice policies from this report are projected to lead to similar levels as enhanced policies, i.e. 1.0 $GtCO_2e$ by 2020 and 1.0 to 1.1 $GtCO_2e$ by 2030. Reduction from additional renewable electricity are small compared to other countries as the share of renewables in Brazil in 2012 is already 85% (REN21, 2014). The good practice policy of annually increasing renewable electricity by 1.35 percentage points would lead to 100% renewable electricity by 2030, which was not possible to implement in the PBL TIMER model. Measures that could lead to large additional emission reductions are methane reduction from oil and gas production, reduction of F-gases and improving efficiency standards for light duty vehicles lead to high reductions compared to current policies, which could lead to 50% or more reductions (see Table 34).

Table 32 Absolute and relative reductions below current policies projections (excl. LULUCF) per policy area for Brazil

Policy area	Absolute reductions below current policies [$MtCO_2e/a$]		Relative reduction below current policies	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	[5; 10]	[5; 30]	[6%; 14%]	[8%; 28%]
Support for renewable electricity	[0; 5]	[0; 25]	[2%; 12%]	[0%; 25%]
Reducing electricity demand from industry and buildings	[0; 5]	[5; 10]	[2%; 4%]	[4%; 13%]
Targets for methane reduction from oil and gas production	15	25	35%	50%
Promotion of energy efficiency in industry[1)]	[25, 40]	[35, 50]	[16%, 16%]	[19%, 19%]
Reduction of F-gases	0	[20; 30]	0%	[60%; 77%]
Efficiency standards for the building envelope[4)]	n.a.	n.a.	n.a.	n.a.
Efficiency standards for light duty vehicles	[20; 60]	[80; 95]	[14%; 52%]	[58%; 79%]
Promotion of electric vehicles[2)]	0	5	1%	10%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations; 4) could not be calculated because of lack of data on floor space

Good practice policies as analysed in this report, lead to stronger reduction in Brazil than found in the enhanced policy scenario in den Elzen et al. (2015), because of the extended scope and stronger building envelope, f-gas reduction and vehicle efficiency targets.

4.2.6 Russian Federation

In the projections used in this study, current policies in Russia lead to 2.3 to 2.4 $GtCO_2e$ in 2020 and 2.2 to 2.8 $GtCO_2e$ by 2030 (excl. LULUCF). The emission levels calculated here indicate an achievement of Russia's pledge for 2020 emissions. Replicating "good practice" policies decreases projected emission levels from 2015 onwards and leads to levels of 2 $GtCO_2e$ or below by 2030 (see Figure 26).

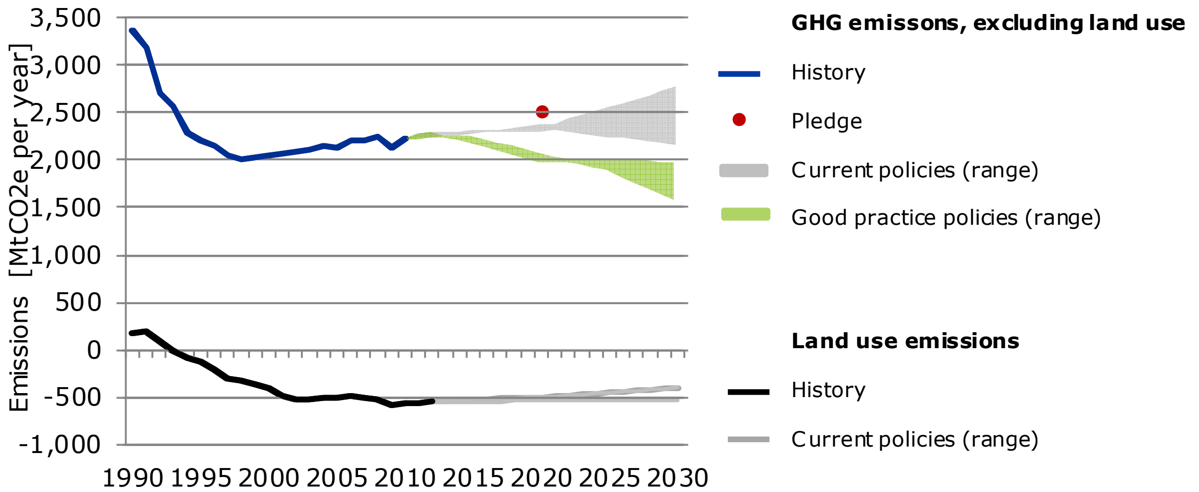

Figure 26: Impact of climate policies on greenhouse gas emissions in the Russian Federation.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC, and forestry emissions from the Sixth National Communication (Russian Federation, 2013)

Table 33: Greenhouse gas emissions for Russia excluding LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	**Absolute**	**[GtCO₂e/a]**	**Relative to 2010**	
	2020	**2030**	**2020**	**2030**
Excluding LULUCF			14%	
Pledge	2.5		14%	
Current policies	[2.3, 2.4]	[2.2, 2.8]	[3%, 7%]	[-3%, 25%]
Enhanced policies	[2.3, 2.3]	[2.1, 2.3]	[2%, 6%]	[-8%, 5%]
Good practice policies	[2.0, 2.1]	[1.6, 2.0]	[-10%, -6%]	[-29%, -11%]

The current policies scenario assumes implementation of renewable energy targets, energy intensity targets and measures to decrease emissions from venting and flaring in oil and gas production as described in Den Elzen et al, 2015. This report also analysed the impact of possible enhanced measures such as enhanced renewable targets, improved vehicle efficiency standards, energy efficiency measures in buildings and phase-down of HFCs. The emission level after implementation of enhanced policies was 2.1 to 2.3 $GtCO_2e$ by 2030. To compare, implementation of good practice policies could lead to an emission level of 1.6 to 2.0 $GtCO_2e$ by 2030.

Most reductions in the good practice scenario are coming from the implementation of ambitious renewable targets, reduction of methane from oil and gas production and promotion of energy efficiency in industry (see Table 34). The results for renewable energy can be explained from the very ambitious renewable energy targets in this scenario compared to Russia’s renewable electricity target, excluding hydro, of 4.5% in 2020. The impact of flaring and venting is large because the current policy is a 5% limit on gas flaring and because Russia is the second largest oil and gas producer in the World. Also the impact on industry is large because Russia has a huge potential for energy efficiency.

Table 34 : Absolute and relative reductions below current policies projections per policy area for Russia

Policy area	**Absolute reductions below current policies [$MtCO_2e/a$]**		**Relative reduction below current policies**	
	2020	**2030**	**2020**	**2030**
Electricity generation, of which:	[30; 170]	[85; 390]	[10%;12%]	[10%; 42%]
Support for renewable electricity	[20; 165]	[75; 390]	[2%; 19%]	[9%; 42%]
Reducing electricity demand from industry and buildings	[5;10]	[5;5]	[0%;1%]	[0%;1%]
Targets for methane reduction from oil and gas production	125	275	31%	62%
Promotion of energy efficiency in industry1)	[45, 75]	[70, 115]	[17%, 17%]	[24%, 24%]
Reduction of F-gases	0	[30; 40]	0%	[70%; 82%]
Efficiency standards for the building envelope2)	25	60	16%	37%
Efficiency standards for light duty vehicles	[5; 25]	[50; 110]	[5%; 45%]	[55%; 85%]
Promotion of electric vehicles2)	5	10	2%	10%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations

The good practice policies lead to stronger reductions compared to the enhanced policy scenario from den Elzen et al (2015) because of additional policies in oil & gas production and industry efficiency. Also the stronger F-gas policies and buildings policies lead to higher projected emission reductions.

4.2.7 Japan

In the projections used in this study, emissions after implementation of current policies in Japan remain at around 2010 levels by 2020 and decrease by 5% to 17% by 2030 (see Figure 27). This reflects emission levels of 1.1 to 1.3 $GtCO_2e$ by 2020 and 1.0 to 1.2 $GtCO_2e$ by 2030. The wide range can be explained by the uncertainty about the phase-out of nuclear energy, as it is not clear whether this will occur and which energy carriers would replace nuclear energy. With these projections, meeting the 2020 pledge could be challenging for Japan. Replicating "good practice" policies translates to projected emission levels of 0.5 to 0.9 $GtCO_2e$ in 2030.

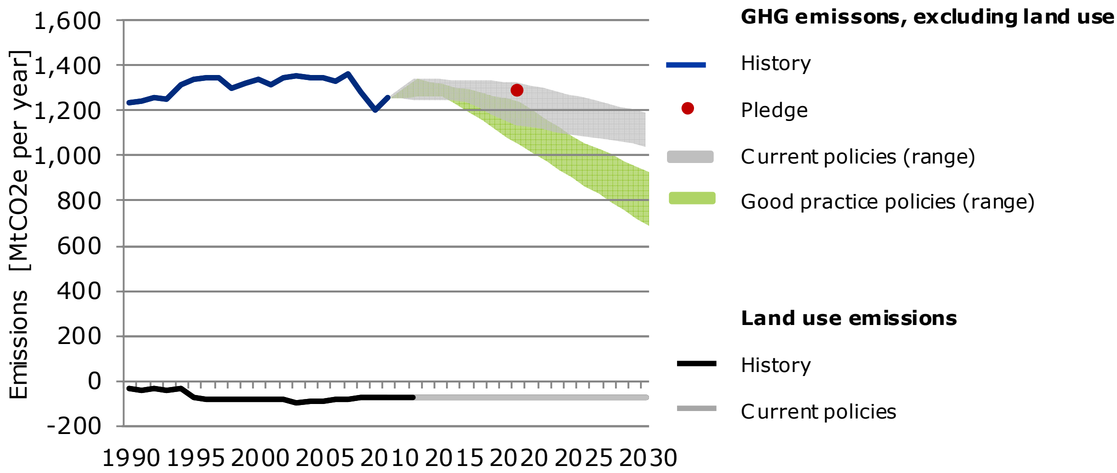

Figure 27: Impact of climate policies on greenhouse gas emissions in Japan.

Historical greenhouse gas emissions (excluding LULUCF) are based on national inventories submitted to UNFCCC

Table 35: Greenhouse gas emissions for Japan excluding LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	Absolute	[$GtCO_2e$/a]	Relative to 2010	
	2020	2030	2020	2030
Excluding LULUCF				
Pledge	1.3		3%	
Current policies	[1.1, 1.3]	[1.0, 1.2]	[-10%, 6%]	[-17%, -5%]
Enhanced policies	[1.0, 1.3]	[1.0, 1.1]	[-12%, 6%]	[-24%, -16%]
Good practice policies	[1.0, 1.2]	[0.7, 0.9]	[-17%, -1%]	[-45%, -26%]

The current policies scenario is described in more detail in den Elzen et al (2015) and includes implementation of the Basic Energy Plan for renewable targets and vehicle emissions standards and fuel efficiency from the Top Runner Programme. This report also analysed the impact of enhanced policies such as implementation of renewable energy together with the phase-out of nuclear energy, improved vehicle efficiency standards, energy efficiency in buildings and phase-down of hydrofluorocarbons. Implementation of these policies could lead to an emission level of 1.0 to 1.3 $GtCO_2e$ by 2020 and 1.0 to 1.1 $GtCO_2e$ by 2030. Good practice policies could go further and would lead to 1.0 to 1.2 $GtCO_2e$ emissions by 2020 and 0.7 to 0.9 $GtCO_2e$ by 2030 (see Table 35).

Most good practice policies have substantial impact on GHG emissions leading to reductions compared to the current policies scenario. Especially renewable energy policies and policies on reduction of F-gases could reduce emissions compared to implementation of current policies. The impact of renewable targets is large because the phase-out of nuclear targets in the current policies scenario is mainly accompanied by introduction of coal-fired power plants. Although F-gas policies have been proposed (Government of Japan, 2013), they are not implemented yet and good practice policies could lead to 75% reduction compared to current policies by 2030. The good practice policies lead to larger reductions compared to the enhanced policies because of the larger scope and strong policies on F-gases and renewable energy targets.

Table 36 : Absolute and relative reductions below current policies projections per policy area for Japan

Policy area	Absolute reductions below current policies [MtCO₂e/a]		Relative reduction below current policies	
	2020	2030	2020	2030
Electricity generation, of which:	[0; 75]	[25; 150]	[0%; 17%]	[6%; 32%]
Support for renewable electricity	[0; 75]	[20; 150]	[0%; 16%]	[6%; 31%]
Reducing electricity demand from industry and buildings	0	0	0%	0%
Promotion of energy efficiency in industry[1)]	[15, 35]	[30, 65]	[10%, 10%]	[18%, 18%]
Reduction of F-gases	[10; 25]	[25; 70]	[26%; 28%]	[74;75%]
Efficiency standards for the building envelope[2)]	15	40	10%	29%
Efficiency standards for light duty vehicles	[0; 25]	[30; 70]	[2%; 23%]	[35%; 65%]
Promotion of electric vehicles[2)]	0	5	2%	10%

Sources: 1) only PBL calculations, NewClimate uses PBL's reduction below reference for energy consumption in industry; 2) only NewClimate calculations; 3) only IIASA calculations

4.2.8 Rest of world

The previous sections showed the results of implementation of "good practice" policies for six example countries. Replication of "good practice" policies for the rest of the world lead to 5% above 2010 emission levels by 2020 and around 2010 levels by 2030, according to our projections (see Table 37).

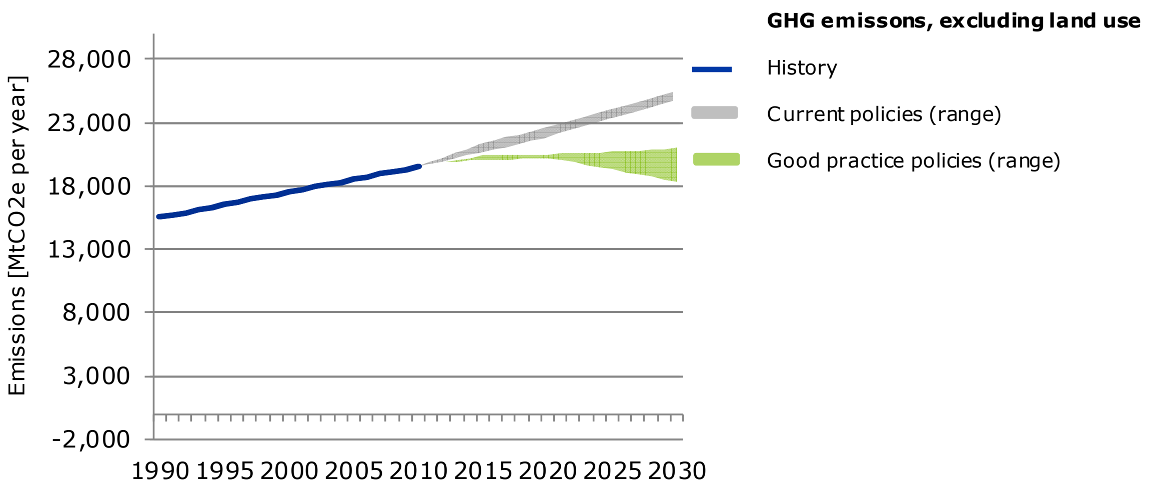

Figure 28: Impact of climate policies on greenhouse gas emissions in "Rest of the World"

Table 37: Greenhouse gas emissions for "Rest of World" excluding LULUCF emissions, absolute and relative to 2010, by 2020 and 2030 for different policy scenarios

Scenario	Absolute 2020	[GtCO₂e/a] 2030	Relative to 2010 2020	2030
Excluding LULUCF				
Current policies	[21.8, 22.6]	[24.7, 25.5]	[12%, 16%]	[27%, 31%]
Good practice policies	[20.2, 20.5]	[18.3, 21]	[4%, 5%]	[-6%, 7%]

5 Conclusions

If current good practice policies that are currently implemented by example countries were scaled up and implemented by all countries, global emissions in 2020 and 2030 would decrease the growth in emissions close to the range necessary to hold temperature increase below 2°C. This requires fast implementation of policies, as well as complete geographical and broad sectoral coverage. All the parameters chosen for this analysis are based on analyses of policies that have already been implemented by several countries and have proven to be feasible, successful and effective.

5.1 The global picture

With current policies, global emissions are expected to increase to 53.9 to 54.3 $GtCO_2e$ by 2020 and 58.6 to 60.1 $GtCO_2e$ by 2030.

With the nine policy areas that we have analysed, emissions could peak by 2020 at 49.2 to 49.7 $GtCO_2e$ and decrease to 43.7 to 47.4 $GtCO_2e$ by 2030, which would be close to - or at the upper end of - the 2°C range (UNEP, 2014). The emissions range that reflects scenarios compatible with holding temperature increase below 2°C is between 30 to 44 $GtCO_2e$ in 2030 in the UNEP Emissions Gap Report 2014, with the median of all of those scenarios being 42 $GtCO_2e$ (UNEP, 2014).

Most emission reductions in our study result from increasing support for electricity generation from renewable energy (3.7 to 6.0 $GtCO_2e$ reduction in 2030). The range is due to different assumptions that can be made for current trends after 2020 for which often no specific renewable policies are yet in place and to different assumptions for implementation of good practice policies (see Section 3.1.1).

Many countries see these technologies in the electricity sector as an important opportunity to develop a cleaner energy system and are already implementing policies in this area. The good practice policies can build on those efforts. Note that this does not include other types of renewables, such as renewable heat or biofuels.

Globally phasing down F-gases can reduce an important share of emissions equal to 1.1 to 2.2 $GtCO_2e$. By working on the basis of the North American Amendment Proposal on HFC gases to the Montreal Protocol and EU proposals on this, the global community could make an important step towards achieving this.

Energy efficiency is another area where good practice policies can lead to emission reductions. Efficiency measures in the transport, appliance and industry sectors, 2.9 to 5.1 $GtCO_2e/a$ could be avoided in 2030. Most countries already have efficiency standards in place that limit the energy consumption of technologies. These standards could be extended in scope, enhanced in terms of ambition and their enforcement strengthened. Good practice policies for reducing deforestation could imply emission reductions of 1.5 $GtCO_2e$ below scenarios with current policies.

5.2 Decarbonisation of sectors

Good practice policies can decrease the energy and carbon intensity to levels required for 2°C in the analysed sectors, while maintaining or even increasing the activities. An increase in activity may especially occur in developing countries, for example as an increase of access to electricity, vehicle ownership, increase use of electric appliances, larger floor space of housing facilities, etc. This development ensures economic sustainable development and mitigation of GHG emissions at the same time.

This analysis shows, that good practice policies can significantly reduce the impact of often much-needed economic development on greenhouse gas emissions, by decarbonising the energy supply and improving energy efficiency in the demand sectors.

The impact of good practice policies on a sectoral level is compared to global scenarios compatible with 2°C from the IPCC Fifth Assessment Report, using sectoral indicators. The emission intensity of the electricity sector and the per capita energy consumption in the building sector are in line with the 2°C compatible scenarios for 2030. The same is valid for the reduction of F-gases and the transport sector. For the LULUCF sector, 2°C scenarios indicate emission levels around zero, some even result in negative emissions from this sector already in 2030 (IPCC, 2014). In our assessment, the total emissions for the good practice scenario in the LULUCF sector by 2030 are low but do not go to zero.

5.3 Reduction of absolute emissions in the countries

For all countries analysed, the good practice policies can lead to significant emission reductions. In most countries, implementation of these policies halts emissions growth from today's level, or decreases them. An exception is India, where current activity levels are extremely low and further development will still slightly increase emissions until 2030, even with the implementation of good practice policies.

Specifically high are absolute reductions in China in 2030, in comparison to the scenario with current policies. Under current policies, China's emissions will increase to approximately 15 $GtCO_2e$ by 2030, whereas under a good practice policy scenario, emissions in 2030 would be at approximately 12 $GtCO_2e$ or lower. For China, this can be explained from the combination of the implementation of good practice policies, together with high growth and fast changing technology. In general, this means for example that the impact of good practice efficiency standards can be large due to the large turnover of car stock and appliances. Also, the strong increase of electricity demand together with the implementation of a high share of renewable electricity has a strong impact on absolute emissions.

The smallest difference between current policies and good practice policies is found in Brazil. This country already has a very high share of renewable energy and is also reducing emissions from deforestation, so therefore it is already implementing good practice policies.

5.4 Further research

The analysis in this report could be enhanced in two ways:

1. The selected good practice policies in this study cover 65% of global greenhouse gas emissions. No analysis has been done to estimate the potential emission reductions from the remaining 35% of emissions. I would be useful to understand good practice policies in the remaining areas, and provide their mitigation impact if replicated globally.
2. The study assumes that the good practice policies can be implemented without significant delays globally. However, policy implementation is very complex and dependent on country specific circumstances. More research on the feasibility of such policies could thus increase the robustness of the results.

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7 List of Acronyms

APG	Associated Petroleum Gas
AR4	Fourth Assessment Report of the IPCC
EEG	Erneuerbaren Energien Gesetz (renewable energy law in Germany)
EEO	Energy Efficiency Opportunities (Japan)
ESCerts	Energy Savings Certificates
F-gases	Fluorinated gases
GHG	Greenhouse Gas
GDP	Gross Domestic Produce
GWP	Global Warming Potential
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
NAPCC	National Plan on Climate Change (India)
PIGGAREP	Greenhouse Gas Abatement through Renewable Energy Project
PoA	Programme of Activities
PPCDAm	Deforestation Prevention and Control in the Legal Amazon
PPCerrado	Deforestation Prevention and Control in the Cerrado region
PRONASE	National Program for Sustainable Use of Energy (Mexico)
RE	Renewable Energy
SEAI	Sustainable Energy Authority of Ireland
UNFCCC	United Nations Framework Convention on Climate Change
VAP	Voluntary Action Plan (Japan)

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