Econability

Sustainable Economics in Research and Practice

Intended Nationally Determined Contributions (INDCs) under the Paris Agreement on Climate Change:

Fact sheets for selected countries and assessments of underlying efforts

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Table of contents

1 Introduction 7

2 Methodology 8

2.1 Delimiting the scope 8

2.2 Quantitative information and qualitative appraisal 9

2.3 Assessing the significance of INDC targets 9

2.4 Assessing the effort: abatement costs, ancillary benefits and welfare 11

3 Country analyses regarding efforts implied by the INDC targets 14

3.1 Switzerland 14

3.1.1 Brief description of the INDC 14
3.1.2 Further characteristics 14
3.1.3 Significance of the INDC 14
3.1.4 Underlying effort 15

3.2 Australia 17

3.2.1 Brief description of the INDC 17
3.2.2 Further characteristics 17
3.2.3 Significance of the INDC 17
3.2.4 Underlying effort 17
3.2.5 Comparison to Switzerland 19

3.3 Brazil 20

3.3.1 Brief description of the INDC 20
3.3.2 Further characteristics 20
3.3.3 Significance of the INDC 20
3.3.4 Underlying effort 21
3.3.5 Comparison to Switzerland 22

3.4 Canada 24

3.4.1 Brief description of the INDC 24
3.4.2 Further characteristics 24
3.4.3 Significance of the INDC 24
3.4.4 Underlying effort 25
3.4.5 Comparison to Switzerland 26

3.5 Chile 28

3.5.1 Brief description of the INDC 28
3.5.2 Further characteristics 28
3.5.3 Significance of the INDC 28
3.5.4 Underlying effort 30
3.5.5 Comparison to Switzerland 31

3.6 China 32

3.6.1 Brief description of the INDC 32
3.6.2 Further characteristics 32
3.6.3 Significance of the INDC 32
3.6.4 Underlying effort 34
3.6.5 Comparison to Switzerland 35

3.7 EU-28 37

3.7.1 Brief description of the INDC 37
3.7.2 Further characteristics 37
3.7.3 Significance of the INDC 37
3.7.4 Underlying effort 38
3.7.5 Comparison to Switzerland 38

3.8 India 40

3.8.1 Brief description of the INDC 40
3.8.2 Further characteristics 40
3.8.3 Significance of the INDC 40
3.8.4 Underlying effort 41
3.8.5 Comparison to Switzerland 41

3.9 Indonesia 43

3.9.1 Brief description of the INDC 43
3.9.2 Further characteristics 43
3.9.3 Significance of the INDC 43
3.9.4 Underlying effort 44
3.9.5 Comparison to Switzerland 45

3.10 Japan 46

3.10.1 Brief description of the INDC 46
3.10.2 Further characteristics 46
3.10.3 Significance of the INDC 46
3.10.4 Underlying effort 47
3.10.5 Comparison to Switzerland 48

3.11 Republic of Korea 50

3.11.1 Brief description of the INDC 50
3.11.2 Further characteristics 50
3.11.3 Significance of the INDC 50
3.11.4 Underlying effort 50
3.11.5 Comparison to Switzerland 51

3.12 Mexico 53

3.12.1 Brief description of the INDC 53
3.12.2 Further characteristics 53
3.12.3 Significance of the INDC 53
3.12.4 Underlying effort 54
3.12.5 Comparison to Switzerland 55

3.13 New Zealand 57

3.13.1 Brief description of the INDC 57
3.13.2 Further characteristics 57
3.13.3 Significance of the INDC 57
3.13.4 Underlying effort 58
3.13.5 Comparison to Switzerland 59

3.14 Norway 60

3.14.1 Brief description of the INDC 60
3.14.2 Further characteristics 60
3.14.3 Significance of the INDC 60
3.14.4 Underlying effort 61
3.14.5 Comparison to Switzerland 62

3.15 Russia 63

3.15.1 Brief description of the INDC 63
3.15.2 Further characteristics 63
3.15.3 Significance of the INDC 63
3.15.4 Underlying effort 64
3.15.5 Comparison to Switzerland 64

3.16 Singapore 65

3.16.1 Brief description of the INDC 65
3.16.2 Further characteristics 65
3.16.3 Significance of the INDC 65
3.16.4 Underlying effort 66
3.16.5 Comparison to Switzerland 67

3.17 South Africa 68
3.17.1 Brief description of the INDC 68
3.17.2 Further characteristics 68
3.17.3 Significance of the INDC 68
3.17.4 Underlying effort 69
3.17.5 Comparison to Switzerland 69
3.18 USA 71
3.18.1 Brief description of the INDC 71
3.18.2 Further characteristics 71
3.18.3 Significance of the INDC 71
3.18.4 Underlying effort 72
3.18.5 Comparison to Switzerland 73
4 Conclusions 75
Appendix A: Information in the INDCs concerning the sector land use, land use change and forestry (LULUCF) 77
Appendix B: Fact sheets on the world`s largest greenhouse gas (GHG) emitters and other countries of particular interest 79

1 Introduction

For 18 selected countries this report explores the effort that is implied by their Intended Nationally Determined Contribution (INDC). The INDCs have been submitted to the UNFCCC in preparation of its 21st Conference of the Parties in Paris. The target year for emission reductions in the INDCs is usually 2030. Some countries have formulated targets for 2025, and some convert the target into a budget for the period 2021-2030. We compare each country's effort to the effort implied by the Swiss INDC, which pledges a 50% emission reduction for greenhouse gases (GHGs) relative to 1990.

"Effort" is largely defined in terms of abatement costs, e.g. in % of national GDP or consumption. In general, only a qualitative assessment is possible. This is due to several factors:

- uncertainties in long-term demographic, economic and technological developments,
- uncertainties in accounting methods, especially for emissions and removals related to land use,
- a lack of comparability of relevant studies.

Next to abatement costs, the term "effort" includes the notion that considerable institutional advancement may be needed for implementing the policies that are required to meet a particular emissions reduction target. Such type of effort, which clearly differs from effort defined in terms of abatement costs only, can be especially relevant for some emerging economies with rather weak public institutions and law enforcement.

The analysis in this report is merely a snapshot of the situation at the time of writing. The INDCs were analyzed before COP21 began in Paris. They were updated after COP21 selectively. Whether a pledged target will be difficult or easy to achieve depends a lot on macroeconomic conditions, especially on economic growth, technical progress, and fuel prices. Change is the only thing that is certain.

Chapter 2 describes the methodology used for assessing the efforts. In chapter 3, we analyze first the Swiss INDC followed by the other 17 selected countries in alphabetical order. Chapter 4 provides some conclusions from this assessment.

Appendix A is an overview of statements included in the INDCs concerning the sector land use, land use change, and forestry (LULUCF).

Appendix B contains fact sheets with additional information per country: (1) indicators that are relevant for climate policy, (2) a graphical representation of the main INDC target, (3) a brief summary of existing climate policies and measures.

2 Methodology

2.1 Delimiting the scope

This report attempts to answer **two main questions**:

1. *What is the effort underlying the selected countries' INDC targets for 2030?*
2. *How do the assessed efforts compare to the effort of Switzerland connected to the 50% reduction target by 2030 in relation to 1990?*

To keep this task manageable, we delimit the scope of this investigation in several ways:

- **We do not investigate or presume the likelihood of the INDC targets being met.** Some countries may already be putting policies in place to safeguard compliance with the INDC, while others may show no sign of such endeavor. Some INDC targets are unconditional, while others are subject to conditions such as an ambitious global climate agreement or foreign financial support for domestic mitigation actions. None of this will influence the efforts stated in this report, because we only investigate the effort needed for complying with the pledged target, if it is met, irrespective of who is going to pay for the effort. This arguable assumption is necessary, because any assumptions about amounts of foreign financing in the respective countries would be entirely hypothetical. Where conditional targets have been put forward next to unconditional targets, we put more emphasis on the unconditional pledge. In general, we tend to presume that – where a range has been pledged or several targets have been put forward – the less ambitious extreme could be more policy relevant than the more ambitious boundary.
- **We consider the period up to the 2030 targets only and thus identify *additional* efforts needed in this period to meet the INDC targets**, which is different from appreciating a country´s climate policy in general. If a country´s INDC target does not require policies and measures that are additional to the (possibly substantial) existing ones, the *additional* effort for meeting the pledged target is zero. This approach may be disputable, because it disregards past achievements in greenhouse gas abatement. Even worse: past achievements raise the bar for abatement measures to qualify as additional effort. There is, however, no practicable alternative: In many countries, climate policy measures have influenced greenhouse gas emission trajectories and technical progress since the 1990s. As a consequence, it has become nearly impossible to define today baselines until 2030 that could represent a hypothetical world without climate policy measures.
- We consider **INDC targets** only, although some governments may have announced domestic emission reduction targets that go beyond those formulated in the INDC.
- The analysis in this report is merely a **snapshot of the current situation**: Things change over time. Growth rates change, and as a consequence BAU emission trajectories are revised. Until 2030, unanticipated advancements in key technologies for GHG abatement could significantly reduce the effort needed to achieve any given INDC target.

- **We do not intend to judge the adequacy of the countries´ efforts.** The Convention has the principle of "common but differentiated responsibilities and respective capabilities", which has led to extensive discussions about national circumstances and equity in international climate policy. Our approach avoids these difficult discussions by restricting itself to an analysis of efforts, leaving it to the reader to undertake further considerations.

In summary, this is **not an evaluation of overall climate policies of the countries, but only of the additional efforts implied by the INDC targets relative to already existing trends**.

2.2 Quantitative information and qualitative appraisal

Countries´ efforts can be assessed from many perspectives using a variety of facts and indicators such as

- the required emission reductions (in absolute terms, per capita, relative to business as usual, relative to long-term trends, and compared to existing economical abatement potentials),
- required changes in emissions intensity (compared to the current level and relative to long-term trends),
- abatement costs (marginal and total costs, in absolute terms or as a proportion of GDP, taking into account or neglecting external/ancillary benefits of abatement), and
- welfare implications (measured as change in total surplus or Hicks Equivalent Variation, taking into account or neglecting environmental benefits).

While studies exist for many – although not for all – relevant countries, they often investigate other quantitative objectives or are not fully up to date. It is an even greater issue that the existing studies differ in methodologies and that in many cases these methodologies are poorly documented. While individual cost studies provide important evidence, it is necessary to add other relevant information on national circumstances. These include e.g. economic structure and existing capital (e.g. types of power plants), available energy sources and potential of renewable energy, climate and topography, and whether the country intends to buy emission reductions abroad.

Ultimately, any meaningful assessment of efforts in this report consists of a qualitative and integrated appraisal of the information that is available at the time of writing.

This approach reflects the complexity of greenhouse gas abatement economics and policy and the lack of dependable and comparable quantitative studies. The main disadvantage of the approach is that qualitative appraisals by experts remain subjective where positive results are desired. However, we regard this to be more reliable than pretending exactness.

2.3 Assessing the significance of INDC targets

A pledged target can be deemed significant if it implies considerable emission reductions relative to the country's business as usual (BAU) emissions path. For graphical representations of the INDC targets and of existing BAU projections, see the country fact sheets in Appendix B. The following difficulties arise when assessing the significance of the INDC targets:

- Some countries have formulated targets in such a way that the absolute quantitative emissions target implied by the INDC remains unclear. In other cases, the quantitative emissions target is clearly stated, but it has been left open how total greenhouse gas emissions are calculated. The lack of consensus concerning accounting rules for land use, land use change and forestry (LULUCF) emissions is especially influential in this respect. In their INDC target formulations, Parties have suggested a variety of LULUCF accounting methods. In some cases, they have omitted relevant information on LULUCF accounting, or they have chosen not to include LULUCF emissions in their targets. See Appendix A for an overview of statements in the different INDCs concerning the treatment of the LULUCF sector.
- Pledged targets can be unclear with respect to coverage, reference levels, conditions of foreign support, or concerning the potential use of flexible mechanisms (quality of the offsets and banking procedures affecting crediting post-2020). Even double counting of emission reductions is possible, e.g. if one country´s pledge includes international transactions of emission rights or under a linked emissions trading system, while another country´s pledge excludes them.
- In macroeconomic terms, it is still a long way to go until 2030. BAU trajectories over such a long time horizon are very uncertain. This adds to the uncertainty concerning the further (cost) development of key abatement technologies such as photovoltaics, electric vehicles, carbon capture and storage (CCS) etc.
- It is difficult to make BAU projections from different sources comparable. If the target is expressed as a reduction relative to BAU, even the absolute emissions target depends on the official BAU projection, which – in most cases – will be included in the INDC itself. With both absolute and relative targets, there is an incentive for governments to overstate their BAU emissions to let the target appear more ambitious. This is reflected in some of the BAU trajectories that are provided in the INDCs or in the latest National Communications. Some countries, on the other hand, tend to issue BAU projections which seem rather optimistic in terms of the impact of already existing policy measures on emissions abatement. One way to test the plausibility of a BAU projection is to check whether its emissions path is a continuation of previous trends. If it is not, there must be a traceable and legitimate reason for the deviation. In contrast to this, a few of the BAU projections by governments exhibit unmotivated kinks at the point where historical emissions meet projected emissions. Clearly, such BAU projections must be discarded as unrealistic. We try to consider all of the most relevant aspects when evaluating BAU trajectories, to the extent that time and resources allow. It has to be emphasized, however, that we can only take a snapshot at the time of writing. Every few months, the accuracy of BAU projections is altered by business cycle changes and diverging economic growth rates around the world.

In summary, when evaluating the significance of INDC targets, we check for **unambiguousness of the targets and transparency of the underlying assumptions**, and we focus on the **abatement** which the pledge implies **relative to BAU**. We check whether available BAU emission projections are plausible, e.g. with a view on **historical long-term emission trends**.

2.4 Assessing the effort: abatement costs, ancillary benefits and welfare

Methodological considerations

In this assessment, we have to rely on existing studies and other available information to investigate national costs and welfare effects of the abatement implied by the INDC targets. These **existing studies differ widely with respect to country coverage, methods, rigor and extensiveness**, which makes it difficult to compare their results. In many cases, e.g. for a majority of abatement cost curves, the underlying assumptions even remain intransparent. To complicate things further, different methodological approaches use **different concepts of total cost or welfare effects**:

Pure **bottom-up studies** calculate total costs by integrating the marginal abatement cost curve. In such studies, total costs are usually low or even negative for rather modest abatement targets. This is for the following reason: Many bottom-up studies suggest that countries have large potentials of **no regret measures**, which pay off for the investor (e.g. LED lighting and insulation of old buildings). Hence, total costs of abatement measures are negative as long as the net revenues from no regret measures are larger than the net costs from measures with positive costs that are needed to reach the abatement objective. Only as an ambitious abatement target requires more expensive measures, we pass the break-even point and total costs become positive.

The existence of no regret measures has been subject to debate. They are overestimated when

- transaction costs – such as information, search and planning costs – are insufficiently included,
- assumed potentials insufficiently consider social, cultural and environmental restrictions,
- a discount rate has been assumed which is lower than the actual discount rate of the decision-maker.

Bottom-up modelers are aware of these points and usually try to consider them as much as possible. Still, benefits from reaping no regret potentials have to be interpreted with caution, because many of the related measures require behavioral changes or the overcoming of barriers. In fact, some of these potentials have proven to be very hard to exploit through policy instruments for many years or even decades. The examples given above, lighting and insulation, are no exceptions in this respect.

While bottom-up studies tend to be on the optimistic side regarding no regret measures, they do usually not consider the efficiency potentials that can be reaped by recycling revenues connected to abatement policies. **Top-down studies** consider these latter potentials, but usually deny technical no regret potentials.

Rather than calculating total costs, top-down studies present changes in welfare measures (usually Hicks Equivalent Variation, HEV), which are based on changes in household consumption evaluated at market prices.

In top-down studies, much depends on policy design in the scenarios. With efficient policy design and moderate reductions, many top-down studies find mildly negative or even positive welfare effects of mitigation policies, even without considering climate and ancillary benefits. While some top-down modelers use results from bottom-up simulations to calibrate abatement costs in their models, the encouraging results are mainly due to something completely different: **Remaining efficiency potentials in the tax system can be exploited when designing climate policy instruments which generate public revenues**. Similarly to efficient technical measures considered in bottom-up models, these efficiency potentials of public policy reforms are often hard to achieve, because they can face fierce opposition by those who lose (or suspect to lose) under the reform. Nevertheless, reaping these potentials is an opportunity that can be exploited by well-designed GHG abatement policies.

In between bottom-up and top-down, there are partial economic analyses of GHG abatement policies, for example when bottom-up models include demand modules or a macroeconomic module. These models typically present welfare effects in terms of total surplus (i.e. an aggregate of consumer and producer surplus), which is yet another welfare measure.

Clearly, the diverging methodologies that are used in the studies cited in this report transfer into a lack of comparability of results and a need for cautious interpretation. We translate the available information into an **integrated qualitative appraisal to the best of our knowledge**. Our work experience includes many modeling projects for national and international clients with different kinds of climate policy and energy economic models: top-down, bottom-up, coupled, and partial. Yet, comprehensive methodological appraisals of all the cited studies are impracticable due to time constraints and due to a lack of methodological transparency of many studies.

Ancillary benefits

Ancillary benefits of climate policy measures are positive effects of GHG mitigation other than the reduction of GHG emissions itself. There are not only ancillary benefits, but also ancillary *costs*. However, many studies in the international literature indicate that by including ancillary effects in the analysis, the net economic costs of climate policy measures decrease considerably (e.g. Van Vuuren et al. 2004, Riekkola et al. 2011). The following examples illustrate the vast array of possible effects of GHG abatement (Krupnick et al. 2000, Davis et al. 2000):

Some examples of ancillary benefits:

- improved air quality by reducing emissions of air pollutants associated with combustion of fossil fuels,
- reduced safety risks due to a decrease in coal mining,
- better opportunities for recreation through reforestation measures,
- protection of biodiversity due to prevented deforestation,
- efficiency gains through adopting new technologies,
- reduced hazards from road transport and less traffic congestion through modal shift,
- time savings in rural households when the use of wood for fuel is replaced by electricity from renewable sources,
- positive employment effects from GHG abatement projects in developing countries with low levels of employment.

Some examples of ancillary costs:

- higher concentrations of air pollutants in households when higher electricity prices lead to replacement of electricity use by wood, manure or fossil fuel combustion,

- higher air pollution due to the promotion of diesel fuels,
- negative employment effects from GHG abatement policies which adversely affect economic growth.

While the benefits of GHG abatement on the mitigation of climate change unfold globally, independently from the location of the abatement, most of the ancillary benefits and costs take effect on the local or regional level only.

Ancillary benefits from health improvements represent the bulk of the positive benefits (Davis et al. 2000). For the greater part, they originate from improved air quality. In developing countries with less regulation concerning air pollutants, GHG abatement usually implies much larger improvements in air quality and thus has much greater positive impact on public health than in developed countries.

It comes as no surprise that **the international literature on ancillary benefits predominantly concentrates on air pollutants. Benefits in this field are substantial** and can be assessed in variations of the number of premature deaths due to local air pollution. For example, Bollen et al. 2009 analyze a reduction in worldwide CO_2 emissions relative to a baseline by 73% in 2050 (-50% relative to 2005 levels). They estimate the related ancillary benefits as a 40% reduction of premature deaths, i.e.: of 13 Mio. premature deaths that occur in 2050 in the baseline, more than 5 Mio. lives are saved in the GHG abatement scenario in the year 2050 alone.

Unfortunately, restricted availability and insufficient comparability of quantitative information on ancillary benefits from greenhouse gas abatement targets for the selected countries do not allow for a systematic and comprehensive inclusion of these substantial benefits. We add information on ancillary benefits in some cases only and in the form in which this information is available. From a welfare perspective, ancillary benefits are, however, fully relevant and would deserve better attention, even if they are external to those who bear the investment cost of the measure.

Overall appraisal of efforts

Based on the appraisal of the available information on economic structure, the energy system, abatement costs, simulated welfare effects, and ancillary benefits, we comment on the efforts that are required in order to comply with the INDC targets. The meaning of effort is largely congruent with the approximate magnitude of cost of abatement relative to national GDP or consumption. Yet, it also includes a second notion: In some cases, even if abatement costs may be low, considerable institutional advancement is required for the implementation of the policies that can achieve significant GHG reduction targets. In principle, any country that implements effective climate policy measures has some institutional effort. This effort is, however, especially relevant for some emerging economies, particularly when public institutions and law enforcement are generally weak.

We provide bilateral effort comparisons with Switzerland to the best extent possible, even if comparability may be limited for countries that are very different from Switzerland.

3 Country analyses regarding efforts implied by the INDC targets

3.1 Switzerland

3.1.1 Brief description of the INDC

As the first country, Switzerland submitted its INDC on February 27th, 2015, and announced an unconditional GHG emissions reduction target of 50% in 2030 relative to 1990 levels, corresponding to an average reduction of greenhouse gas emissions by 35% over the period 2021-2030. Carbon credits from international mechanisms will partly be used. The INDC is subject to approval by Parliament.

3.1.2 Further characteristics

All seven GHGs comprised under the second commitment period of the Kyoto Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) are covered from the sectors energy, industrial processes and product use, waste, agriculture, and LULUCF. In buying international carbon credits, Switzerland will follow UNFCCC rules, high environmental standards and quality criteria at least in line with Switzerland's current national legislation. For 2025, a reduction of 35% relative to 1990 levels is anticipated.

Emissions from forest management are accounted for according to the rules of the second commitment period of the Kyoto Protocol, including living and dead biomass and harvested wood products in the reference level. In LULUCF accounting, Switzerland follows the net-net approach. For the target year, net emissions from LULUCF are expected to be zero. Emissions from natural disturbances are ruled out. For the period after 2020, the inclusion of non-forest land is intended, but the respective accounting method has not yet been determined. The INDC assumes zero emissions from non-forest land.

Switzerland completes the INDC by adding an indicative target for 2050 to reduce greenhouse gas emissions by 70 to 85% relative to 1990 with a partial use of carbon credits from international mechanisms. In the long run, per capita emissions in Switzerland shall be reduced to 1-1.5 tCO_2-eq.

3.1.3 Significance of the INDC

Generally, the level of information and clarity is high in the Swiss INDC, setting standards for transparency in INDC submissions as the first mover. A few unknowns remain, however, with regard to the implementation of the INDC: Firstly, for the non-forest land use emissions, the accounting is yet to be determined. This may not have a substantial impact on the overall significance of the target, provided that these emissions are comparably low. Secondly, there are some uncertainties regarding the use of international market mechanisms, which will be analyzed in the next section ("Underlying effort").

The Swiss emissions trend in recent years saw considerable decreases in per capita emissions, which were however almost fully counterbalanced by population growth. The 6th National Communication from 2013 offers several projections until 2030 (Swiss Confederation 2013). The scenario "without measures" (WOM) shows a slight decrease in overall GHG emissions until 2030. Although it is labeled "without measures", it does include "policies and measures as of 2010 and a moderate further evolution of these policies and measures as predetermined by the energy scenarios". On the other hand, it does not incorporate climate policy which has been enacted in recent years. The most important of these policies is the revision of the CO_2 Act, which legally obligates Switzerland to reduce greenhouse gas emissions domestically by 20% in 2020 compared to 1990 and was put into force in 2013.

Despite this omission, we consider the WOM scenario's emissions, as presented in Switzerland's 6th National Communication (Swiss Confederation 2013), to be a reasonable BAU trajectory, because there are compensating factors. One of these is the underlying assumption regarding population growth. Switzerland's population is expected to reach 8.73 mio in 2030. However, in July 2015, the Swiss Statistical Office released new population growth scenarios (Bundesamt für Statistik 2015), correcting the reference population development to 9.5 mio in 2030, 8.8% higher than assumed for the WOM projection. Due to continued immigration, uncertainty with respect to population projections remains. Economic growth assumptions in the WOM scenario are also rather low. Real per capita income is expected to grow annually by 0.45%. This growth rate is considerably lower than the 1.1% recorded as an annual average for the period 2004 to 2013 (World Development Indicators 2015). Switzerland is currently elaborating a new emissions scenario "without political measures".

It can be concluded that the Swiss INDC target implies reductions from BAU that are substantial (about 45% relative to WOM emissions in 2030). It is thus a very significant target.

3.1.4 Underlying effort

The Swiss economy already exhibits low carbon intensity, and Switzerland would have to considerably strengthen existing policies and take additional measures to fully achieve the proclaimed target domestically. However, Switzerland's INDC states that it will partly compensate GHG emissions through international market mechanisms. Switzerland points out that double counting needs to be avoided and supports development of the related rules under the UNFCCC. For the CDM under its current use and operation, Switzerland states that it assumes that only the acquiring Party will account for the emission reductions covered by the credits acquired from the host Party.

Much greater than the uncertainty regarding the environmental integrity of the international market mechanisms is the lack of definition at international level regarding the volume that may be purchased. The INDC announces that on the national level policies will be discussed which will be suited to achieve the reduction mainly in Switzerland. The text of the official press statement, which was released along with the INDC, is more concrete, stating that 30% of the reduction must be achieved domestically". The remainder is quantified at 20% (in the German version of the press statement), which clarifies that 30% of the reduction is meant in relation to 1990 levels rather than percentages of the reduction target. This national goal is subject to approval by Parliament, as well as the overall reduction target of 50%.

The 6th National Communication describes a scenario "with existing measures" (WEM) with GHG emissions in 2030 which are only slightly above the 30% domestic target (Swiss Confederation 2013). To reach this level of abatement, the WEM scenario requires a strengthening of the existing measures, including e.g. the intensification of the current buildings programme, continuously rising building standards (energy consumption for new buildings nearing zero by 2020), a gradual increase of the CO_2 levy on heating and process fuels (2018: 96 CHF per tCO_2 in 2018), and tightening CO_2 emission standards for new vehicles. In the case of higher than assumed population and economic growth, we deem further measures necessary, such as a CO_2 levy on transport fuels.

There are no studies which analyze the cost of Switzerland's target. However, conclusions can be drawn from the findings of the Deep Decarbonization Pathways Project (DDPP), which investigates the effects of a CO_2 emissions trajectory leading to a reduction of 76% relative to 1990 in 2050 (Babonneau, Thalmann and Vielle 2015). By 2030, CO_2 emissions are calculated at 32% below 1990 levels[1]. Considering that the INDC covers total GHG rather than CO_2 emissions, this is a somewhat lower reduction than what is required by the domestic target of the Swiss INDC. In the DDPP study, it is achieved by a much more stringent climate policy than in the reference scenario, including a uniform CO_2 levy. For 2030, the CO2 levy is 257 CHF (of 2013), and the annual welfare cost is estimated at around 0.4%. In order to reach the full cost of the INDC target, the cost of carbon credits from international mechanisms must be added.

Ecoplan 2012 also studies the impact of policy trajectories up to 2050 and delivers further insights, although differences in underlying reference trajectories and base year emissions limit the comparability of both studies. Ecoplan 2012 includes a scenario that roughly corresponds to a 30% domestic reduction relative to 1990 in 2030 at a welfare cost of 0.13% in 2035 (no value given for 2030). Another scenario implies a reduction which could be slightly lower than the INDC target of -50%, if it was to be achieved fully domestically. In this second scenario, the total welfare cost in 2035 is simulated at 0.49%. Thus, although constituting a societal and political effort, even a fully domestic implementation of the INDC target is achievable at a very moderate cost. These costs are almost fully compensated when ancillary benefits of mitigation on air pollution are incorporated (Ecoplan 2012). Notwithstanding, different groups of society may be affected in different ways, and a political effort would be required to secure that the respective reductions will be achieved.

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[1] Figure from personal communication with the authors of the study.

3.2 Australia

3.2.1 Brief description of the INDC

Australia's economy-wide target is to reduce GHG emissions by 2030 to 26 to 28 percent below 2005 levels. The INDC was delivered on the 11th of August, 2015, and is to be developed into an emissions budget covering the period 2021-2030.

3.2.2 Further characteristics

The INDC covers all sectors and seven GHGs.

Australia intends to apply IPCC 2006 guidelines, including the 2013 supplement, or as otherwise agreed. Furthermore, Australia plans to account for LULUCF emissions according to a net-net approach. The INDC builds on the assumption that the accounting provisions under the Paris Agreement omit double counting and recognize emission reductions from all sectors.

The INDC states that Australia's target represents projected cuts of 50-52% in emissions per capita by 2030 and 64-65% per unit of GDP by 2030.

3.2.3 Significance of the INDC

At the Copenhagen Conference of the Parties, Australia pledged an unconditional reduction of 5% compared to 2000 until 2020. The 2030 target marks a significant increase of the country's GHG mitigation efforts over this 2020 Copenhagen pledge. Also in comparison to available BAU scenarios for 2030, the INDC target's emissions are distinctively lower. In fact, the INDC requires emission reductions of at least 28% compared to the Government's BAU scenario. This even corresponds to a conservative estimation, given that the Government's BAU was developed before the revocation of the carbon tax policy. BAU scenarios by independent organizations confirm that Australia's INDC target is significantly different from the reference case; according to the projections for 2030 available from various institutions (see Appendix B for included institutions), a GHG emissions reduction of 30-41% is necessary to reach the less ambitious end of the INDC range.

Currently, Australia displays the highest per capita emissions of any OECD country (30.1 t/capita in 2012, incl. emissions from LULUCF). The targeted reduction in connection with projected population growth would bring this value down severely by 50-52%; the resulting per capita emissions, however, would still be among the highest in the OECD today – even before considering the targeted emission reductions of the other countries (Australian Bureau of Statistics 2013; CAIT 2015).

Consequently, Australia's target can be deemed as significantly different from a BAU scenario. Some uncertainty to this statement is added by a clause included in the INDC that allows Australia to alter the target following the finalization of the rules and other underpinning arrangements of the global agreement.

3.2.4 Underlying effort

Considering the previously outlined large gap between BAU emissions and target, the required action for Australia to reach the INDC is considerable. Depending on the source, Australia needs to annually mitigate 173-310 Mt CO_2-eq of annual GHG emissions by 2030 to reach the -26% INDC target. Australia currently lacks an incisive, comprehensive climate policy, particularly after having revoked a national carbon price in summer 2014, two years after its introduction. While stringent measures are hence required in order to reach the target, this also offers the opportunity to tap on unexploited GHG emission reduction potentials. The Turnbull Government, which assumed office in September 2015, is regarded as being more inclined towards active climate policy than the previous Abbott Government. The following sectors offer particularly large potentials:

- Electricity is still predominately produced from fossil fuels (90% in 2012) and from coal power in particular (70%; World Development Indicators 2015). This makes electricity generation by far the largest emitter in Australia, contributing a third to Australia's total GHG emissions with approximately 200 Mt of CO_2. A 2014 working paper by O'Gormann & Jotzo investigates the effect of the carbon price on the electricity sector. According to the study, the emissions of the sector declined by 8.2% from 2012-2014 following the introduction of the carbon price in 2012. This was due to lower electricity demand and a lower emission intensity of electricity supply. The article also states that more substantial cuts and long-term investments in the sector could only be expected if the carbon price became a stable long-term instrument. According to a 2013 simulation by Elliston et al., a carbon price of A$50-65/t$CO_2$ (36-47 US$/t$CO_2$) would result in the replacement cost of the electricity system being lower for a 100% renewable energy option than for a fossil fuel equivalent.
- The buildings sector offers significant reduction potentials in the order of 60 Mt CO_2-eq by 2030, according to a 2008 study by McKinsey. Most of these measures can be implemented at negative cost.

According to McKibbin Software Group 2015, the 26% emissions reduction brought forward by Australia in the INDC would result in a reduction of real GDP by 0.4-0.6% compared to when no climate target was in place. The same study suggests that a higher, 45% GHG emissions reduction target would trigger an economic cost of 0.7-1.0% of GDP.

Some uncertainty as to the required effort to reach the target is exerted by the LULUCF sector. Historically, the LULUCF sector has been a source of emissions in Australia, mainly due to deforestation activities, with rather large fluctuations (adding 3-11% to gross emissions since 1990 according to CAIT 2015). In its INDC, Australia announces that the accounting towards the target will be conducted according to a net-net approach, meaning that both in the reference and the target year, the LULUCF sector will be included in the calculation of total emissions[2]. The reference year (2005) displays rather high LULUCF emissions at 80.1 Mt CO_2, while a long-term forecast by the Government expects a drop in net LULUCF emissions to around 33.6 Mt CO_2. Thus, LULUCF could contribute significantly to the 26-28% reduction (Australian Government 2013).

Another factor of uncertainty comes from the possible use of international market mechanisms, which is not mentioned in the INDC. According to McKibbin Software Group 2015, cost would

[2] This is unlike what was used during the Kyoto Commitment period: Clause 3.7 (coined "the Australia clause" by environmental groups), which – only applied to Australia – allowed Annex-I countries with LULUCF emissions in 1990 to add these emission to the base year. In the case of Australia this added as much as 30% to the base year emissions and significantly facilitated the compliance with the target.

decrease from 0.6% to 0.3% of GDP if 45% of the reductions were to be achieved through international mechanisms (for the 26% emissions reduction target). This value, however, is subject to uncertainty concerning future prices in international mechanisms.

3.2.5 Comparison to Switzerland

Australia has issued a significant INDC target, which contrasts with the lax domestic climate policy of recent years. On this basis, the required effort to reach the target can be expected to be high, although this may depend on the development and accounting of emissions in the LULUCF sector and on the domestic share of abatement. Reaching Australia's INDC target domestically is projected to come at a cost of 0.4-0.6% of GDP in 2030. This seems similar to estimates for Swiss welfare cost (Ecoplan 2012), but full comparability of studies cannot be assumed. These cost estimates do not take into account the use of international mechanisms, which could significantly lower the cost in either country.

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3.3 Brazil

3.3.1 Brief description of the INDC

The INDC of Brazil was submitted to the UNFCCC on September 28th, 2015, and commits unconditionally to reduce GHG emissions by 37% below 2005 levels in 2025. It is supplemented by a "subsequent indicative contribution" for the year 2030 of -43%, also relative to 2005 levels. Brazil may use international market mechanisms "established under the Paris agreement".

3.3.2 Further characteristics

The INDC covers six GHG gases. The target includes emissions from land use, land use change and forestry (LULUCF). A further specification of LULUCF accounting methodologies is not included, apart from the formulation that the INDC "takes into account the role of conservation units and indigenous lands as forest managed areas, in accordance with the applicable IPCC guidelines on the estimation of emission removals."

In a supplement to the INDC, superscribed "for clarification purposes only", Brazil reports several projections:

- The reduction of the INDC is consistent with emission levels of "1.3 $GtCO_2e$ (GWP-100; IPCC AR5) in 2025 and 1.2 $GtCO_2e$ (GWP-100; IPCC AR5) in 2030". "Furthermore, this contribution is consistent with reductions of 6% in 2025 and 16% in 2030 below 1990 levels."
- "Brazil's INDC corresponds to an estimated reduction of 66% in terms of greenhouse gas emissions per unit of GDP (emissions intensity) in 2025 and of 75% in terms of emissions intensity in 2030, both in relation to 2005."
- "Brazil's per capita emissions will decline further to an estimated 6.2 tCO_2e (GWP-100; IPCC AR5) in 2025 and 5.4 tCO_2e (GWP-100; IPCC AR5) in 2030 under this contribution."

The supplement states further that Brazil "intends to adopt" the following measures:

- "increasing the share of sustainable biofuels in the Brazilian energy mix to approximately 18% by 2030",
- "in land use change and forests: (…)
    - strengthening policies and measures with a view to achieve, in the Brazilian Amazonia, zero illegal deforestation by 2030 and compensating for greenhouse gas emissions from legal suppression of vegetation by 2030;
    - restoring and reforesting 12 million hectares of forests by 2030, for multiple purposes".

3.3.3 Significance of the INDC

The Brazilian INDC is expressed as a nationwide absolute emissions target relative to a base year, while the Copenhagen pledge refers to a business as usual (BAU) scenario (which had been far too high, leading in Econability 2014 to the categorization of the Copenhagen pledge as insignificant). This shift to an absolute emissions target is noteworthy.

The unconditional INDC target refers to 2025. The exact meaning of designating the objective for 2030 as “indicative” is not further specified in the INDC.

Brazil achieved a substantial reduction of GHG emissions in the past. Figure 1 shows an almost continuous decline in total emissions including LULUCF since 2005. Total emissions decreased by 41% between 2005 and 2012, 4 percentage points more than the reduction defined by the unconditional INDC target of -37% for 2025. Thus, the INDC allows absolute emissions to rise compared to 2012 levels. Relative to BAU scenarios, however, minor reductions may be required. The trajectory defined by the 1.3 Gt CO_2-eq in 2025, which are given in the INDC as consistent with the unconditional target, lies in the range of BAU scenarios from independent sources (IEA 2014; PBL et al. 2015). The “indicative contribution” for 2030 is translated into GHG emissions of 1.2 Gt CO_2-eq in 2030 in the INDC. This is slightly below current emissions. Relative to the BAU scenario of PBL et al. 2015, reductions in the range of 0.29-0.34 Gt CO_2-eq would be needed for full achievement (including LULUCF emissions) in 2030.

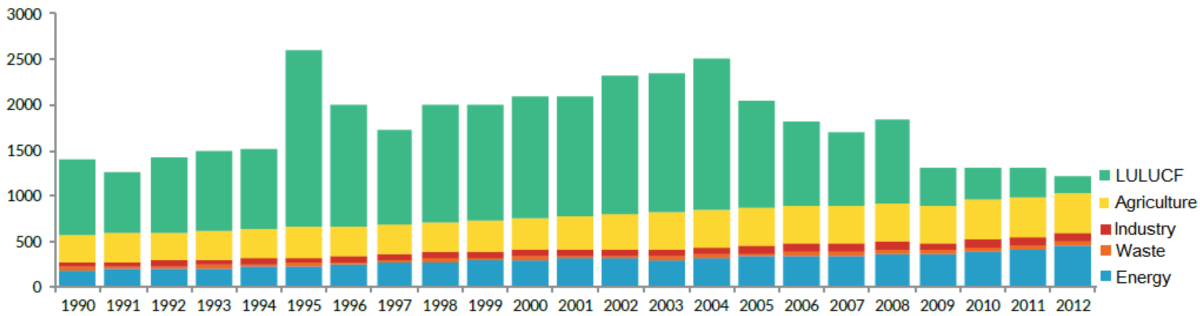

Figure 1: Brazil: GHG emissions 1990-2012 in Mt CO_2-eq. Ministério da Ciência, Tecnologia e Inovação 2014.

Figure 1 shows that the decrease in emissions since 2004 is due to achievements in the LULUCF sector, mostly a cutback of the deforestation rate, which was reinforced by the National Forest Code and deforestation prevention and control plans in the Amazon and Cerrado regions. Emissions from other sectors, especially from energy and agriculture, increased since 1990. It is obvious from Figure 1 that emissions from LULUCF are particularly crucial for the assessment of the INDC. With emissions from other sources rising, LULUCF emissions, which did not follow a linear development in the past, need to be reduced, possibly to net levels below zero. Unfortunately, the INDC is tight with information on which rules are being followed in LULUCF accounting.

In the supplement of the INDC (“for clarification purposes only”), Brazil states the intention to stop illegal deforestation and restore and reforest 12 million hectares by 2030. Reforestation in the order of 2.4% of the country’s current forest area (or about 1.4% of Brazil’s territory) and rigorous enforcement of forest protection laws would likely turn the emissions from LULUCF into a net removal in the future.

3.3.4 Underlying effort

Marginal abatement cost curves (MAC curves) for Brazil show the dominant role of low-cost measures concerning land-use-activity (De Gouvello 2010; McKinsey 2009), although volatility of emissions from the LULUCF sector represents a major challenge. A study by the World Bank (De

Gouvello 2010) explores additional mitigation potentials relative to a BAU scenario by calculating a MAC curve for 2030 (at an 8 percent interest rate). The BAU scenario assumes annual emissions from LULUCF in the range of 0.4-0.5 Gt CO_2-eq until 2030 (after a mild decrease in 2009-2011). The study concludes that an annual abatement of about 0.36 Gt CO_2-eq in the period 2010-2030 can be achieved at an annual cost of 5.5 bn. US$ (0.2% of GDP of 2014). This figure is for the LULUCF sector only and includes mostly measures for avoided deforestation.

The electricity sector is characterized by a large share of hydropower in electricity generation (above 70%). Although Brazil still has great potential for the expansion of hydropower, a renaissance of coal-fired thermal plants in order to secure electricity supply in the face of rising incidence of droughts could be at issue (Unterstell 2015). De Gouvello 2010 estimates the cost of additional reductions in the whole energy sector at 7 bn. US$ for 0.117 Gt CO_2-eq annually. We reckon that the achievement of Brazil's INDC requires only a mild effort in terms of economic cost, because of low-cost opportunities in the LULUCF sector. For Brazil, mitigation by reforestation and avoiding deforestation might be the ideal effective contribution. Brazil has already achieved a lot in this field and intends to intensify the effort in the future. Enforcement of the National Forest Code and the connected action plans in such vast areas as the Amazon basin and the Cerrado requires a great deal of determination and does not come without institutional cost. It is thus challenging to achieve ambitious objectives in this domain, such as eliminating illegal deforestation in Amazônia by 2030. Ambitious targets had already been issued earlier, for example zero net deforestation in 2015 in the National Climate Change Plan from 2008. It has been reported that the deforestation rate increased by 28% between August 2012 and July 2013 (Mongabay 2008; Carbonbrief 2015). Opportunity costs of avoided deforestation need to be taken into account. Hence, for Brazil effort might not be predominantly defined in terms of technical abatement cost, but in having to face large institutional challenges in enforcing objectives in the LULUCF sector. Under these circumstances, it would be desirable for other sectors (energy, industry, transportation) to also take over a predefined share of emissions abatement.

3.3.5 Comparison to Switzerland

Comparing reforestation and forest protection challenges in the Amazon to efforts towards energy change in Switzerland is hardly possible. Brazil's effort might better be measured not in terms of economic cost, but in terms of institutional challenges. Probably, Brazil's emissions target will be easier to reach than Switzerland's. On the other hand, the Brazilian INDC mentions – "for clarification purposes only" – ambitious objectives in the LULUCF sector, which can lead to important and not-easy-to-deliver contributions to climate stabilization.

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3.4 Canada

3.4.1 Brief description of the INDC

Canada intends to reduce GHG emissions by 30% relative to 2005 levels in 2030. The INDC was issued on May 15th, 2015. Canada "may use international mechanisms, subject to robust systems that deliver real and verified emissions reductions".

3.4.2 Further characteristics

The economy-wide target covers seven GHGs and all IPCC sectors. LULUCF accounting is specified as being based on a net-net approach and including harvested wood products (HWPs) by applying a production approach. Natural disturbances are ruled out as a potential emissions source.

3.4.3 Significance of the INDC

Business as usual (BAU) projections for 2030 show that the reduction target of the INDC cannot be reached with current policies. Canada's 6th National Communication expects total GHG emissions (excluding LULUCF) to be 11% above 2005 levels (Government of Canada 2014). PBL et al. 2015 estimate a BAU emissions range of -11% to 11% relative to 2005. Bataille et al. 2015a calculate a BAU path until 2050 and see emissions in 2030 roughly at the same level as in 2005, but point to the high influence of the future oil price. In the baseline scenario, the oil price grows slowly and remains clearly below 80 US$ (in 2014 dollars) in 2030. Assuming a higher price trajectory (above 100 US$ in 2030) leads to an emissions level in 2030 close to the upper end of the aforementioned sources. The positive correlation between oil price and emissions level can be explained by Canada's very particular role as oil producer. Canadian oil extraction is mainly based on oil sands, a method which is emissions intensive and expensive. Production tends to increase with higher oil prices.

The emissions from LULUCF are of importance for the GHG inventory of Canada. However, some figures suggest that they could be less essential for the assessment of the INDC target than one would expect (Canada's forests are 75 times as large as the national territory of Switzerland). The National Communication reports a fluctuating course for historic LULUCF emissions, oscillating between net sink and net source, e.g. from a net sink of 0.011 Gt CO_2-eq in 2008 to a net source of 0.103 Gt CO_2-eq in 2010 (see Figure 2; including natural disturbances, Government of Canada 2014). The oscillations are mainly due to wildfires and insect infestation. Addressing the high uncertainty attached to this sector, the National Communication projects future emissions from LULUCF only for 2020 and without natural disturbances, estimating a net sink of 0.028 Gt CO_2-eq. A different Government source (Environment Canada 2014) calculates for the same year a net removal of only 0.019 Gt CO_2-eq. Both numbers exclude emissions from natural disturbances, which the INDC target also does. The range of these estimates corresponds to 2.6-3.8% of total GHG emissions of 2005. Compared to the gap between BAU projections and the INDC target, this is rather small. Therefore, the conclusion can be maintained that achieving the reduction target implies substantial reductions.

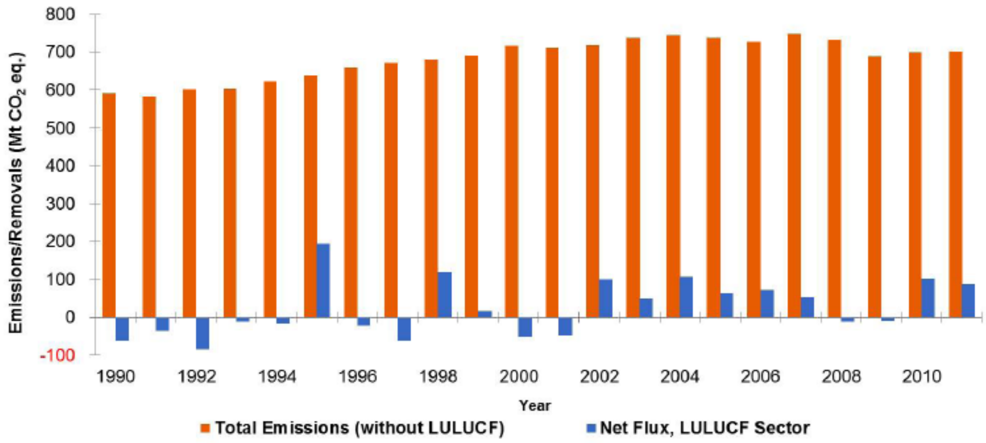

Figure 2: Canadian GHG emissions (LULUCF and other) 1990-2011. Government of Canada 2014.

Canada's historic emissions trajectory has been the result of domestic abatement policies with limited effect. From 1990 to 2007, the emissions trend pointed upward, reaching a peak in 2007. Mostly due to recession, emissions decreased slightly afterwards and have remained on roughly the same level since 2010. Canada's Kyoto target was missed, and Canada withdrew from the Kyoto Protocol in 2011. For reaching the Copenhagen pledge (-17% relative to 2005 levels), immediate additional action is necessary. We consider the INDC target to be a reasonable continuation of the target path to the Copenhagen pledge. In contrast to the Copenhagen pledge, it is not conditional on an agreement with the USA or legislative progress of US Congress. Furthermore, the recently elected Trudeau administration may re-establish credibility in Canada's willingness to accomplish its internationally communicated reduction targets.

3.4.4 Underlying effort

Total GHG emissions of Canada are estimated at 0.726 Gt CO_2-eq in 2013 (excluding LULUCF; Environment Canada 2015). The largest part comes from the oil and gas sector (25%), followed by transportation (23%), electricity (12%) and buildings (12%) (see Figure 3).

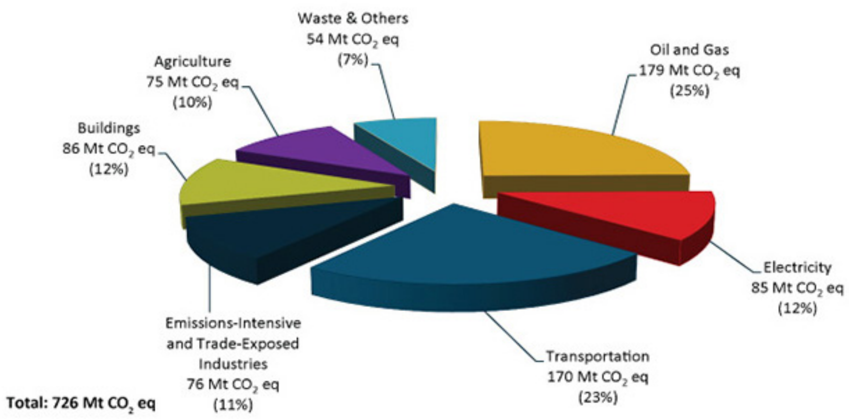

Figure 3: Canada's GHG emissions 2013 by economic sectors. Environment Canada 2013.

Net LULUCF emissions were recorded as a sink of 0.015 Gt in 2013. Emissions intensity almost continuously improved since the late 1990s, but was still the fifth highest among OECD countries in 2010 (OECD 2013).

In its 6th National Communication, Canada estimates the emissions from the oil and gas sector to rise by 49% from 2005 to 2030 (Government of Canada 2014). The extraction of oil from oil sands is expected to be the largest contributor, with emissions increasing by about 300% (17% of total BAU emissions in 2030). This puts the sector in the focus of future abatement efforts. Emissions intensity in oil sands operations has improved significantly since the 1990s, but further gains seem to be compensated in the future by shifts to poorer reservoir quality and more complex extraction technology. Considerations on abatement potentials concentrate upon improvements in technology and carbon capture and storage (Walden 2011). On the other hand, there are reasons to doubt current growth prospects of the oil sands industry: Prices for crude oil are currently low. Also, the Obama administration has decided to abandon plans for the Keystone pipeline, which should have connected Canada's north with the Gulf of Mexico.

In other parts of the Canadian economy, emissions are expected to rise slower than in the oil sector. Electricity supply, for example, is by about two thirds based on renewable sources (mostly hydro). On the federal level, performance standards for new coal power plants have been established. Some of the Provinces, which in Canada are also important players in climate policy, issued stricter rules. For example, Ontario completed a phase-out for coal in 2014. The Deep Decarbonization Pathways Project (Bataille et al. 2015a) investigates the cost of reducing Canada's total GHG emissions to 0.078 Gt CO_2-eq in 2050. It calculates the incremental investment in the electricity sector at 10 bn. US$ annually from 2015-2050 (0.7% of GDP of 2014).

In the transport sector, BAU emissions are expected to rise by 6.5% from 2005 to 2030 (Government of Canada 2014). This limited increase is due to emissions standards which are already in force and will be strengthened progressively in the coming years. Further abatement is possible in this sector, but not at a low cost (McKitrick 2012).

McKibbin Software Group 2015 calculate the economic impacts of the reduction targets of various countries for 2030, albeit for Canada together with New Zealand and for an emissions reduction of only 22% below 2005 levels. In this combination, costs in 2030 are 0.8% of GDP compared to a scenario without climate policy. This confirms the notion that the INDC target implies an effort in terms of economic costs, at least when ancillary benefits of GHG mitigation are excluded. The use of international mechanisms is not ruled out, which may reduce the necessary effort, depending on the share of domestic abatement and on carbon prices in the international mechanisms.

3.4.5 Comparison to Switzerland

With respect to an upward sloping BAU path, the Canadian INDC target implies a substantial effort, if achieved domestically. The effort of Switzerland's nationally communicated 30%-target could be below that level. However, Canada is also going to use international mechanisms, to an extent which is not specified in the INDC. Furthermore, the Canadian INDC is ambitious to a large extent for the country's rather weak dedication to climate policy in the past. Historic emissions developed on a trajectory which now requires immediate action to achieve the target.

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3.5 Chile

3.5.1 Brief description of the INDC

Chile submitted its INDC on October 8th, 2015.[3] Chile pledges a 30% reduction in GHG emission intensity of GDP between 2007 and 2030. Conditional on foreign financing, Chile pledges to improve GHG[4] emissions intensity of GDP by 35% to 45% between 2007 and 2030. The LULUCF sector is excluded from this target. Chile does not rule out the use of flexible mechanisms.

3.5.2 Further characteristics

Both emissions intensity pledges are conditional on economic growth which is large enough to allow for the implementation of the necessary measures. More precisely, economic growth would need to be similar to the past decade, excluding the crisis years 2008/2009. This corresponds to an annual GDP growth rate of approximately 4.8%.

For GHG emissions intensity in 2007, a reference number of 1.020 tCO_2-eq per million Pesos of 2011 is provided. GHG emissions will be calculated according to the 2006 IPCC guidelines for national inventories. They exclude the sector land use, land use change and forestry (LULUCF), which currently is a considerable sink in Chile.

For the forestry sector, the INDC pledges 100.000 ha of forestation and another 100.000 ha of managed native forest and forest "recuperation". The net effect of these two goals on annual GHG emissions is estimated at 1.5 Mt CO_2-eq. Both goals for the forest sector are conditional to changes in national laws.

3.5.3 Significance of the INDC

Checking the reference number for 2007 of 1.020 tCO_2-eq per million Pesos of 2011 is at least very difficult. Chile's National Greenhouse Gas Inventory (Climate Change Office 2014) includes emission values for 2005 and 2010, while intermediate values are given in a graph. The emissions intensity (0.88 tCO_2-eq per million Pesos of 2011) that we calculated from this approximate reading is significantly lower than the given reference value in the INDC[5]. This could mean that the actual emissions intensity in 2007 was about 14% lower than indicated.

2007 may have been chosen as a reference year to fully include the measures taken since 2007 in the period accounted for. When looking for the most meaningful reference for future climate policy achievements, a more recent reference year would be more informative. This is mostly due to Chile's very dynamic macroeconomic development in recent years: According to OECD.stat 2015a, Chile's real GDP was 28% higher in 2014 than in 2007. In the same period, the consumer price index in-

[3] The document is written in Spanish. After COP21, an English translation has been provided. This analysis, however, draws on the Spanish document.

[4] The targets are expressed for CO_2 only, which seems to be a writing error, because according to paragraph 2.3.6 of the INDC, coverage includes CO_2, CH_4, N_2O, HFCs and PFCs.

[5] GDP values from Banco Central de Chile 2015.

creased by 27% (OECD.stat 2015b), which also provides room for considerable structural changes in prices and sectoral activities.

The respective period saw high copper prices (which are highly relevant for Chilean exports and foreign exchange rates) and a significant increase in global fossil fuel prices. When high economic growth joins high fossil fuel prices, CO_2 efficiency of GDP often surges. This was also the case in Chile: Calculated from the numbers provided by the Climate Change Office 2014, carbon intensity (excluding LULUCF) in tCO_2-eq per million Pesos of 2011 had already improved to 0.80 in 2010, which corresponds to a drop of CO_2 emissions per unit of GDP of approximately 9% in 3 years. Furthermore, the 2010 intensity value only requires 11% of further improvement to reach the target value stated in the INDC for 2030.

Mitigation Action Plans and Scenarios (MAPS) is a collaborative project amongst developing countries. The MAPS Chile report (Gobierno de Chile 2014) presents, in Spanish, projections generated with seven sectoral models and a macroeconomic model (a dynamic stochastic general equilibrium model). The submitted Chilean INDC is based on this analysis, although the MAPS Chile report does not directly consider or present numbers in terms of tCO_2-eq per unit of GDP.

Rather, it discusses emissions trajectories and analyzes their sectoral and economic foundations and consequences. It compares eight mitigation scenarios with three baseline scenarios, with the medium growth baseline scenario as the main reference. This medium baseline scenario includes climate policy measures taken after 2007. Indeed, the 2013 baseline scenario is much lower in emissions than most of the previous baselines from 2007, although the dominant reason for this has been an economic growth which was lower than previously projected.

In the baseline period 2013-2030, GDP is expected to grow by 96%. In the medium growth scenario, GHG emissions including LULUCF are estimated to grow 98.3%. GHG emissions growth without considering LULUCF is projected at 69.2%. Considering the projected population growth of 11.6%, per capita emissions of 7.86 tCO_2-eq result in 2030, with LULUCF included, or 9.15 tCO_2-eq excluding LULUCF. This corresponds to increases, respectively, of 222% and 70% relative to the 2010 figures calculated from the National Climate Change Inventory (Climate Change Office 2014; Gobierno de Chile 2014; Instituto Nacional de Estadisticas Chile 2015). As with many of the emissions indicators for Chile, these numbers vary a lot with the data sources used.

For 2030, the MAPS Chile project's (Gobierno de Chile 2014) medium baseline implies a greenhouse gas efficiency (excluding LULUCF) in tCO_2-eq per million Pesos of 2011 of 0.73. This indicator is 9% lower than in 2010 and approximately in line with the postulated INDC target value. Given the previously outlined drop already attained between 2007 and 2010, this baseline estimate is very prudent, especially as high economic growth is assumed to continue. Also, when comparing to other countries, this baseline estimate seems to underestimate future improvements in greenhouse gas efficiency.

In other words: At the assumed growth rates, we consider reductions in GHG emission intensities even beyond the INDC's 30% target to be very likely under business as usual. Under the high economic growth required by the INDC, even the conditional -35% to -45% target does not seem to deviate from an expectable trajectory. It should also be noted that even when achieving the -45%

goal, the projected GDP increase (MAPS Chile medium baseline) would imply a per capita emissions growth of 36% (excluding LULUCF).

While low growth rates can be a challenge for the achievement of intensity targets, Chile's INDC is too prudent in two ways:

- The required growth path under the condition is overly ambitious, making it unlikely for the condition to be fulfilled.
- At this required growth path, the intensity target lacks any ambition.

Considering that the 2007 reference value for emission intensity given in the INDC seems to be significantly higher than what can be calculated from other data, the target value does not represent climate policy ambition.

The above is not meant to criticize the INDC's approach to target emissions intensity of GDP per se. We find this approach adequate for a country in a rather unstable macroeconomic environment (Chile has been among the fastest growing countries of the planet between 1990 and 1997 as well as between 2003 and today, but had virtually no economic growth between 1997 and 2003; OECD.stat 2015a). However, the implied development of per capita emissions in the process of convergence to industrialized country income levels needs to be considered. As long as economic growth continues, a (hypothetical) target of about -50% (relative to 2007; or about -45% relative to 2010) would be well achievable, limiting the growth of per capita GHG emissions. One interesting possibility for countries like Chile would be to connect GHG emissions and GDP growth not through a constant factor, but to increase the efficiency targets with economic growth.

The contribution of the target for the forestry sector of 100,000 ha of forestation and another 100,000 ha of managed native forest and forest "recuperation" sums up to an increase of around 1.2% of the total forest area. The INDC assumes a net effect of an annual removal of 1.5 Mt CO_2-eq, which is less than 1% of Chile's projected emissions in 2030.

3.5.4 Underlying effort

In MAPS Chile, the medium mitigation scenario reduces GHG emissions by 29% below the baseline. The high effort scenario does not go much beyond this (33%). The report conveys the notion that a reduction of up to about 10% below the baseline is rather easy to achieve. According to the report, effects of mitigation efforts on GDP are generally positive, which actually may or may not be the case.

Indeed, mitigation options are abundant. For example, the electricity sector could play a major role in reducing emissions, given that hydroelectric potentials still exist (EIA; Hydropower and Dams 2009) and other renewables are emerging as a low carbon alternative. The attractiveness of some of the options largely depends on global technological progress, which Chile alone has little influence on. This concerns e.g. the fields of electromobility, electricity generation from renewables and energy efficiency in general. Together with the large dependency of the Chilean economy on copper prices, which translates into an unusually uncertain projection of economic growth rates, these uncertain-ties may induce a certain prudence in formulating goals, at least when addressing the international community.

In the case of the submitted INDC, this prudence was so large that we cannot state any considerable effort related to the efficiency targets. At best, the INDC target is going to make sure that progress in terms of GHG emissions intensity will be monitored to ensure compliance with the target. With the possibility to resort to international market mechanisms, even this is not imperative.

3.5.5 Comparison to Switzerland

The Swiss INDC implies an effort, while the Chilean INDC does not.

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3.6 China

Introductory remark: The analysis of the INDC is based upon the English translation delivered by China along with the Mandarin original and labeled "unofficial".

3.6.1 Brief description of the INDC

The INDC of China, which was submitted on June 30th, 2015, consists of four pillars:

- to achieve its peak carbon dioxide emissions around the year 2030 and to additionally make "the best efforts to achieve the peak early",
- to lower carbon dioxide emission intensity by 60 to 65% in 2030 compared to 2005,
- to increase the share of non-fossil fuels in "primary energy consumption" to around 20%,
- to increase the forest stock volume by around 4.5 billion cubic meters compared to 2005 levels.

3.6.2 Further characteristics

The INDC encompasses all sectors of the economy, but only CO_2 emissions[6]. Details on the type of accounting are not given.

3.6.3 Significance of the INDC

The aim to peak CO_2 emissions before 2030 can generally be deemed as ambitious. On the other hand, the INDC does not make statements on absolute GHG emission levels and rather targets CO_2 emissions intensity. With China being the world's largest CO_2 emitter, this creates considerable uncertainty for global climate objectives.

Amid massive economic growth and transformation, China's GHG emissions have increased steeply. More recently, China's economy showed slowing growth and a slumping stock market. By some experts, this was interpreted as a sign of a transformation to an economy of slower growth than previously assumed (The Guardian 2015). Nonetheless, China's economy is expected to further grow considerably and with it its emissions.

In recent decades, *emissions intensity* in China has already decreased significantly as is typical under a rapid economic catching-up process. In 1990, more than 0.6 kg of CO_2 were necessary per CNY of GDP (see Figure 4). This value dropped to 0.35 kg in 2005, a value which may have to be revised after the release of the Chinese Statistical Yearbook in November 2015. It reported a sudden massive increase of coal use, nurturing further doubts about Chinese emission statistics (The New York Times 2015).

Starting from the official figure, a further decrease of 60-65% compared to 2005, as pledged in the INDC, would result in a value of around 0.12-0.14 kg CO_2/CNY (incl. LULUCF). To compare this 2030 target value to more developed countries, it helps to convert the CNY into US$. The resulting value of

[6] CO_2 emissions correspond to a share of 84% of total GHG emissions in 2012 (incl. LULUCF). This share tends to increase. In 1990, it was 70% (World Development Indicators 2015).

0.86-0.98 kg CO_2/US$_{2005}$ is evidence for China's enormous potential for improvement, even before catering for the previously mentioned glitch in coal usage statistics. For instance, the USA had an emissions intensity of 0.33 kg CO_2/US$_{2005}$ in 2012, and the lower bound value of China's target for 2030 has not been exceeded in the US since the late 1970s. More service oriented economies like Switzerland have even lower values at below 0.1 kg CO_2/US$_{2005}$ (emissions data from CAIT 2015 and Indexmundi, GDP data from World Development Indicators 2015)[7]. Moreover, as can be seen in Figure 4, China has continued to make substantial progress with regard to carbon intensity since 2005 (19% until 2012) and has hence achieved a substantial portion of the proclaimed target.

Converting the emissions intensity targets into absolute emission levels in 2030 proves to be difficult due to uncertainty in economic growth projections. Using IEA's projected economic growth rates, the maximum emission levels that keep China on target are above the BAU projections by various institutions (IEA 2014).

Two further points are worth pointing out concerning the intensity target:

- It only relates to CO_2, but not CO_2 equivalents. Some highly climate-damaging gases are hence not captured under the target.
- The year of reference is 2005. As can be seen in Figure 4, data report for this particular year the highest emissions intensity since the end of the 1990s. Therefore, the absolute target value is less ambitious than if it were in relation to any other base year within the last 15 years.

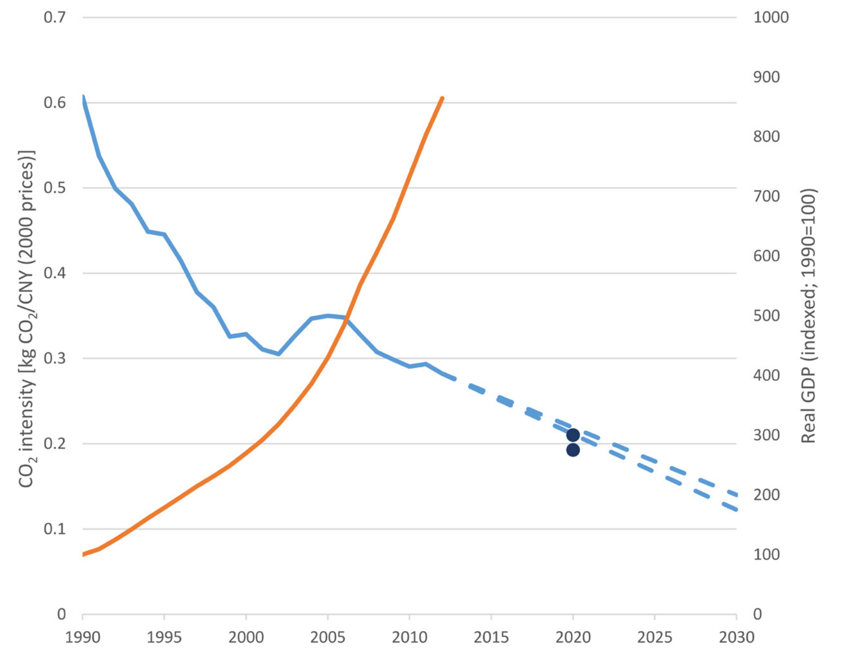

Figure 4: Historical development of emission intensity (blue line / left axis) and target (dashed line) and historical development of GDP (orange line / right axis). The two dark blue dots depict the 2020 pledge range. Own figure with data from CAIT 2015 and World Development Indicators 2015.

[7] Unlike emission data from after 1990 (CAIT 2015), emission data prior to 1990 were taken from Indexmundi.

Following the analysis above, the pillar of the emissions intensity target has to be labeled as rather unambitious. At best, it further follows the trend of CO_2 intensity improvements set out by China's Copenhagen pledge (40-45% intensity), but it fails to clearly aim for additional improvement beyond this trend.

China targets an *increase in forest stock volume* by 4.5 billion m^3 on the basis of a stock volume of 13.255 billion m^3 in 2005. In 2013, the nationwide forest stock amounted to 15.137 billion m^3 (State Forestry Administration of China 2014). Hence, there has already been an increase of approximately 1.9 billion m^3 since 2005 (more than the 1.3 billion m^3 pledged under the Copenhagen Accord for 2020). While this cuts the targeted future increase to 2.6 billion m^3, this latter increase is still sizable.

The *share of non-fossil fuels in primary energy consumption* amounted to approximately 10% in 2012 (EIA 2015). There is thus still a remarkable gap to the target of 20% in 2030, and the considerable efforts to increase wind and solar power capacity will have to be further increased. Furthermore, there are plans to strongly increase the to date relatively low level of nuclear power by 2030[8]. The pledge under the Copenhagen Accord included a target share for non-fossil fuels of 15% in primary energy consumption by 2020.

3.6.4 Underlying effort

The *aim related to peak emissions* around 2030 will require considerable effort, since this will clearly require a deviation from available business as usual scenarios. On the other hand, the wording "around 2030" is vague and provides room for interpretation. The recently identified underestimation of coal usage could facilitate reaching the peak earlier, although on a higher level than previously anticipated.

Subject to the large uncertainty in both the development of GDP and emissions, no additional effort seems to be required to reach the proposed *intensity target* given the assumed economic growth rates. More specifically, the target path seems to follow the natural course of an emerging economy as well as measures that have already been put in place. Typically, intensity targets become easier to reach with economic growth. The event of a major economic crisis could thus render the achievement of the intensity target more difficult. Furthermore, the emissions intensity target is marked by uncertainty due to the previously mentioned adjustment of coal use statistics. Depending on whether or not the base year data will be revised, the target will be easier or harder to achieve than suggested by current official data.

In order to reach the target regarding the *increase of non-fossil energy in primary energy consumption*, China will have to close the gap between the current 10% and the future 20% share while meeting growing domestic energy demand. This is a challenge. It requires a restructuring of the energy sector and the power generating sector in particular. According to a reference scenario by Fridley et al. 2012, China will consume close to 6'900 TWh of electricity in 2030, up from 4'468 TWh in 2012 (EIA 2015). A major part of the required expansion of the electric power capacity in China will likely be driven by coal power. According to NGO data, more than 130 GW worth of coal power

[8] There is a certain range with regard to projections of China's installed nuclear power capacity in 2030; they range from 120-200 GWe, up from 26 GWe in 2015 (World Nuclear Association 2015).

plants were under construction in mid-2015, while hundreds of GW were in earlier planning phases (Endcoal 2015). Although China is trying to reduce air pollution as well as the dependence on imported fuels, a fossil-free share of 20% leaves much room for expansions in fossil fuel consumption, provided that it remains compatible with the other INDC objectives. Especially in electricity generation, large potentials exist across all renewable energy sources. For example, approximately half of the additional electricity consumption in 2030 could be met with the economically feasible, but yet unused, hydropower potential alone (Hydropower & Dams 2009). Thus, although the targeted increase in non-fossil fuel shares clearly represents an effort, there are further opportunities for restructuring the energy sector beyond the formulated objective.

3.6.5 Comparison to Switzerland

The overall effect of the four separate pillars in China's INDC remains hard to evaluate. Nonetheless, the Swiss INDC can be classified as more ambitious. Switzerland's INDC represents an intensification of the target path for 2020 and requires measures that are additional to those taken in the past. Under expectable trends, the further improvement of emissions intensity under the Chinese INDC beyond 2020 does not represent an intensified ambition for GHG emissions abatement under expectable trends. Adding the other three pillars of the Chinese INDC to the picture means that the INDC as a whole is still going to require an effort.

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3.7 EU-28

3.7.1 Brief description of the INDC

On March 6th, 2015, the EU announced a binding target of at least 40% reduction of domestic GHG emissions by 2030 relative to 1990 levels. The reduction will be achieved 100% domestically.

3.7.2 Further characteristics

The INDC covers seven greenhouse gases. LULUCF is included in the target, but accounting rules are to be specified later ("in any case before 2020"). A planning process is announced which is to lead to proposals for domestic legislation.

3.7.3 Significance of the INDC

Unlike earlier emission target announcements, the EU's INDC lacks the high degree of clarity needed for a very precise assessment. The greatest source of uncertainty is constituted by the fact that on the one hand emissions from LULUCF are included in the target, but on the other hand accounting rules are not (yet) defined in the INDC. In a rough estimate, the Climate Action Tracker 2015 calculates the range of variation due to LULUCF emissions as about 1-4% of 1990 emissions.

Further uncertainty arises from the unclear treatment of surplus allowances in the EU-ETS. The European Commission estimates that the oversupply may reach 2.6 bn. allowances in 2020 (European Commission 2014b). Each allowance is equal to 1 t of CO_2-eq. In a subsequent trading period, the related certificates may be used by energy and industrial sectors in place of emission reductions. If the EU decided to use these certificates for the 2030 target, this could have considerable consequences for stringency (Höhne et al. 2013). To tackle the issue, a new mechanism, the Market Stability Reserve (MSR), was approved by the European Parliament on July 7th, 2015, and by the EU Council on October 6th, 2015[9]. It automatically withdraws 12% of surplus allowances from the market until an upper excess supply threshold of 833 mio. is reached and returns 100 mio. allowances when the total number in circulation is less than 400 mio. Furthermore, 900 mio. allowances which were originally set to be auctioned between 2014 and 2016 will be transferred to the MSR. Although the exact amount of the future excess supply remains unclear, it can be derived from these figures that the establishment of the MSR will reduce the surplus substantially and therefore increase the significance of the INDC.

Despite the remaining uncertainties, attaining the -40% goal w.r.t. 1990 will require a trajectory path below current BAU projections. The EU's 6th National Communication projects a BAU emissions reduction of 24.4% by 2030 compared to 1990 (European Commission 2014c). This BAU emissions path is, however, close to the upper end of BAU estimates of other institutions for 2030. In an impact assessment study, the European Commission presents a different reference scenario for the EU's GHG emissions in 2030 (European Commission 2014a). Next to existing policies, it entails the assumption that all EU targets for 2020 (GHG emissions, renewables, energy efficiency) will be achieved. In the view of the European Commission, the latter is likely to happen despite 13 Member

[9] Decision (EU) 2015/1814 of the European Parliament and of the Council.

States still needing to increase their efforts to reach the respective national targets under the Effort Sharing Decision (ESD). Under this latter scenario, total GHG emissions in 2030 will be 32% below 1990 levels. These two BAU numbers about set the range for probable BAU trajectories. Most other BAU estimates for 2030 also fall into this range. BAU trajectories are influenced by the current slow economic recovery in the EU. Indeed, uncertainties concerning economic growth until 2030 add to the uncertainties described above. As a consequence, it is yet unclear whether the EU's INDC implies much more than minor reductions w.r.t. BAU. Notwithstanding, we regard the reductions under the INDC target to be more significant than those pledged for 2020 in Copenhagen.

3.7.4 Underlying effort

In the impact assessment mentioned above (European Commission 2014a), a general equilibrium model is applied to assess the impact of a 40% GHG emission reduction in 2030 on GDP. The expected GDP impact is simulated at a range of -0.10 to -0.45%. The less costly end of the range can be achieved by putting a uniform price to carbon in all sectors of the economy (e.g. by extending the ETS) and recycle revenues by reducing labor taxation.

Similar results are delivered in the general equilibrium analysis by Hof et al. 2012. According to this study, the INDC's 40% reduction target can be achieved at a welfare cost of -0.25 to -0.4% of GDP in 2030. The range is determined by the level of mitigation which is accomplished outside the EU.

Several studies confirm that considering ancillary benefits makes GHG abatement more attractive. In European Commission 2014a, two scenarios with GHG emission reductions of 40% in 2030 relative to 1990 reduce air pollution significantly. Lower emissions of PM2.5, SO_2 and NO_X are expected to reduce mortality in 2030 by 4 to 11 million of life years lost. Hof et al. 2012 estimate ancillary benefits of reaching the INDC target as a reduction of premature deaths due to air pollution. Relative to the baseline, which mitigation and air pollution policies up to 2010 are incorporated in, premature deaths in 2030 would be 3.5% lower. The European Environment Agency estimates for the EU-25 and a 40% GHG reduction target that air quality in Member States improves to a degree that would cost 12 bn. Euros if achieved through air pollution policies alone (EEA 2006). Within the EU, the ancillary benefits are especially high in the eastern European Member States.

The current low prices of allowances in the EU ETS are an indication of the ease with which targets are achievable under the current macroeconomic conditions. However, these conditions can change. Furthermore, it needs to be acknowledged that energy and climate policies both on the EU and the Member State levels have helped to keep allowance prices low. Due to the long history of climate policy in the EU, many implemented measures are already incorporated in the current BAU path. As a consequence, even a target that might be close to such a BAU path is not achieved without any effort.

3.7.5 Comparison to Switzerland

At first glance, the Swiss INDC with its -50% target relative to 1990 is more ambitious than the EU's INDC. It has to be considered, however, that the EU intends to achieve its -40% target entirely with domestic measures. Assuming that Switzerland follows up on its intention to achieve 30% of its reduction target domestically, the Swiss domestic target seems to be slightly less ambitious than the EU target. Yet, the EU has already achieved larger absolute GHG reductions than Switzerland since

1990, and Switzerland will have to pay for any purchases of foreign emission reductions. Such purchases are negligibly cheap at the moment, but this could change until 2030. In summary, the EU and Swiss INDCs could be quite similar in significance and effort. This may change in the future depending on LULUCF accounting rules, differences in economic growth, and prices for emission reductions on international markets.

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3.8 India

3.8.1 Brief description of the INDC

The INDC from India was submitted to the UNFCCC on October 1st, 2015, and pledges a GDP emissions intensity target of 33-35% below 2005 levels by 2030.

3.8.2 Further characteristics

The emissions intensity target is complemented by several national goals. India pledges to achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of “transfer of technology and low cost international finance including from Green Climate Fund (GCF)”. It promises to create an additional carbon sink of 2.5-3 Gt CO_2-eq through additional forest and tree cover by 2030. Further announcements hold out the prospect of enhanced investment in sectors and regions that are particularly affected by climate change such as agriculture, water resources, health and disaster management, the Himalayan region and coastal regions.

Only the renewable target calls explicitly for technology transfer and financing. Contingency from international aid is, however, suggested by several formulations on the 38 pages of the document. India expresses its intentions to mobilize financing from developed countries for support of mitigation and adaptation activities.

3.8.3 Significance of the INDC

As part of the INDC, India delivers an overview of the country’s climate policy with a comprehensive description of mitigation and adaptation measures taken in the past. In contrast, the targets themselves are characterized in a rather brief manner. For example, it is not clarified whether the GDP intensity is based on constant prices or on nominal values, nor does the INDC denominate figures for the base year or for 2030. Irrespective of these uncertainties, it is very likely that currently implemented policies will already be sufficient to reach the proclaimed intensity target.

Under current policies, the Climate Action Tracker 2015 projects a reduction of 41.5% in emissions intensity relative to 2005 by 2030, which exceeds the reduction pledged in the INDC. For this projection, the annual GDP growth rate is set at 6.4%. The Centre for Policy Research, a public policy think tank from India, conducted a comparative review of several recent modeling studies (Dubash et al. 2015). It assumes higher GDP growth rates (7.0% to 8.75%), which are closer to the projections of the Indian Government in the INDC (8.6% on average 2014-2030). According to the reviewed studies, emissions intensity from the BAU scenarios is estimated to be 23-45% below 2005 levels in 2030. The reduction of the INDC (33-35%) is located right in the middle of this range. The appropriate caveats due to differing methodologies apply.

Figure 5 presents another way to put India’s INDC into perspective. It shows the long-term trend of emissions intensity, which has almost steadily declined since 1991. From 2002-2012, intensity fell by 23%. Both the INDC and the Copenhagen pledge are roughly in line with the trend. The pledges even seem to slightly flatten the trajectory. These considerations support the statement that the INDC target is unlikely to imply any GHG emission reductions from business as usual.

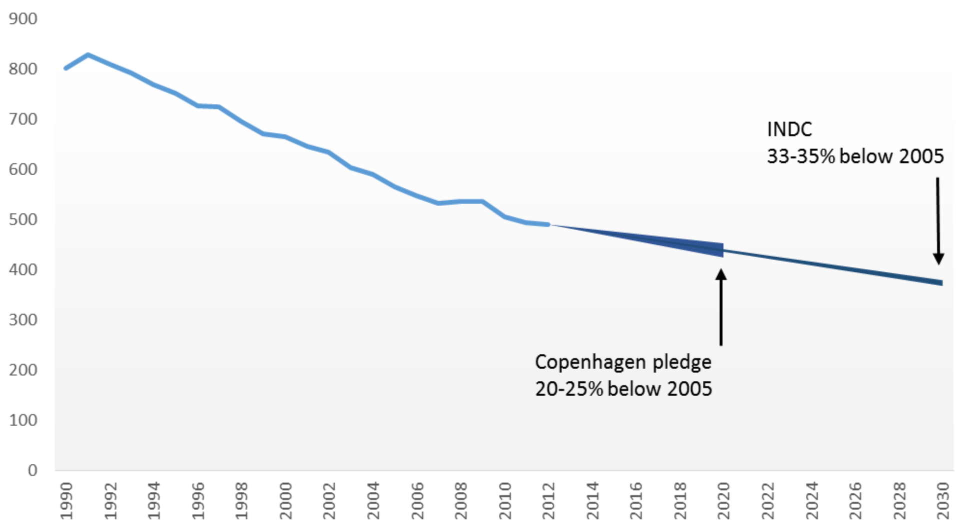

Figure 5: Total GHG emissions (excl. LULUCF) - tCO_2 per unit of GDP in million US$ (conversion at purchasing power parities), 1990-2012 – India. CAIT Climate Data Explorer, World Resources Institute.

The emissions intensity target and the conditional non-fossil fuel electricity generation target are not particularly well aligned: According to several sources, if the non-fossil fuel objective is met, total emissions will be below the level which is implied by the intensity target in 2030 (World Resources Institute 2015; Climate Action Tracker 2015). India has a very high emissions intensity of electricity generation (OECD 2015), and emissions from this sector are expected to rise substantially in the BAU projections. The non-fossil fuel target seems to represent some ambition in the light of the large capacity of coal powered plants which are currently being planned and will ensure that coal remains the dominant electricity source in the future (NRDC 2015).

3.8.4 Underlying effort

It is likely that the emissions intensity target of India's INDC implies no additional effort, because it is located in the range of recent BAU projections. In addition to the downward sloping trend of emissions intensity, India's economy has great efficiency potentials (Fekete et al. 2013). For example, the iron and steel and cement industries exhibit many low cost mitigation opportunities. The same applies to electricity supply, where installed capacity is dominated by inefficient coal plants. The renewable target of the INDC is conditional on technology transfer and "low cost international finance". Raising the share of non-fossil fuels to 40% in 2030 (currently about 30%) requires building more capacity in renewables and nuclear electricity generation than in coal and natural gas. There are good opportunities for hydro, solar and wind power in India, which already have large installed capacities (e.g. 5th highest capacity of wind power and of geothermal heat generation in the world, REN21 2015). Although prices for renewable energy have dropped significantly over the last years, this is not a particularly cheap mitigation option, which may be a reason for the conditionality attached to the related goal.

3.8.5 Comparison to Switzerland

India's INDC is unlikely to imply GHG emission reductions relative to business as usual projections. The related effort is far lower than Switzerland's. Nevertheless, the non-fossil fuel target in the

Indian INDC does imply an effort. This particular goal could entail more GHG emission reductions than the emissions intensity objective.

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3.9 Indonesia

3.9.1 Brief description of the INDC

The INDC of Indonesia, which was submitted to the UNFCCC on September 24th, 2015, commits to an emissions reduction of 29% relative to a BAU scenario by 2030. This unconditional reduction target is not based upon the use of international market mechanisms.

3.9.2 Further characteristics

With support from international cooperation as a prerequisite, Indonesia pledges to decrease emissions further up to 41% below BAU. The conditional target "is subject to provision in the global agreement including through bilateral cooperation, covering technology development and transfer, capacity building, payment for performance mechanisms, technical cooperation, and access to financial resources."

Three GHG gases are covered (CO_2, CH_4, N_2O), and five sectors: energy (including transport), industry, agriculture, LULUCF, and waste.

Indonesia provides a BAU scenario in the INDC. Total emissions are projected to reach about 2.881 Gt CO_2-eq in 2030.

Indonesia emphasizes the need to improve emissions accounting by refining methodology and data sources. LULUCF accounting is specified as being based upon "the IPCC GHG". It also points to the large share of emissions from LULUCF (including peat and forest fires) and proclaims to cut LULUCF emissions by reducing deforestation and forest degradation.

3.9.3 Significance of the INDC

The INDC states that in 2005 63% of Indonesia's total emissions originated from LULUCF and peat and forest fires. This makes a reliable assessment of the Indonesian INDC difficult, especially due to high volatility of the underlying sources such as deforestation, peat oxidation and peat fires. For example, peat fires are often of non-anthropogenic origin, but are also often started deliberately in an illegal way and as a means of deforestation to clear land for agriculture (e.g. palm oil plantations). Peat oxidation is a very strong contributor to LULUCF emissions, but still not fully understood scientifically. Peatlands contain large amounts of CO_2 in the form of organic matter, which decomposes and is set free when peat soils are drained for cultivation purposes. The exact amount of emissions caused by this is still unknown. PBL et al. 2015 highlight the great deal of uncertainty which derives from the fluctuation of emissions from peat oxidation. These can approach the magnitude of 30-50% of total annual LULUCF emissions in Indonesia. The Climate Action Tracker 2015 emphasizes the large differences between the Government's reporting of LULUCF emissions for the last decade and estimates from independent sources (Margono et al. 2014), which disclose much higher deforestation rates than the Government.

Given this, it is not surprising that even historic emissions are particularly contested in the case of Indonesia. Carbonbrief 2015 points to a huge discrepancy in the calculations of CAIT and EDGAR databases. For example, whereas CAIT sets total emissions of 2012 (including LULUCF) at 2 Gt CO_2-eq, EDGAR shows only 0.8 Gt CO_2-eq for the same year.

It is a favorable feature of the Indonesian INDC that it includes a figure for BAU emissions in 2030. Considering the above uncertainties, the INDC still lacks desirable clarity. For example, sectoral carbon budgets for the BAU and target scenarios would help to determine how the Government is planning to distribute the emissions total among LULUCF and other sectors.

PBL et al. 2015 cautiously estimate a BAU range of total GHG emissions including LULUCF which cover peat oxidation, but not emissions from the also highly volatile peat fires. For the year 2030, the BAU spreads from 2.070 to 2.145 Gt CO_2-eq, which is close to total emissions in 2010. This is mainly due to the expected downward trend of LULUCF emissions, which causes total emissions to decrease slightly until 2020 in spite of continuously rising emissions from other sources. After 2020, this effect weakens and total emissions start to rise again slowly. The unconditional INDC target allows for 2.046 Gt CO_2-eq from the three covered gases and is therefore located close to the lower end of the BAU range. Taking into account the uncertainties attached to the BAU path, it can be concluded that, as was already the case for the Copenhagen pledge, it is unclear whether the target implies any emission reductions at all. If so, they are possibly minor. However, given the high volatility of historic LULUCF emissions, it cannot be ruled out that the required reductions might be more substantial.

3.9.4 Underlying effort

Despite the great uncertainty concerning the required abatement, cost studies provide useful further insights. Based on the McKinsey abatement cost curve, the National Council of Climate Change 2010 estimated a great potential of low-cost abatement measures in Indonesia. Policies which have been implemented in the five years since the publication of the study are not included in the BAU scenario, which therefore – apart from the uncertainties concerning LULUCF accounting – projects higher emissions in 2030 than the BAU of the INDC. Despite this caveat, the resulting low average (purely technical) abatement cost of 2 US$ per tCO_2-eq for a 2.3 Gt CO_2-eq reduction in 2030 still illustrates Indonesia's huge low-cost abatement opportunities. The assumed reduction would exceed the projected annual BAU emissions. More than 75% of the abatement potential lies in LULUCF and peat.

The Deep Decarbonization Pathways Project follows a different approach and analyzes opportunities to reduce emissions up to 2050 in accordance with the 2 degree goal (Siagiana et al. 2015). The main focus of the study is on restructuring the energy sector. The authors expect emissions from energy consumption to be more important in the future than emissions from LULUCF. Today's second largest contributor, the energy sector is reported to have grown at an annual rate of 4.5% between 2000 and 2012, which is faster than LULUCF (2.7% annually). Following this trend, energy is crucial for any strategy which seeks to reduce GHG emissions substantially. In the decarbonization scenarios, the per capita emissions from the energy sector are assumed to decrease by about 28% between 2010 and 2050. Although the scope of the study is different from our analysis, the resulting cost figures deliver useful insights about Indonesia's abatement potentials. By 2020, the required investments for the deep decarbonization pathway peak at a maximum of 1.22% of GDP and decrease afterwards to 0.54% of GDP in 2050. The figure for 2020 is higher than what is needed to reduce emissions to anywhere near the Indonesian INDC target, because the investment path to a low-carbon economy in 2050 requires a strong commitment in the first decades. Ancillary benefits of abatement should be considered. For example, positive health effects due to reduced air pollution are common and strong advantages of emissions abatement in developing countries.

3.9.5 Comparison to Switzerland

Uncertainties regarding past and future LULUCF emissions hamper the evaluation of the Indonesian effort. Despite this, it is possible to conclude that the INDC of Switzerland requires more substantial effort than Indonesia's.

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3.10 Japan

3.10.1 Brief description of the INDC

Japan sets its INDC target at a reduction of GHG emissions by 26% in 2030 compared to 2013. The INDC was submitted on July 17th, 2015. Reductions and removals from the Joint Crediting Mechanism (JCM) will be counted as Japan's reductions.

3.10.2 Further characteristics

The INDC encompasses seven GHGs and all sectors, including LULUCF. The accounting for the latter follows the rules under the Kyoto Protocol. Other accounting standards are in line with the guidelines by the IPCC.

The INDC is underpinned by a bottom-up calculation, offering emission targets for the various sectors by 2030.

Japan highlights its contribution to international technological progress. The INDC contains the estimate that 1'000 Mt CO_2 will be saved through Japanese technology in other countries in 2030, but no intention of crediting these emission savings towards the emission reduction target is expressed.

The annual dates refer to the Japanese fiscal year, which runs from the 1st of April of said year until the 31st of March of the following year.

3.10.3 Significance of the INDC

For the year 2020, Japan targets a 3.8% reduction of GHG emissions compared to 2005. Starting off from this revised 2020 pledge, the 2030 INDC compares favorably, clearly presenting a strengthening of the country's efforts towards climate mitigation. However, the final 2020 pledge signified an attenuation of a previously suggested 25% reduction compared to 1990. The revision of the pledge occurred in the aftermath of the Fukushima disaster and with the intention of turning away from nuclear power. Since the 2020 pledge comprises only a very modest target and the intention of abandoning nuclear power has since been revoked, the 2020 pledge is hence not a particularly meaningful starting point to assess the 2030 INDC target.

While a Government BAU scenario is not available for 2030, BAU scenarios from other institutions show a large spread for Japan (with the highest projection being 32% above the lowest; see Appendix B), indicating that uncertainty for Japanese reference emissions could be higher than for many other industrialized countries. In relation to these BAU scenarios, the INDC target falls into the lower end of that range. Reaching the INDC target may hence require some climate policy actions on the behalf of Japan, but possibly only little, unless economic growth resumes strongly.

According to Government projections, population is expected to decrease to 116.62 million by 2030 (under a medium fertility scenario; IPSS 2012). This represents a decrease of more than 9% compared to 127.5 mio in 2012 (Statistics Bureau 2012). Under the INDC, per capita carbon emissions would consequently decrease by only 12%. This value compares to 56% for Switzerland's 2030 INDC or 23% in the case of the USA until 2025.

Japan's INDC can be deemed as transparent and plausible. It gives indication on how targeted emissions in 2030 shall be reached by offering a bottom-up compilation by sector. Measures for carbon mitigation are stated, as well as the amount of targeted LULUCF removals.

3.10.4 Underlying effort

As outlined in the previous section, the INDC is on the lower end of BAU projections. The implied effort to reach the target might therefore be low. However, the range of BAU projections is large. Two other factors also have a large influence on the effort required for compliance with the INDC:

- The inclusion of the usage of international mechanisms, mainly under the JCM, a mechanism with the aim of generating carbon credits from the international diffusion of low carbon technology. While not being included in the bottom-up analysis, the credits "will be appropriately counted" towards Japan's goal. It is estimated in the INDC that JCM credits may contribute 50-100 Mt CO_2 to the INDC (4.6-9.3% of 2030 INDC gross target emissions[10]).
- The usage of LULUCF credits towards the achievement of the INDC. According to Japan, this will contribute approximately 37 Mt CO_2 (3.4% of 2030 INDC gross target emissions).

Deducting these two factors from the target emission level would allow Japan to emit up to 1'179 Mt CO_2 domestically, a value on par with 1990 emissions and 12% under the 2005 level.

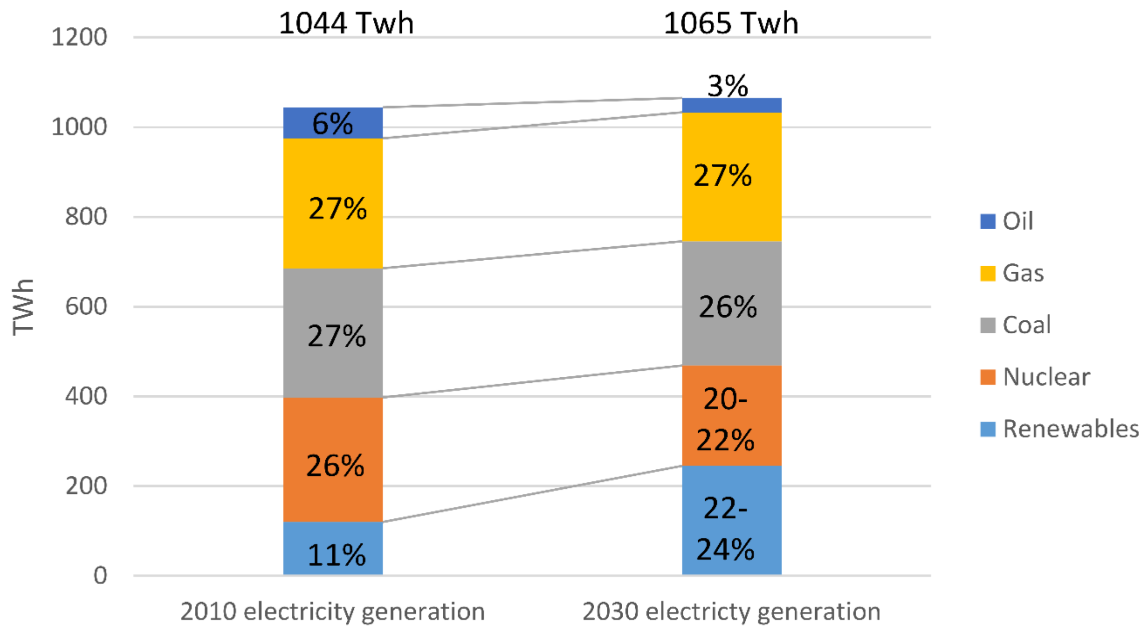

Figure 6: Comparison of electricity generation in 2010 to the generation target in 2030, by source. 2010 percentages do not add up to 100% due to rounding. Own figure with data from INDC for 2030 and World Development Indicators 2015 for 2010.

The electricity sector is currently Japan's largest emitter and hence offers great potential for carbon mitigation. In the INDC, Japan states its target power mix for 2030. Accordingly, Japan will continue its reliance on fossil fuels for electricity generation (see Figure 6). Coal power is estimated to make

[10] For this purpose, gross emissions shall be defined as GHG emissions excluding the LULUCF sector.

up 26% of the electricity mix in 2030, which corresponds to the share prior to the Fukushima disaster (25-28%). The same is also valid for gas power; its estimated 27% share in 2030 is in line with the share before 2011. Nuclear power is projected to slightly decrease from 24-27% to 20-22%. On the other hand, renewable energy is expected to form 22-24% of the total electricity mix (up from 11% in 2010; World Development Indicators 2015).

Japan's sustained dependence on coal power deviates from the path that some industrialized countries have chosen. Given the intention of Japan to make investments in new coal power plants and also to replace older, inefficient facilities, a stronger shift towards renewable energies would seem like an effective option of carbon mitigation[11]. Some of the untapped renewable energy potentials shall be highlighted in the following:

- For the instance of solar power, Bloomberg New Energy Finance (BNEF) state that the learning curve for solar PV panels is strongly underestimated by the Japanese Government. BNEF 2015 projects that 95.3 GW of solar PV will be installed in Japan by 2030, 49% more than estimated in a projection of the Japanese Government upon which the energy mix in the INDC is based.
- Wind power is only projected to make up 1.7% of total electricity production in 2030. While the overall potential for this technology is very high in Japan, it currently faces strict approval processes. According to BNEF 2015, the environmental assessment process for coal power plants is less stringent than for a wind park of comparable size.

In the industrial sector, a decrease of emissions by around 7% from 2013 until 2030 is proposed in the INDC. This corresponds to the same percentage improvement that was achieved between 2005 and 2013. In view of the industrial energy intensity, which is higher in Japan than in comparable countries like Germany and the UK, as well as the numerous proposed measures to decrease emissions in this sector, this specific sub-target seems unambitious.

In the transport sector, Japan aims to reduce emissions by 28% by 2030 compared to 2013. With regard to Wagner et al. 2012, who estimate marginal abatement cost curves for 2020 for the various sectors in Japan, this seems to be an ambitious sub-target. The paper proposes a steep cost curve for the transport sector, with emission reductions above approximately 5% having costs of EUR 100/t CO_2-eq and above. However, as these calculations are with respect to 2020, the longer time horizon for the INDC can be expected to lower the costs. The buildings sector, on the other hand, displays a flatter marginal cost curve. According to the same study, 20% of the emissions can be mitigated with a net benefit, while the marginal cost curve quickly steepens after that value. Therefore, the targeted 40% reduction for this sector will likely also entail net macroeconomic cost.

3.10.5 Comparison to Switzerland

Both the significance and the effort of Switzerland's INDC can be rated as higher than Japan's. The latter's targeted emission level is inside the range of BAU scenarios, although at its lower end. The Japanese INDC will likely require a mitigation effort. However, it seems like opportunities for

[11] An OECD paper summarizes various mitigation potential models. Depending on the model, a potential of 9-32% is predicted for 2030 at the price of 50 US$/t$CO_2$-eq (Clapp et al. 2009).

substantial emission reductions are left out, as Japan continues its reliance on fossil fuels. The projected growth path of renewable energy appears to be much below realistic potentials.

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3.11 Republic of Korea

3.11.1 Brief description of the INDC

The INDC of the Republic of Korea from June 30th, 2015, is expressed as a reduction of 37% in total GHG emissions relative to business as usual emissions in 2030. A business as usual (BAU) scenario is provided, which projects emissions of 850.6 Mt CO_2-eq by 2030. Korea will partly use international market mechanisms to help achieve its target.

3.11.2 Further characteristics

The Korean INDC covers six GHGs. The scope of the INDC is economy-wide. However, the decision on whether or not to include LULUCF will be made at a later point in time. The 1996 IPCC Guidelines are the dominant inventory methodology (2006 IPCC Guidelines for rice cultivation and waste).

3.11.3 Significance of the INDC

Absolute emission levels for mitigation targets that are based on BAU projections are inherently uncertain, because BAU scenarios may be subject to change. Remarkably, in the context of the 2020 pledge, which had also been expressed relative to a BAU scenario, Korea lowered its BAU scenario and therewith rendered reaching the pledge more difficult.

After the rapid growth of emissions since 1990 (emissions more than doubled between 1990 and 2010) driven by economic and industrial development, the growth in both emissions and GDP has recently slowed down. The BAU scenario presented in the INDC foresees a sustained, but further slowing growth of emissions in Korea. This is also in line with economic forecasts, as the OECD 2014 predicts a much lower economic growth rate in Korea up until 2030 (average of 2.9% after an effective average growth rate of 6.7% in the 1990s and 4.7% in the 2000s). Under these economic growth projections, achieving the emissions reduction target implies a further decoupling of emissions and GDP growth.

According to the Climate Action Tracker (CAT), the BAU scenario presented in the INDC is too high, as it underestimates the effect of implemented climate policy. CAT 2015 estimates that in 2030, Korea's BAU emissions will amount to 669 to 796 Mt CO_2-eq, which makes the goal easier to attain. The INDC's emissions level corresponds to a reduction of 20-33% relative to the CAT's BAU scenario.

The significance of the INDC may be attenuated by the fact that the decision on whether or not to include LULUCF in the emission accounting has been postponed. Since LULUCF is a net sink in South Korea, reaching the target could later be facilitated by adding LULUCF to the accounting. Yet, the effect of its inclusion would be somewhat limited, since the net emissions reduction by LULUCF has not exceeded 6% of total emissions in the past decade (CAIT 2015).

3.11.4 Underlying effort

For effective GHG emission reduction, changing the energy mix is both crucial and challenging, since electricity and heat production is responsible for just about half of Korea's GHG emissions. A comparative OECD 2013 study on effective carbon prices states that, in the year 2010, Korea's CO_2

abatement in the electricity sector was below 1% of counterfactual emissions of a no-policy scenario and came at a net cost to society of 0.03% of GDP. On the one hand, this reflects the challenges: Since domestic resources of natural gas are scarce and the potential for hydropower is limited due to geographical conditions (also see below), other more costly or more disputed options, such as solar and nuclear energy, come into focus. On the other hand, it also indicates that the existing abatement potentials can still be exploited, as renewable energies still play a very minor role in the electricity mix. Today, approximately two thirds of electricity production originate from conventional fossil fuel sources, with the bulk (42%) coming from coal power and natural gas (23%). The rest is mainly produced by nuclear power and oil combustion and only a low one-figure percentage from renewable sources (World Development Indicators 2015). To satisfy the rising demand for electricity, which is fostered by the low electricity price, new coal-fired power plants are planned for the medium-term, along with nuclear power (EIA 2015).

This means that potentials for electricity generation from renewables in South Korea are currently not being exploited to a significant extent. For instance, although hydropower potentials are somewhat limited, data by the International Journal on Hydropower and Dams 2009 indicate that only a sixth of the economically feasible potential of 18.6 TWh was used in 2009. Similarly, data by SolarGis 2014 show that solar power potential in South Korea is large in many areas. While the Korean solar power market is among the fastest growing in the world, total installed capacity in 2014 was still at a rather modest 2’384 MWp, responsible for 0.3% of total electricity production in 2013 (IEA 2015).

Another driving factor for the increasing emissions has been the growing export of industrial goods, such as electronics, vehicles and machinery. While energy efficiency has increased in these sectors in the past years, these savings were generally outpaced by growing foreign demand. In order to foster energy efficiency in these sectors, a number of policies has been put in place. A new and prominent instrument is the Korean Emissions Trading System (ETS), which was introduced at the beginning of 2015 and covers approximately two thirds of the country’s emissions. However, during the first phase, which lasts until the end of 2017, mitigation pressure can be expected to be very limited, since the cap is more than 20% above average annual historic emissions for the covered sectors. All allowances are given away for free. The cap for the subsequent periods has not been announced yet (ICAP 2015).

Overall, compared to the ambitious Copenhagen pledge for 2020, the required additional effort for the INDC is small. The targeted emission levels are 543 Mt CO_2-eq for the 2020 pledge and 535.9 Mt CO_2-eq for the 2030 INDC.

3.11.5 Comparison to Switzerland

With respect to the 2020 pledge, South Korea’s required effort may be somewhat larger than Switzerland’s. South Korea’s 2030 INDC does not contain considerable ambition beyond this, while Switzerland’s INDC is a conceivable step forward compared to its 2020 pledge. Overall, for 2030, we rate the effort implied by the Swiss INDC higher than the respective effort for South Korea.

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3.12 Mexico

3.12.1 Brief description of the INDC

In its INDC submission of March 30th, 2015, Mexico commits unconditionally to a 25% reduction of GHG and Short Lived Climate Pollutants emissions relative to a BAU scenario in 2030. A conditional target of a 40% reduction is subject to an international agreement on climate policy including, inter alia, market mechanisms and border tax adjustments.

3.12.2 Further characteristics

The unconditional 25% target entails emission reductions of 22% of GHGs and 51% of Black Carbon. Mexico informs that this implies "a net emissions peak starting from 2026" and a reduction of emissions intensity per unit of GDP by around 40% from 2013 to 2030.

According to Mexico's INDC, the conditional reduction of 40% corresponds to an abatement of GHG emissions of up to 36% and of Black Carbon up to 70% in 2030.

Mexico emphasizes the advantages of global market based mechanisms for cost-effective implementation, but does not set them as a prerequisite for its unconditional 25% target. This is different for the conditional 40% target, which "will require fully functional bilateral, regional and international market mechanisms". Furthermore, the 40% target is "subject to a global agreement addressing important topics including international carbon price, carbon border adjustments, technical cooperation, access to low-cost financial resources and technology transfer, all at a scale commensurate to the challenge of global climate change."

The INDC covers six greenhouse gases and Black Carbon. Emissions from LULUCF are included. In terms of methodology, Mexico refers to "IPCC guidelines; national statistics: sector activity and economic forecasts."

3.12.3 Significance of the INDC

Mexico's INDC targets are related to a baseline scenario. The baseline values are provided in the INDC. Despite this, uncertainty with respect to absolute targets could arise from the fact that BAU scenario projections may be subject to updates according to the latest economic development, unless this is explicitly ruled out in the INDC formulation. This adds to the usual uncertainty of emissions accounting, especially in the LULUCF sector.

The scope of the emissions underlying the pledge includes black carbon. Under the targeted abatement levels for black carbon, this lowers the percentage reduction requirements for the usual basket of greenhouse gases. According to Mexico's own estimates, these latter requirements amount to -22% for the unconditional and -36% for the conditional target. Black carbon has a climate forcing effect, but its inclusion in the basket of greenhouse gases is unusual and contentious, due to its short atmospheric lifetime. Our analysis of the Mexican INDC thus concentrates on the implied GHG reductions by -22% and -36%, respectively.

PBL et al. 2015 suggest a baseline at a level of 13-14% below the BAU provided in the INDC. Yet, even according to this emissions trajectory, the unconditional target still implies reductions and will not be reached without further policy measures. The conditional reduction of 36% will even require substantial reductions. The Climate Action Tracker 2015 estimates that current policies will lead to emissions of 9-16% below the Government's BAU scenario (incl. LULUCF). This also indicates that further reductions are needed to achieve the respective targets.

Mexico's Copenhagen pledge is conditional on the provision of adequate financial and technological support from developed countries as part of a global agreement. It proposed a reduction of 30% in 2020 relative to a BAU scenario disclosed in the National Communication, which was revised later (Government of Mexico 2012 and Danish Energy Agency et al. 2013). Due to baseline revisions and different time horizons, it is not entirely clear whether the Copenhagen pledge or the INDC has the more ambitious target, possibly the former. On the positive side, it has to be noticed that, while the pledge for 2020 is conditional, the INDC consists of both a conditional and an unconditional pledge. Furthermore, the prerequisite for the conditional INDC target settles on a lower level, because international financial support is no longer required. On the other hand, it is unlikely that the condition of international border tax adjustments will be satisfied.

The INDC indicates a net emissions peak starting from 2026 and includes an intensity target of -40% in 2030 relative to 2013. Especially the second of these objectives gives more substance to the INDC. On the other hand, there is room for improvement with regard to transparency. The emissions level at which emissions will peak is not given. A figure for the emissions intensity per unit of GDP is not yet available for 2013 and is based on data which is subject to frequent revisions.

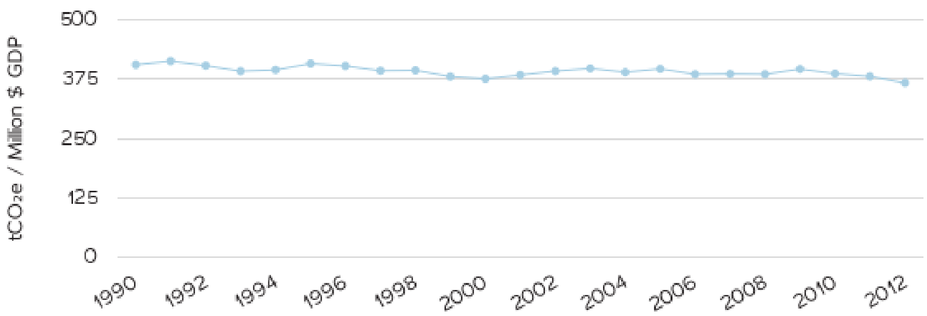

Figure 7: Total GHG emissions (excl. LULUCF) per unit of GDP (million US$, conversion at purchasing power parities) 1990-2012 – Mexico. Data and visualization by CAIT 2015.

Figure 7 shows that Mexico's emissions intensity remains on a rather stable level since 1990. The slight downward turn of the trajectory since 2009 needs to be perpetuated in order to get close to the intensity target for 2030. With an annual decrease of 2.5% (average of 2009-2012), emissions intensity in 2030 would be 37% below 2012 levels.

3.12.4 Underlying effort

Although Mexico is an OECD Member, it is still an emerging economy with a high emissions intensity. In 2010, total GHG emissions per unit of GDP were the 7th highest among OECD countries. The effort in terms of abatement costs is thus lower than the implied reductions alone suggest. A study by the World Bank (Johnson et al. 2010) followed a bottom-up approach and detected an abatement potential of 477 Mt of CO_2-eq in 2030 at a negative total direct cost. This implies that the reduction of the INDC could be achieved at a cost close to zero. However, since many alleged “no regret” measures of bottom-up studies require behavioral changes or the overcoming of barriers to implementation, these figures need to be interpreted with caution. On the other hand, bottom-up studies do usually not consider the efficiency potentials that can be reaped by recycling revenues connected to abatement policies (e.g. a CO_2 tax). Mexico introduced a carbon tax on fossil fuels in 2014. The tax is set at approximately US$ 3.50 per tCO_2-eq, although firms will be allowed to use offset credits (from CDM projects) to fulfill their tax liability.

Johnson et al. 2010 locate the most cost-effective mitigation measures in the transport sector, which was responsible for about 33% of energy related GHG emissions in 2010 (Government of Mexico 2012). BAU projections expect this share to grow further in the future. Large reductions at a rather low economic cost could be realized by an improvement of public transport and bus systems, fuel efficiency standards for vehicles and optimization of road freight logistics. Of course, emission reductions in the transport sector have high ancillary benefits, particularly in emerging countries like Mexico. Most important among these are the lower health costs by reducing air pollution and time savings due to less traffic congestion in urban areas. Considering these benefits of abatement leads to lower or negative abatement costs.

PBL et al. 2015 analyze the emissions effect of an enhanced policy package. It includes a stop to deforestation, a significant increase of the renewables share in electricity generation (40% in 2034), ambitious fuel efficiency standards in transport as currently discussed in the EU, a strong reduction of gas flaring, and the elimination of hydrofluorocarbons (HFCs). This set of policies is suitable for an emissions reduction in the range of the unconditional -36% target of the INDC. The study does not calculate cost figures, but it is likely that for Mexico the implementation at least of some of these policy measures will require considerable effort, certainly at the institutional level, but also in terms of implementation and opportunity costs.

3.12.5 Comparison to Switzerland

Switzerland’s and Mexico’s INDC targets are both significant. They cannot be achieved by pursuing current implemented policies alone. Considerations of abatement costs suggest that the effort for Mexico’s unconditional target might be lower than in the case of Switzerland. This could be reverse for Mexico’s conditional target. However, the comparison is complicated by the fact that for both countries the share of domestic reductions is not entirely clear. Switzerland, according to the press release which comes with the INDC, intends to reduce domestic GHG emissions by 30% relative to 1990. Mexico has expressed interest in hosting programs under market mechanisms, but indicates that the unconditional target will be met even if international mechanisms are not available. This potentially implies a fully domestic target stated in the INDC. In conclusion, both countries could have similar levels of domestic ambition. However, the actual share of domestic reductions has not yet been decided on by either Parliament.

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3.13 New Zealand

3.13.1 Brief description of the INDC

New Zealand aims to reduce GHG emissions by 30% by 2030 compared to 2005, which corresponds to an 11% reduction compared to 1990. The INDC was submitted on July 7th, 2015. International mechanisms may be used to achieve the target.

3.13.2 Further characteristics

The target covers all sectors and seven greenhouse gases. It can be reached with unrestricted access to international carbon markets, complying with "reasonable standards and guidelines to ensure the environmental integrity of units / credits generated or purchased, guard against double-claiming / double-counting, and ensure transparency in accounting".

Accounting is according to the IPCC 2006 method and the 2013 KP Supplement. The land sector will be accounted for on a land or activity basis. Harvested wood products will be accounted for by a production approach. The INDC will be finalized following the confirmation of definite accounting standards at the Paris Conference of the Parties. On November 25th, 2015, New Zealand submitted an addendum to the INDC with further clarifications concerning LULUCF accounting.

3.13.3 Significance of the INDC

Given that New Zealand's GHG emissions rose by almost 20% between 1990 and 2005, a reduction by 30% compared to 2005 would be a turnaround of New Zealand's emissions growth trend (CAIT 2015). This is affirmed by the fact that the target lies one third below the Government's BAU projections.

However, both the significance and the transparency of the INDC are somewhat challenged by the three following points:

- The INDC contains the provision that the INDC will be completed once "full and final agreement on the accounting rules/guidelines" is reached or there is confirmation that new rules will not be applied retroactively.
- Despite not having officially submitted a pledge for the Kyoto Protocol's second commitment period, New Zealand applies the Kyoto Protocol's accounting methods for its "unofficial" 2020 target (5% below 1990 emission by 2020), according to Climate Action Tracker 2015. These accounting methods include the possibility to carry over excess carbon credits to the post-2020 period. Since New Zealand is expected to have ample excess of such credits, the factual significance of the INDC target could be drastically lowered.
- New Zealand's vast forests (a third of the land area is covered with forests) are responsible for substantial removals of CO_2. According to official emissions time series by New Zealand's Government, LULUCF removals never fell below 30% of gross emissions in any individual year since 1990 (Statistics New Zealand 2015).

The fact that New Zealand's Government BAU scenario for 2030 lies 38% above the Government's official 1990 value (excl. LULUCF) may partly be explained by population and economic growth.

However, it may also indicate that New Zealand's past and currently implemented climate policy falls short in comparison to some other countries comparable in development such as Switzerland and Norway.

3.13.4 Underlying effort

The targeted absolute GHG emission levels lie a third below the Government's BAU scenario, and therefore a distinguished effort is required to reach the target. Nevertheless, the required effort is strongly dependent on the degree of usage of the following two options:

- The potential usage of carbon credits from earlier periods, which is mentioned above, may strongly lower the required effort to reach the target.
- New Zealand retains the option to fully reach the target through access to international market mechanisms. At current market prices, this would correspond to a low cost buy out option. However, in case the international community agrees on ambitious climate policy, prices are likely to increase.

Due to the relative weakness of New Zealand's climate policy, mitigation opportunities remain in various sectors. Some of these opportunities are highlighted below.

While New Zealand already possesses a high share of renewable energy in the electricity sector, still 28% of the generation came from either coal or natural gas in 2012 (World Development Indicators 2015). Consequently, the electricity sector still disposes of potential for increasing renewable energy deployment, especially with regard to the historic share of renewable electricity: In the 1990s, it clearly exceeded 80%. The potential for more renewable electricity generation is large for hydro-power (Hydropower and Dams 2009), as well as wind and solar power (New Zealand Wind Energy Association; New Zealand Ministry of Economic Development 2009).

Beyond electricity, the energy sector generally exhibits some comparably low cost mitigation options. A study by New Zealand's Government with a time horizon until 2020 estimates that 7 Mt CO_2-eq (10.5% of 1990 GHG emission excl. LULUCF) can be mitigated at a cost for New Zealand's economy of NZ$ 40/t (US$ 27/t) and less, of which almost 3 Mt CO_2-eq come with a net benefit (New Zealand Ministry of the Environment 2009).

In the transport sector, the currently implemented policies are comparably sparse and hence potential for setting incentives towards less emissions intensive transportation is large.

In 2008, New Zealand introduced a domestic emissions trading system (ETS), which fully integrates certified reductions from the CDM. The total emissions falling under the ETS are uncapped, and a large part of the certificates is distributed at no cost. Furthermore, not all sectors are covered by the ETS: Agriculture, the largest contributor to New Zealand's total GHG emissions through methane emissions, was excluded from the ETS after pressure from the industry (ICAP 2015). Overall, the effect of the ETS on GHG emission mitigation can be expected to be rather low, at least in the first few years.

Daigneault 2015 investigates the economic impact of the INDC and highlights the crucial role of international carbon prices for New Zealand's climate policy. With agriculture and land-use excluded from carbon pricing, despite their large share in total emissions, a fully domestic reduction would need a carbon price of 243 US$ (of 2012) to yield a reduction of about 10% below 1990 levels. The economic cost of this scenario is estimated at an annual GDP loss of 2.1% from 2021-2030. Assuming a domestic reduction share of 35% and an international carbon price rising from 20 to 40 US$ between 2020 and 2030, the GDP loss is calculated at 0.23%. Higher carbon prices raise the share of domestic reduction and the abatement cost. For example, the annual GDP loss is almost threefold (-0.64%) in a scenario in which the international carbon price rises to 109 US$ in 2030. The share of domestic reduction increases to 58%.

3.13.5 Comparison to Switzerland

Like Switzerland's INDC target, New Zealand's INDC target is significantly different from the BAU scenario and requires substantial effort to reach. However, the effort and significance of New Zealand's INDC are strongly conditional to accounting uncertainties and the usage as well as the price development of the international market mechanisms. Switzerland's INDC seems more ambitious in terms of effort mainly for two reasons:

- a greater intention to achieve reductions domestically, and
- a more stringent climate policy in the baseline, which implies a smaller availability of low hanging fruit.

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3.14 Norway

3.14.1 Brief description of the INDC

Norway's INDC announces a GHG emissions reduction target of at least 40% relative to 1990 levels. It was issued on March 27th, 2015. The target will be translated into an emissions budget covering the period 2021-2030. Next to domestic measures, Norway intends to use flexible international mechanisms to achieve the reduction target, either within the EU or – in absence of an EU agreement – within the framework of the UNFCCC.

3.14.2 Further characteristics

The INDC covers seven GHGs. The emissions target will be pursued in association with the EU and its Member States on the basis of a common agreement. If there is no such agreement, Norway proclaims to fulfill its commitment individually. In accordance with the EU, Norway leaves the final solution for LULUCF accounting for later. It is stated that the accounting of removals and sinks in the land sector will not affect the ambition level of the reduction target. If necessary, the 40% commitment will be recalculated.

3.14.3 Significance of the INDC

The unconditional Copenhagen pledge from Norway calls for a 30% reduction relative to 1990 in 2020. This is likely to imply substantial reductions (Econability 2014). At first glance, the INDC seems to involve less stringent requirements. However, mitigation beyond -30% could be more difficult to achieve. We thus consider the INDC target to be in line with the Copenhagen pledge.

The Government's BAU scenario projects a fairly flat trajectory for Norway's emissions until 2030, resulting in baseline emissions slightly above 1990 levels (Norwegian Ministry of Climate and Environment 2014). Due to population growth (21% from 1990 to 2014; World Development Indicators), Norway's total GHG emissions increased since 1990. This means that the proposed reduction has to be achieved in a shorter time period than e.g. in the case of the EU where total GHG emissions decreased since 1990.

It is clear that the INDC target cannot be reached domestically with currently implemented policies and measures alone and that it implies additional challenges for the decade following 2020.

Over the years, Norway has consistently announced that it is planning to deliver a part of its commitments by using flexible international mechanisms. Accordingly, neither the Copenhagen pledge nor the INDC target are to be achieved 100% domestically. A novelty is constituted by the intention of pursuing a cooperation with the EU first, before resorting to mechanisms under the UNFCCC. However, irrespective of an effective conclusion of such a settlement, it remains unclear what proportion of the reduction eventually will be realized domestically.

Possible removals and sinks from LULUCF are another unknown factor that complicates the assessment. In determining accounting rules, Norway intends to cooperate with the EU, which opts for a postponing approach of leaving final decisions open. If an agreement with the EU fails, Norway will follow a methodology of its own. According to the INDC, it will be finalized later, although in a footnote a specification is already delivered. In contrast to the EU, Norway states in its INDC submission that LULUCF accounting will not be applied as a means to dilute the target in hindsight. In the absence of a final international agreement on LULUCF accounting for the INDCs, we consider it exemplary to express this intention.

3.14.4 Underlying effort

Despite the remaining uncertainties, the Norwegian INDC is ambitious and requires effort in terms of economic cost. Regarding the magnitude of this cost, much depends on technical progress until 2030, especially as a large part of Norway's future domestic abatement has to be achieved in the transport sector. According to data from the European Environment Agency 2014, more than 60% of final energy consumption originates from renewable sources. Electricity generation is almost entirely based on hydropower, which has, however, a limited social potential for future medium and large scale additions.

The transport sector is the country's largest emitter of greenhouse gases, and Norwegian topography and low population density imply a high importance of transportation. Extraction industries, especially for crude oil and natural gas constitute the base of the Norwegian economy. Policy measures in the transport sector have been issued in the last years, including a CO_2 tax on fuel. Norway's fuel prices are among the highest in the world. Emission reductions resulting from these policies are already incorporated in the BAU scenario. Hence, further and potentially more costly measures need to be taken in the transport sector to reach the target. Among the less costly policies are improvements of energy efficiency by promoting the use of low carbon vehicles and the partial substitution of fossil fuels by biofuels (Climate Cure 2020 2010). In this respect, technical progress in the field of electrically powered cars may reduce costs substantially, but Norway as a country without a car manufacturing industry is dependent on developments which it has little influence on. Higher costs apply to measures which aim to influence the modal split in passenger and freight transport.

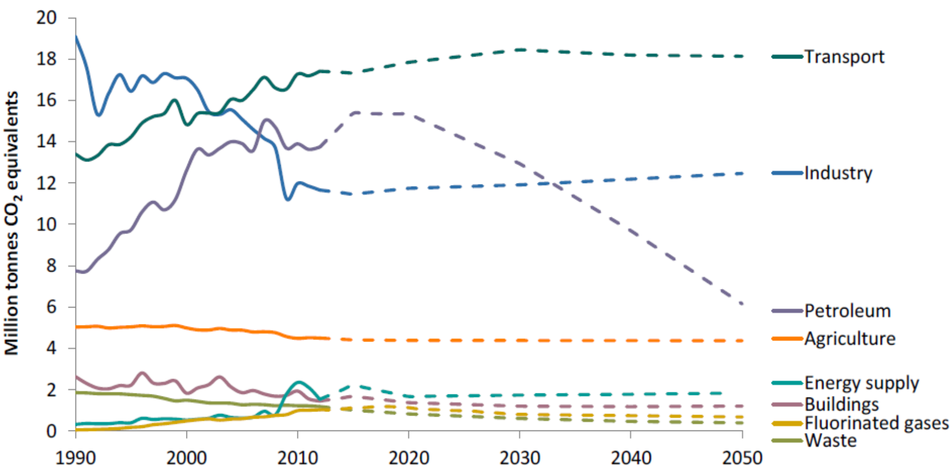

Figure 8: GHG emissions by sector 1990-2050 – Norway. Norwegian Environment Agency 2014.

A report for the Norwegian Ministry of Climate and Environment offers emission projections on a sectoral basis (see Figure 8; Norwegian Environment Agency 2014). The report also presents cost figures from a bottom-up analysis which indicate that meeting the INDC goal domestically involves substantial effort. The study investigates a comprehensive set of policy measures to reduce GHG emissions to 28.5 Mt CO_2-eq in 2030. This corresponds to a reduction of about 43% relative to 1990 and thus exceeds slightly the INDC target. The low-cost part of the policy package consists of measures which come at a cost of less than 500 NOK (59 US$) per ton of CO_2-eq and procure a share of 31% of the total reduction in 2030. A further 21% can be achieved by measures in the 500-1500 NOK (59-176 US$) range. All other policies, which represent 48% of the total reduction, come at a higher cost. The complete set of measures includes a reduction of total vehicle-kilometers for passenger cars by 10%, a shift of 20% of goods transport from road to rail, a 40% share of biofuels in road transport and shipping (20% for other mobile emission sources and domestic aviation). Important measures in the petroleum sector are the extensive electrification of extraction sites not only close to the shore but also further from land. In the industrial sector, the required mitigation has to be achieved by increasing the renewables share of stationary combustion substantially, major progress in CCS technology, and a switch to biogas in metals industry. Many of these policies do not only carry a price tag, but also require substantial institutional and societal effort.

The probable use of flexible mechanisms to reach the reduction target implies that the overall costs of the INDC are going to depend on

- the share of emission reductions that is achieved domestically,
- the international prices for allowances and certificates. At current prices, the related purchasing price hardly matters, but this would be likely to change in a future with more ambitious international climate policy.

3.14.5 Comparison to Switzerland

In the past, both countries extensively used flexible mechanisms to reach their Kyoto targets and are planning to buy emission reductions from abroad for both the Copenhagen pledge and the INDC (or do not rule out to do this). While the price of foreign emission reductions for 2030 is still completely unclear, it is likely that the actual mitigation effort for both countries is largely going to depend on the share of domestic target implementation. With 100% domestic implementation, the Norwegian INDC target could well be more costly per capita than the Swiss INDC target, neglecting ancillary benefits. In comparison to Norway, the main advantage of the Swiss INDC is the intention expressed in the press statement to achieve 30% of the abatement domestically.

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3.15 Russia

Introductory remark: The analysis of the INDC is based upon the English translation published on the UNFCCC website along with the Russian original and labeled “unofficial”.

3.15.1 Brief description of the INDC

According to the INDC of Russia, submitted to the UNFCCC on 31 March 2015, “limiting anthropogenic greenhouse gases in Russia to 70-75% of 1990 levels by the year 2030 might be a long term indicator.” This corresponds to a reduction of 25-30%. The target is to be achieved without use of international market mechanisms.

3.15.2 Further characteristics

The reduction target of the INDC is contingent upon “the outcome of the negotiating process underway throughout the year 2015 and the INDCs announced by major emitters of greenhouse gases” and “the maximum possible account of absorbing capacity of forests” as stated in the unofficial translation of the Russian INDC published by the UNFCCC. Coverage includes seven GHGs and the sectors energy, industry, agriculture, LULUCF, and waste.

3.15.3 Significance of the INDC

The historic GHG emissions of Russia show a trajectory which is different from most other developed countries. Following the major economic downturn after the collapse of the former Soviet Union, emissions dropped significantly in the 1990s and started to rise again in 2003 (see Figure 9). Hence, the pledged reduction relative to 1990 corresponds to a considerable increase of emissions compared to today. The INDC can be translated into an emissions level of 2.5 to 2.6 Gt CO_2-eq in 2030 (including LULUCF based on a net-net approach; Climate Action Tracker 2015), which is 11-15% higher than in 2012.

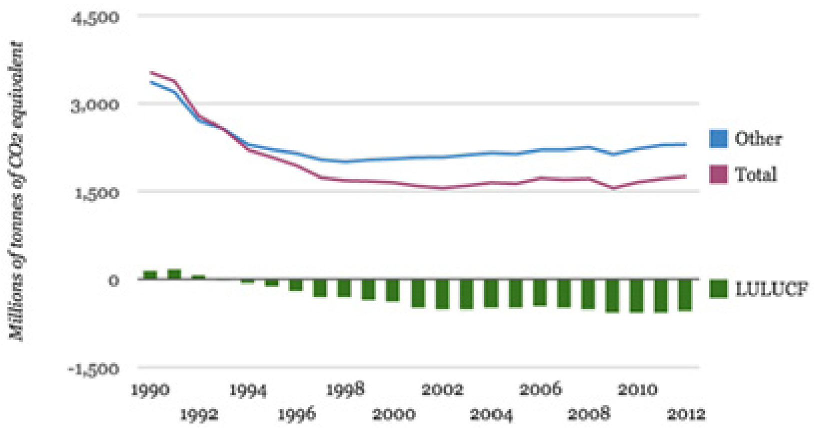

Figure 9: GHG emissions of the Russian Federation 1990-2012. Carbonbrief 2015 with UNFCCC data.

LULUCF emissions changed from a net source to a net sink, which over the last decade has remained at a roughly constant magnitude of 0.5 Gt CO_2-eq per year. BAU projections from PBL et al. 2015 show a range under current policies from 2.175 to 2.77 Gt CO_2-eq 2030 without LULUCF. According to this, Russia is likely to achieve the INDC target even without any sinks from LULUCF. Adding

LULUCF makes it even more likely that the emissions target will be met without reductions from BAU. The Climate Action Tracker 2015 expects emissions under current policies including LULUCF to be 39-40% below 1990 levels in 2030, thus lower than the Russian target range.

Despite the important role LULUCF plays for Russia's emissions, LULUCF accounting rules are not further specified in the INDC, except for the announcement to consider sinks at the "maximum possible account".

The INDC makes reference to the Presidential Decree of 2013 and legislation from the Government of 2014, which implemented policies to achieve a domestic GHG emissions target of a reduction of 25% relative to 1990 levels in 2020. This corresponds to the upper end of the Copenhagen pledge (-15 to -25%). According to the Presidential Decree, Russia intends to achieve in 2020 the same emissions level as indicated in the INDC for 2030.

3.15.4 Underlying effort

Since the Russian INDC does not imply reductions from business as usual emissions, there is no additional effort required in order to achieve the target. In addition, the ongoing recession attenuates current emissions growth.

Russia has sizeable amounts of surplus Assigned Amount Units (AAUs) from the Kyoto Protocol´s 1st Commitment Period (2008-2012). These could be in an order of magnitude of 5.8 Gt (Pointcarbon 2012). However, as Russia does not participate in the 2nd Commitment Period (2013-2020) of the Kyoto Protocol, it has little leverage to lobby for the eligibility of its surplus AAUs.

3.15.5 Comparison to Switzerland

In contrast to Switzerland, the Russian INDC target can most likely be achieved without a change of current policies.

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3.16 Singapore

3.16.1 Brief description of the INDC

Singapore intends to reduce GHG emissions intensity by 36% in 2030 compared to 2005 (from 0.176 kg CO_2-eq/S$ to 0.113 kg CO_2-eq/S$ at 2010 prices). Furthermore, its emissions shall be stabilized with the aim of peaking around 2030. Although the INDC is intended to be implemented domestically, Singapore will "study the potential of international mechanisms". The INDC was submitted on July 3rd, 2015.

3.16.2 Further characteristics

The INDC encompasses the sectors Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land-Use Change and Forestry, and Waste and includes six GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6). The first three GHGs are aggregated following the 1996 IPCC Inventory Guidelines, while the other three GHG inventories are derived according to the 2006 IPCC Guidelines. The INDC shall be implemented between 2021 and 2030.

3.16.3 Significance of the INDC

Singapore's formulated GHG emissions intensity target signifies a shift away from a "below BAU"-form. The latter had been used for the 2020 pledge submitted under the Copenhagen Accord. For 2020, Singapore had pledged an unconditional reduction to 7-11% below BAU levels, which we deemed as lacking "clear signals of climate policy ambition" (Econability 2014).

Singapore's economy has been marked by strong growth in the past decades. From 1990 until 2005, real GDP grew by almost 153% (World Development Indicators 2015). During the same period, GHG emissions increased by 47% (CAIT 2015). Consequently, the INDC's targeted variable, emissions intensity, has already seen improvements by 42% between 1990 and 2005. With the year 2005 being the point of reference for Singapore's INDC, it has to be considered that emissions intensity has further improved since. Indeed, of the targeted 36% decrease until 2030, almost half has already been accomplished (17.5%) between 2005 and 2010 using the officially communicated emission values (National Environment Agency 2014; Department of Statistics Singapore). According to the World Resources Institute's (CAIT 2015) GHG emissions data, a 22% emissions intensity reduction since 2005 has been achieved until 2012 (see Figure 10). With a large share of the INDC target already fulfilled, it is thus likely that it will already be fully reached even before 2021, the starting date for target implementation.

With regard to transparency, the reference levels for the emissions intensity target are provided in the INDC. However, the mentioned source for the absolute emissions level, Singapore's 3rd National Communication from 2014, only depicts this value in a graph with coarse GHG emissions resolution (National Environment Agency 2014). Furthermore, the GHG reference emissions level of 40.9 Mt CO_2-eq strongly deviates from 2005 emission levels provided by other sources; CAIT 2015 offers 47.46 Mt CO_2-eq, and EDGAR 2015 reports 47.60 Mt CO_2-eq. For 2010, the most recent data published in Singapore's NC, the gap persists: The officially communicated 46.83 Mt CO_2-eq compare to 54.62 Mt CO_2-eq (CAIT) and 52.73 Mt CO_2-eq (EDGAR). Other than the previously mentioned

National Communication, Singapore does not officially publish regular GHG emissions time series. Consequently, the transparency of the INDC is somewhat impaired, as the progress towards the target cannot be easily tracked.

When estimating the implications of the INDC for absolute emission levels, the future development of the GDP has to be projected. To this end, two different sources are considered: IMF 2015 offers growth projections up until 2020. If we extend these projections with the OECD's 2012 low end estimate for Singapore's 2020-2030 GDP growth rates, this results in a GDP of 558 mio S$ in 2030 (at 2010 prices). Given the emissions intensity target value in the INDC, Singapore would project to at most emit 63 Mt CO_2-eq. This estimate is similar to the 65 Mt CO_2-eq which are stated in a footnote of the INDC as the level at which Singapore's emissions are expected to stabilize. 65 Mt CO_2-eq correspond to an increase of more than 38% compared to the official 2010 emissions level. These values have to be interpreted with caution, because of the uncertainty adherent to long-term economic growth forecasts.

Figure 10 illustrates the implications of the pledge on both emissions intensity and absolute emissions. Even under modest growth assumptions, the INDC's intensity target allows to further increase absolute emissions. Furthermore, the intensity target does not look ambitious compared to the historic trend. In summary, Singapore's INDC emissions intensity target is unlikely to contribute to a substantial modification of Singapore's GHG emissions growth trend. The same applies to the rather vague objective of peaking around 2030.

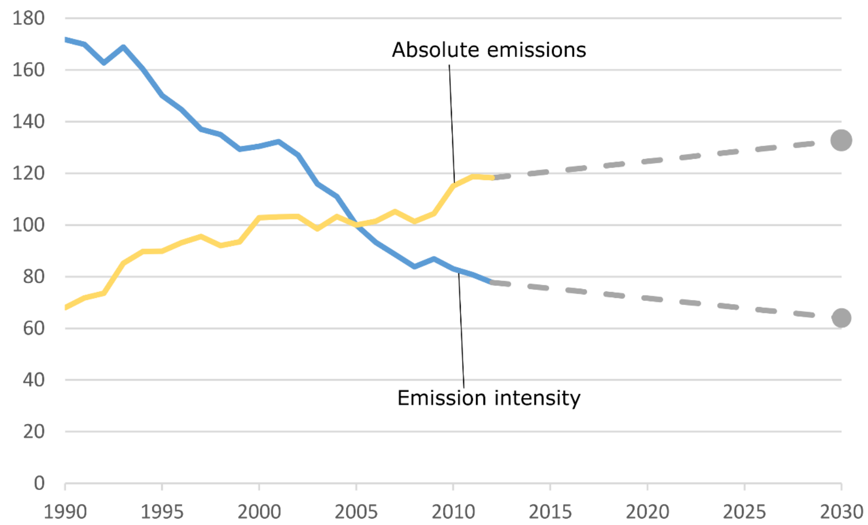

Figure 10: Development of Singapore's GHG emissions intensity (blue line) and absolute GHG emission levels (yellow line, both indexed at 2005=100). The grey points depict the INDC emissions intensity target (bottom) and the estimated implied absolute emission level (top). CAIT 2015 and World Development Indicators 2015.

3.16.4 Underlying effort

Due to the reasons outlined in the previous section, Singapore's INDC is unlikely to require any additional effort. For reasons of topography and economic structure, Singapore argues that it has somewhat limited potential for future large-scale emission reductions. A major emitter of GHGs in Singapore is its petrochemical industry. In fact, Singapore is among the world's largest oil refining centers.

The showcase climate related structural change in Singapore is the shift in electricity production. From purely oil driven in the mid-1980s, Singapore has switched predominantly to the less carbon-intensive gas combustion today (≈84% in 2012; World Development Indicators 2015). According to Singapore's National Climate Change Secretariat, the possibility for Singapore to start producing electricity from renewable sources on a large scale is limited due to a lack of the corresponding natural resources (NCCS 2013). There are exceptions, most notably solar power, which has favorable conditions. Indeed, PV capacity has increased in recent years, and the Government estimates that renewable energy "could potentially contribute up to 8% of Singapore's peak electricity demand", as the INDC states.

3.16.5 Comparison to Switzerland

While Switzerland's and Singapore's economies do have similarities, there are also substantial differences in economic structure which influence mitigation potentials. Most importantly, the petrochemical industry in Singapore is of great importance, and the electricity mix cannot rely on hydropower due to topographic reasons. Nonetheless, the ambition and the required effort of Switzerland's INDC can be rated as considerably higher than Singapore's, mostly because Singapore's emissions intensity target under the INDC can likely be met with currently implemented policies.

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3.17 South Africa

3.17.1 Brief description of the INDC

According to South Africa's INDC dated 25 September 2015, emissions by 2025 and 2030 will be in a range between 398 and 614 Mt CO_2-eq. The INDC is based on the assumption of the finalization of an ambitious, fair, effective and binding multilateral agreement under the UNFCCC at the 21st Conference of the Parties. It also assumes that the extent to which developing countries implement their commitments will depend on the effective implementation of developed countries of their commitments under the Convention.

3.17.2 Further characteristics

South Africa's INDC covers all sectors and six GHGs. In comparison to the Copenhagen pledge, South Africa has moved from a "below BAU"-target to a "peak, plateau and decline"-trajectory. This translates the intention of letting the emissions peak between 2020 and 2025, after which an emission plateau for approximately a decade is planned, before emissions finally start to decline.

3.17.3 Significance of the INDC

This approach is consistent with what was first formulated in the "National Climate Change White Paper", which was published by South Africa's Government in 2011. According to this publication, the emissions will start to decline after 2036 and ultimately reach 212-428 Mt CO_2-eq in 2050. Consequently, the 2025-2030 INDC falls into the "plateau" period of South Africa's envisaged emissions trajectory; South Africa states that in 2025 and 2030, GHG emissions shall reach between 398 and 614 Mt CO_2-eq. The targeted range is large, as the upper end is 54% above the lower end, and therefore uncertainty as to the significance of the target is high. The great difference between reaching the upper and the lower end of the INDC is further underlined by the following facts:

- The upper end of the INDC still lies within the range of BAU scenarios by independent institutions, while the lower end is significantly below them (30-60% reduction compared to the available BAU scenarios).
- The 614 Mt CO_2-eq at the upper end of the range would allow South Africa to increase per capita emissions by 15%, while reaching the lower end of the pledge would see a decrease of per capita emissions by 25% compared to 2012[12].
- The upper end of the pledge would allow South African emissions to increase by 32% compared to 2012, while the lower end would require a reduction of 14%.

The significance of the pledge also depends on economic development. In recent years, South Africa's growth has slowed and prompted economic forecasts to be subdued. For example, the IMF significantly lowered its projections for South Africa in October 2015 compared to April 2015, resulting in a projection for the 2020 GDP which is more than 2% lower (IMF 2015). If this trend of

[12] Calculated with 2030 population projections from the World Population Prospects by the United Nations Population Division (UNPD 2015).

slow growth persists, the significance of the INDC target will be diluted, as the BAU scenarios would also need according adjustment.

In conclusion, the significance of the INDC strongly depends on which end of the given range is considered. The lower end will likely require substantial emission cuts. However, as the upper end might require little or even no action, we consider the INDC much less ambitious than South Africa's Copenhagen pledge.

3.17.4 Underlying effort

As outlined in the previous section, the amount of required action is uncertain due to the INDC's large target range. Thereof independent, South Africa possesses favorable climate mitigation opportunities:

- Partially fostered by low electricity costs, South Africa's industrial energy efficiency is low; among the top 20 emitters, only Russia displays a higher value. Research has shown that the industrial sector offers some economical mitigation potentials. According to a static CGE modeling approach by Moyo & Labintan 2013, which focuses on electrical efficiency in the industrial sector, a 25% improvement would not only reduce the country's CO_2 emissions by 3.2% compared to BAU, but also increase GDP by 0.42%. In Fekete et al. 2013, the emissions reduction potential from an increase in industrial no-regret energy efficiency improvements is estimated at 61 Mt CO_2-eq until 2020 alone (13% of 2012 emissions).
- Electricity is generated almost entirely from coal (94% in 2012), while renewable energy capacities are barely deployed (1%; World Development Indicators 2015). This makes electricity generation the country's dominant source of GHG emissions. A public tender program for renewable energy has been put in place with the aim of installing 20 GW of renewable energy generation capacity by 2030. The program has been deemed highly effective, and the aim of installing 3'725 MW until 2016 is expected to be surpassed (Department of Energy 2015). Another study by Merven et al. 2014 finds that the electricity sector could reduce its CO_2 emissions significantly (-33% relative to 2010) with the help of a renewable energy program at a cost of 1.46% of GDP in 2040. The model predicts the effectiveness of a carbon tax to be lower: -5% emissions in the power sector at a cost of 0.72% of GDP.

3.17.5 Comparison to Switzerland

Due to the large range given in the INDC, a single rating of South Africa's INDC would fall short of grasping the large variety of offered outcomes. Reaching the upper end of the target will require little action and would clearly not be in line with Switzerland's effort under the INDC.

Considering the high emissions intensity and large economical abatement potentials in South Africa, even the more ambitious end of the target range is unlikely to imply considerable macroeconomic costs. However, the related political and administrative challenge to implement the required measures could be tremendous, if this higher mitigation target is pursued.

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3.18 USA

3.18.1 Brief description of the INDC

According to its INDC from March 31st, 2015, the USA intends to achieve a reduction of GHG emissions by 26-28% below 2005 levels in 2025. Best efforts will be made to achieve the upper bound of the reduction range. The use of international mechanisms is ruled out "at this time".

3.18.2 Further characteristics

The INDC covers seven GHGs included in the 2014 Inventory of the United States Greenhouse Gas Emissions and Sinks, and all IPCC sectors. This comprises LULUCF emissions, which are accounted for by applying a net-net approach, and a "production approach" to account for harvested wood products consistent with IPCC guidance. The US Government reserves the right to deduct emissions from natural disturbances.

3.18.3 Significance of the INDC

Compared to independent BAU projections, the INDC of the USA implies substantial reductions. It cannot be achieved by current policies. The INDC target corresponds to an emissions range of 4.925-5.062 Gt CO_2-eq in 2025 (excluding LULUCF; with data from CAIT 2015). BAU calculations by the International Energy Agency (IEA 2014) and the U.S. Energy Information Administration (EIA 2013), which we supplemented with U.S. non-CO_2 emissions estimations in order to obtain total GHG emissions for 2025, show considerably higher numbers. The respective BAU emissions for 2025 are between 0% and 3% above 2005 levels. Thus, the INDC target of -26% to -28% translates into reductions relative to BAU of about the same percentage. Similar results can be extracted from PBL et al. 2015 and the Climate Action Tracker 2015.

Under the Copenhagen Accord, the USA pledged a reduction of GHG emissions by 17% relative to 2005 in 2020. The INDC represents more than a prolongation of the emissions trajectory path needed to reach that target. Achieving the INDC goal will require reductions that go beyond the demands of the Copenhagen pledge, which we rated as "possibly minor" (Econability 2014).

Uncertainties from LULUCF accounting had been crucial for the evaluation of the Copenhagen pledge. The INDC refers for the "land sector" to accounting rules of the 2014 US Inventory: "Consistent with IPCC Good Practice, the United States has continued to improve its land sector greenhouse gas reporting, which involves updating its methodologies. The base year and target for the U.S. INDC were established on the basis of the methodologies used for the land sector in the 2014 Inventory of United States Greenhouse Gas Emissions and Sinks and the United States 2014 Biennial Report." Thus, a methodology has been defined, and IPCC Good Practice Guidance is mentioned. It is not clearly predictable, however, how closely IPCC guidance will be followed in future US inventories. Generally, the USA seems to emphasize the use of methods applied in its own inventory: "*Relationship with inventory*: This approach, and the definitions and metrics used, are fully consistent with our greenhouse gas inventory. The United States intends to continue to improve its greenhouse gas inventory over time, and may incorporate these improvements into its intended nationally determined contribution accordingly."

For the USA, the LULUCF sector is a carbon sink. The Sixth National Communication projects for 2025 a range from 573 to 917 Mt CO_2-eq (U.S. Department of State 2014). This may serve as an indication of the maximum degree of uncertainty which could be imposed by issues in emissions accounting. Since the proposed emissions reduction of all sectors in 2025 is higher than in the Copenhagen pledge, the relative significance of the LULUCF uncertainty is possibly minor in the case of the INDC. The Climate Action Tracker estimates the uncertainty at +/- 2% of total emissions.

Applying the production approach means that emissions of imported harvested wood products (HWP) are assigned to the exporting country. Without a uniform ruling on the international level, there is a risk that emissions from HWP are not fully covered.

The intention “at this time” not to use international market mechanisms to meet the target may be considered as a tightening of requirements, since this was not contained in the Copenhagen pledge. However, it is noteworthy that the USA lack a legal framework at the federal level for the use of international carbon credits. This already makes the Copenhagen pledge almost purely a domestic target, except that individual States may purchase international carbon credits.

3.18.4 Underlying effort

High per capita emissions and large energy efficiency potentials, e.g. in the buildings sector, suggest that the USA exhibit very substantial no regret abatement potentials. The Deep Decarbonization Pathways Project (DDPP, Williams et al. 2014) investigates these potentials, searching for a pathway to a low carbon society in 2050, with an 80% GHG emissions reduction relative to 1990. Figure 11 shows that for such a pathway the largest part of emissions abatement has to be achieved in the restructuring of the power generation sector. This issue is being tackled by the Clean Power Plan. Its final version was issued by the Environmental Protection Agency in August 2015.

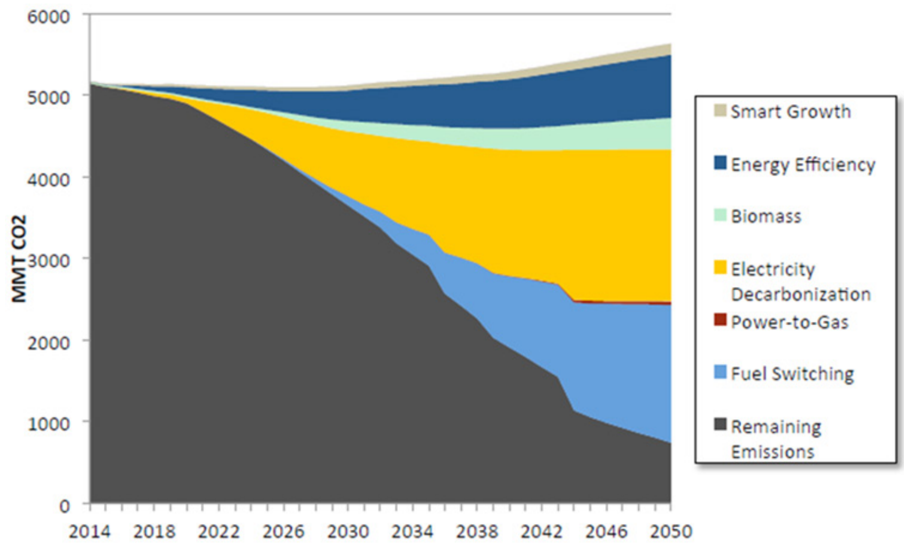

Figure 11: Reductions from Reference Case in Mixed Case Scenario – USA. Williams et al. 2014.

The DDPP emissions trajectories in Williams et al. 2014 suggest that the target of the INDC for 2025 (26-28% below 2005 levels) could roughly be in accordance with the deep decarbonization pathway until 2050. In the Mixed Case Scenario total, GHG emissions in the U.S. decrease by 25% relative to 2005 in 2025. This scenario represents for 2050 a balanced mix of technologies for electricity generation (renewables, nuclear and fossil fuels with CCS), a far-reaching fuel switch to electricity, natural gas and hydrogen, and the use of electricity and biomass for the generation of hydrogen and synthetic natural gas. The cost analysis is restricted to energy system costs, which include the incremental capital and operating costs of energy supply and end use infrastructure. The total cost in 2050 is roughly 1% of GDP (with a wide uncertainty range; Williams et al. 2014).

A similar conclusion is reached by the multi-model, top-down study EMF24, which investigates abatement costs of a reduction of the U.S. GHG emissions by 50% or 80% in 2050 relative to 2005. Clarke et al. 2014 comprises the results of nine energy-economic models including several CGE models. EMF24 puts special emphasis on the influence of different assumptions about technology improvements and availability. In the most pessimistic scenario and at a discount rate of 4%, cumulative economic costs through 2050 amount to 1 to 2 trillion US$ (of 2005) for the 50% reduction in the most pessimistic technology scenario. For the most optimistic scenario, the cost amounts to less than 1 trillion US$. The cost figures are translated into a GDP loss of 2 to 4% in the most pessimistic scenario and 0.5 to 1.5% under the most optimistic assumptions.

Both EMF24 and the DDPP comprise a considerable decarbonization of the electricity sector, which is considered a relatively low-cost abatement measure, because of the low diffusion level of renewables in the USA today.

There are studies that indicate substantial ancillary benefits of GHG abatement scenarios for public health. For example, Groosman et al. 2009 investigate the ancillary effects of GHG mitigation in the US transport and electric power sectors, taking into account six major air pollutants including NO_x, SO_2 and $PM_{2.5}$. For the period 2006 to 2030, they conclude that improvements in public health sum up to 90-725 bn. US$ (2006 US$) depending on three scenarios with varying abatement figures. The ancillary benefits per ton of GHG abated range from 1.4 US$ to 12.0 US$ (annual average of 2006-2030).

A recent study by Höhne et al. 2015 calculates the ancillary benefits of a change in US policies in order to fulfill the INDC target. Health effects are expressed by prevented premature deaths due to $PM_{2,5}$ pollution compared to the current policies scenario. By 2030, 7'000 avoided annual premature deaths are estimated.

Although attractive mitigation potentials exist in the US economy, the substantial reductions implied by the INDC may not be achieved without cost. However, the studies reviewed here show relatively wide ranges of results and need to be interpreted with appropriate caution. Adding ancillary benefits to the picture indicates that the society as a whole may face a lower cost.

3.18.5 Comparison to Switzerland

Both countries committed to INDCs that imply reductions from BAU. If the US target is implemented domestically, this could lead to a somewhat higher effort than for Switzerland's domestic target, announced in the press release issued along with the INDC, of -30% relative to 1990. This depends, however, on clarifications concerning LULUCF accounting.

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4 Conclusions

It is commendable that, among the 18 countries we investigated, more countries submitted significant GHG reduction targets in their INDCs than under the Copenhagen Accord. These targets imply, at least potentially, significant reductions compared to business as usual. This already indicated the greater interest in a significant global climate deal which led to the Paris Agreement. Especially, some OECD countries with very high per capita emissions – such as Australia, Canada and the USA – have (finally) submitted significant pledges. The 2030 targets for Switzerland, the EU, Mexico, South Korea, New Zealand, and especially Norway also deviate unambiguously from business as usual emissions.

On the other hand, some countries have submitted INDC targets which are weaker in terms of economic effort than their pledges under the Copenhagen Accord, considering that the countries have ten more years available to reach these new targets. The most important example is China, the largest emitter of GHG emissions worldwide. Furthermore, some of the countries which had issued particularly ambitious pledges under the Copenhagen Accord, have diminished their level of ambition. The salient examples are South Africa and South Korea. The Copenhagen Accord saw few very impressive pledges and many hardly significant pledges. The INDC targets seem more balanced, although several insignificant objectives have also been submitted.

This concerns India, Russia, Singapore and Chile, with India and Russia being numbers 4 and 5 on the global list of the largest GHG emitters. Furthermore, South Africa's less ambitious end of the targeted range does not imply GHG reductions with respect to business as usual. The list of insignificant targets would be longer, had we included more countries in the appraisal, e.g. countries situated on the Persian Gulf.

As a consequence, it is very unlikely that the pledged reductions under the INDC add up to a path which would be compatible with a rise in mean temperatures well below 2 degrees or even of 1.5 degrees Celsius above pre-industrial levels. Rather, this would require exceptional luck with respect to climate sensitivity or sizable negative emissions in the second half of the century, which will be hard to achieve and would most likely come at a large social cost.

Despite the rising sense of urgency in international climate policy, the submitting Governments were cautious to issue international commitments which could become expensive. In terms of implied economic cost, we do not consider any of the INDC targets to be exceptionally ambitious. After accounting for international mechanisms and ancillary benefits of mitigation, none of the reduction targets in the INDCs is likely to entail a mentionable welfare cost.

Certainly, the actual cost of the targets will depend on efficient policies, prices in international carbon markets, technical progress, economic growth and global peace until 2030. Due to the longer time horizon, baseline uncertainty affects these costs to an even larger extent than for the pledges under the Copenhagen Accord. In the favorable case, technical progress could help to achieve the INDC targets comfortably. The continuous improvements in energy efficiency, renewable energy cost, and electro-mobility may be accelerated by the implementation of the Paris Agreement. They also occur irrespective of international climate policy with important breakthroughs being likely in the period up to 2030.

Possibly reflecting the Governments' uncertain expectations concerning the climate negotiations, many INDC targets come with conditions attached relating to the level of ambition of the other countries. For similar or other reasons, most INDCs exhibit a considerable degree of vagueness. Switzerland, which submitted the first INDC by any country, set an important example for a clear and informative format, along with other early submitters, notably the EU, Norway and Mexico. Unfortunately, such standards were not followed by all countries. The varying formats and contents of the INDCs make comparisons difficult and leave much room for further interpretation and negotiations on stringency.

Especially, the sector land use, land use change and forestry (LULUCF) continues to be an important source of uncertainty, given that a general international agreement on LULUCF accounting rules for the post-2020 period is missing.

Another major source of uncertainty is the future set of arrangements for the international mechanisms. As a large majority of countries intends to realize at least a part of the emissions abatement abroad, it will be crucial that such reductions are – this time – real, additional and verifiable. It will be a difficult task to design international mechanisms that fulfill these requirements, given the many different forms which emission reduction commitments take in the INDCs. For most of the investigated countries, the intended use of international mechanisms leaves the share of domestic abatement unclear. There are important exceptions, however. With the USA and the European Union, two of the three biggest GHG emitters intend to realize the pledged abatement domestically.

Many countries who at least partially want to maintain the option to resort to international mechanisms mention or even emphasize domestic measures. Switzerland's official press statement, which was released along with the INDC, specifies that 30% of emissions reductions relative to 1990 levels must be achieved domestically, subject to approval by Parliament. A supplement to Brazil's INDC itemizes very considerable domestic measures concerning forest protection and afforestation. Furthermore, Brazil can be expected to continue being an important player on the supply side – rather than on the demand side – of the market mechanisms. Other countries who state their interest in hosting programs under market mechanisms underline implementation of mitigation measures independent of the realization of the market mechanisms. For example, Mexico clarifies that their unconditional pledge will be valid also in the absence of international mechanisms.

In summary, the INDC submissions as a whole are an improvement on the pledges under the Copenhagen Accord, both with respect to targeted emission reductions and the international balance between the pledges. Yet, total abatement under the targets is going to depend a lot on rules for international market mechanisms and LULUCF accounting. Also, the pledges remain unbalanced, because some of the biggest GHG emitters have issued insignificant INDC targets. Even for the significant pledges, the effort is probably going to be low, at least in terms of abatement costs when ancillary benefits are taken into account. Thus, the economic fundamentals leave room for a further intensification of abatement efforts, which natural scientists view as necessary for achieving global warming targets of 1.5 or well below 2 degrees Celsius.

Appendix A: Information in the INDCs concerning the sector land use, land use change and forestry (LULUCF)

	Objective		Method					Further information
	LULUCF incl-uded in overall objec-tive?	Separate LULUCF objec-tive?	Conform with IPCC 2006 guide-lines?	Conform with IPCC 2013 KP Supple-ment?	General approach	Natural disturbances	Harvested wood products	
Australia	yes	no	yes	yes	net-net, based on UNFCCC inventory categories	according to IPCC guidance	-	100 year Global Warming Potentials (GWPs) as contained in inventory reporting guidelines, IPCC Fourth Assessment Report 100 year GWPs, or as otherwise agreed.
Brazil	yes	yes	yes	-	inventory based approach	-	-	Brazil aims to achieve zero illegal deforestation by 2030 and compensate GHG emissions from "legal suppression of vegetation by 2030". It further aims to restore and reforest 12 million hectares of forest by 2030.
Canada	yes	no	yes	-	net-net	excluded	production approach	
Chile	no	yes	-	-	-	-	-	Forestry target: Restore around 100'000 ha of degraded forestation lands and manage an additional 100'000 ha of native forests by 2035.
China	yes	yes	-	-	-	-	-	Forestry target: Increase forest stock volume by 4.5 billion cubic meters compared to 2005 levels.
EU	yes	no	yes	yes	activity or land-based	-	-	How LULUCF is included will be established as soon as technical conditions allow and before 2020.
India	n/a	yes	-	-	-	-	-	Aims to create additional carbon sink of 2.5-3 billion tonnes CO_2-eq through additional forest by 2030.
Indone-sia	yes		yes	-	-	-	-	
Iran	n/a		yes	-	-	-	-	
Japan	yes	yes	-	-	-	-	-	Target for removals is set to 37 mio tCO_2 (27.8 t in forestry, 9.1 t in cropland and grazing land management and revegetation). Methodologies are in line with IPCC guidelines, but without mentioning of version. LULUCF removals accounted in line with approaches under Kyoto Protocol.
Korea, Rep. of	t.b.d. (see "Further inform-ation")	no	partly	-	-	-	-	Decision on inclusion of LULUCF will be made at later stage. 2006 IPCC guidelines are used to calculate GHG emissions from rice cultivation in agriculture (4C) and other waste (6D). Other than that, the 1996 IPCC guidelines are used.
Mexico	yes	yes	-	-	activity or land-based	-	-	LULUCF targets: Mexico aims to have zero deforestation by 2030 and to reforest certain watersheds. Reporting guidelines: "IPCC guidelines; national statistics: sector activity and economic forecasts."

	Objective		Method					Further information
	LULUCF incl-uded in overall objec-tive?	Separate LULUCF objec-tive?	Conform with IPCC 2006 guide-lines?	Conform with IPCC 2013 KP Supple-ment?	General approach	Natural disturbances	Harvested wood products	
New Zealand	yes	no	yes (see "Further Inform-ation")	yes (see "Further Inform-ation")	activity or land-based	accounting will include provisions to address natural disturbances.	production approach	Application of accounting methodologies that build on existing IPCC guidance where available (including the 2006 IPCC Guidelines and the 2013 IPCC Kyoto Protocol supplement).
Norway	yes	no	yes	-	comprehensive land-based	considers applying KP rules	considers applying KP rules	Final choice of land sector accounting shall not affect the ambition level compared to when the land sector is not included.
Russia	yes	no	yes	yes	-	-	-	
Saudi Arabia	n/a	no	no	-				
Singa-pore	yes	no	partly	-	-	-	-	Singapore has begun a program to monitor and report carbon storage and carbon fluxes related to LULUCF. Emissions or storage from LULUCF are expected to be small. Conformity with IPCC 1996 guidelines.
South Africa	yes	no	yes	-	-	-	-	
Switzer-land	yes	no	yes	yes	land-based with reference level; anticipates to switch to com-prehensive land-based approach	extraordinary events in forest land excluded		zero emissions anticipated in target year
Turkey	yes	yes	yes	yes	-	-	-	Forestry target: increase sink areas and prevent land degradation.
UAE	n/a	no	-	-	-	-	-	-
Ukraine	yes	no	yes	yes	-	-	-	An approach to including LULUCF in the climate change mitigation structure will be defined as soon as technical opportunities emerge, but no later than 2020.
USA	yes	no	-	-	net-net, based on US GHG inventory and its methods	may be excluded, consistent with IPCC guidance	production approach accord-ing to IPCC guidance	

Appendix B:
Fact sheets on the world's largest greenhouse gas (GHG) emitters and other countries of particular interest

Commissioned by: Federal Office for the Environment (FOEN), International Affairs Division, CH-3003 Bern.

The FOEN is an agency of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

Contractor: Econability F. Vöhringer.

Authors: Frank Vöhringer, Dario Stocker, Wolfgang Knoke.

Note: This study/report was prepared under contract to the Federal Office for the Environment (FOEN). The contractor bears sole responsibility for the content.

Date: 31 December 2015

Disclaimer:
These fact sheets illustrate currently available information on the Intended Nationally Determined Contributions (INDCs) submitted to the UNFCCC in 2015 of the world's largest greenhouse gas emitters and other countries of particular interest to Switzerland. The information has not been approved by the respective Governments. It is drawn from various sources and may include arguable or incomplete assumptions. Furthermore, the INDC targets of some Parties have uncertainties around the real expected emission reductions as the current international regime lacks common rules. The fact sheets have been produced by Econability F. Vöhringer with support provided by the Swiss Federal Office for the Environment FOEN. The content of the fact sheets has not been approved by the Swiss Government and does not prejudge the Swiss position in international climate negotiations.

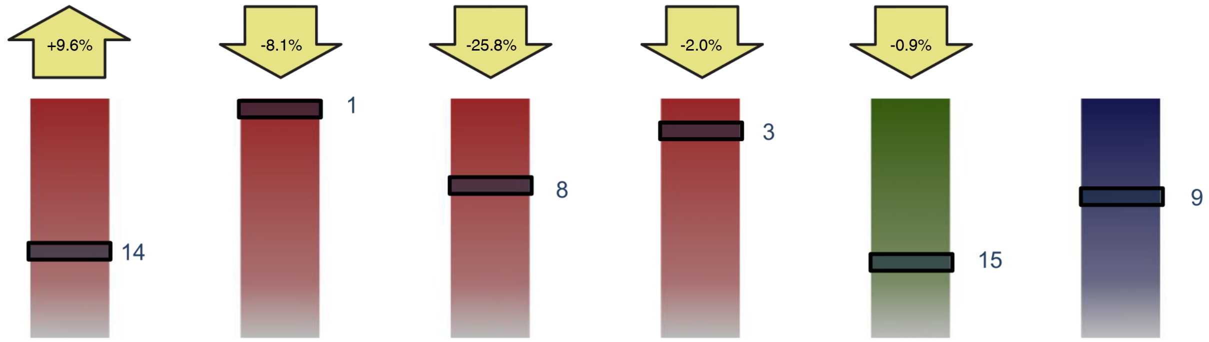
Australia

	Value°	Rank§
Population:	23 mio.	20
Annual population growth:	+1.7%	2
GDP per capita:	67'512 US$/capita	1
Fossil fuel resources:	2'583 tC/capita	1

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	648 Mt	30.1 t/cap	0.12 koe/$2005	89.9 %	19.2 %	1.48 US$/l
Change	+9.6%	-8.1%	-25.8%	-2.0%	-0.9%	
Rank	14	1	8	3	15	9

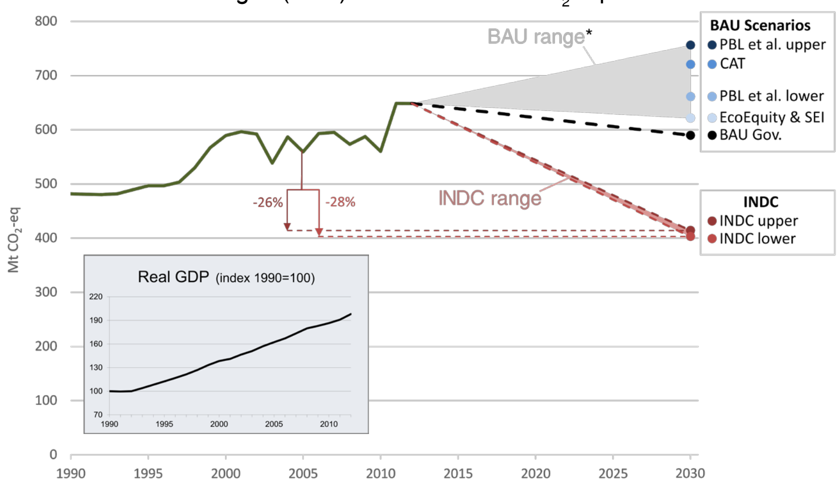


Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
\# incl. LULUCF
\+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* This graph excludes emissions from land use, land use change and forestry (LULUCF), even-though the INDC target includes them. PBL et al. business as usual (BAU) scenarios are given relative to 2010 and were calculated with data from the World Resources Institute. The BAU range excludes the Government BAU scenario. For sources of BAU projections see "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -26 to -28% GHG emissions relative to 2005 levels by 2030
- to be developed into an emissions budget covering the period 2021-2030
- target represents projected cuts of 50-52% in GHG emissions per capita by 2030 and 64-65% per unit of GDP by 2030

DOMESTIC POLICIES

Australia introduced a carbon tax for large emitters (> 25'000 t CO_2-eq/year) of AUD 23 (about EUR 15) per ton of CO_2-eq starting July 2012, rising by 2.5% per year in real terms. This tax was to be replaced by an emissions trading scheme (ETS) in 2015, which was scheduled to be linked to the European ETS no later than 2018. However, in July 2014, the Australian Government decided to repeal the carbon tax and the ETS.

As replacement for the carbon tax and to help achieve the goal of 5% emission reduction compared to 2000 by 2020, an Emissions Reduction Fund was introduced, endowed with AUD 2.55bn (≈ EUR 1.64bn) for its first three years of operation. Designed as an incentive for voluntary climate action, it allows the Government to purchase emissions reduction credits from companies of different sectors including industry. Australia also set up non-financial incentives for businesses to reduce emissions, such as a carbon neutrality label.

Australia aims at raising the share of renewable sources in electricity to around 23.5% until 2015. Since 2010, electricity retailers need to purchase renewable energy certificates. A ban for light bulbs non-compliant with efficiency standards came into force in 2009. A Green Buildings Programme involving tax exemptions was adopted in 2012.

The Carbon Farming Initiative offers opportunities for farmers, landowners and forest growers to receive marketable carbon credits for storing carbon or reducing emissions. In addition, a biodiversity fund of 1 billion Australian Dollars exists.

On top of these national policies, there are also a number of state-level initiatives. For example, South Australia has set a target of increasing electricity generation from renewable sources to 50% by 2025.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

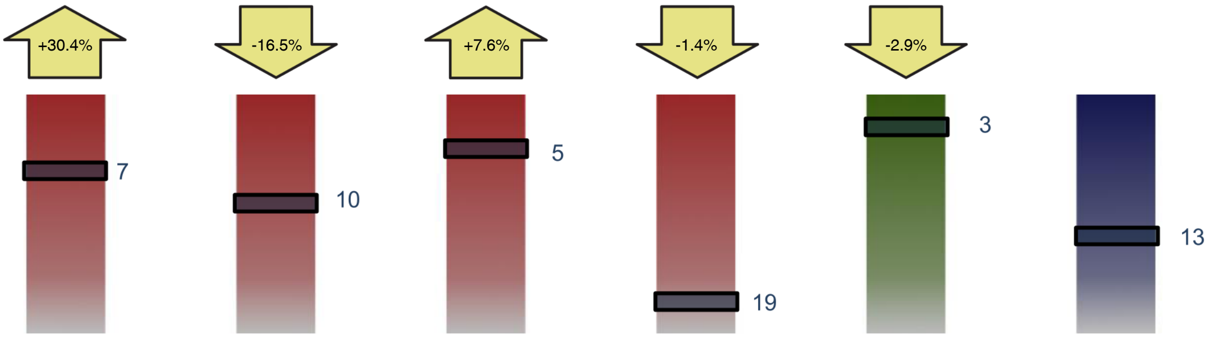
Brazil

	Value°	Rank§
Population:	199 mio.	7
Annual population growth:	+0.9%	10
GDP per capita:	12'148 US$/capita	13
Fossil fuel resources:	33 tC/capita	14

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	1'013 Mt	9.2 t/cap	0.16 koe/$2005	9.8 %	61.6 %	1.21 US$/l
Change	+30.4%	-16.5%	+7.6%	-1.4%	-2.9%	
Rank	7	10	5	19	3	13



Legend: Ranking among the 20 largest emitters

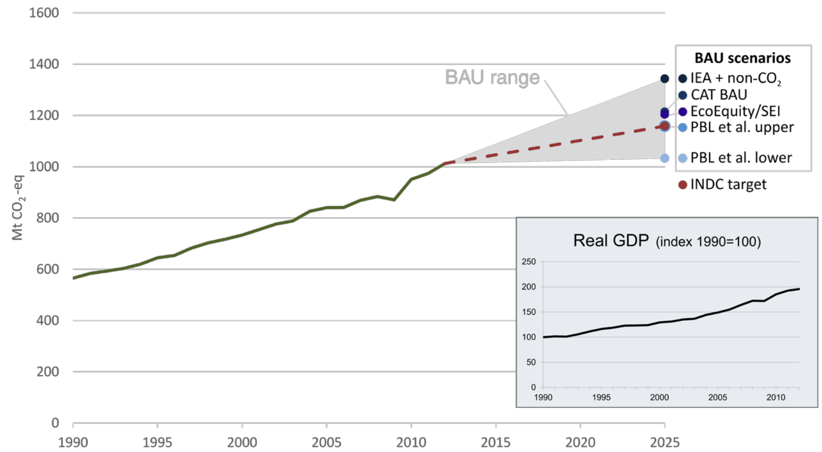
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* This graph excludes target emissions from land use, land use change and forestry (LULUCF), although they are crucial for the understanding of Brazil's INDC. The INDC target without LULUCF emissions as depicted in this graph is an estimation by the Climate Action Tracker. For sources of business as usual (BAU) scenario projections see "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -37% GHG emissions relative to 2005 levels by 2025
- -43% GHG emissions relative to 2005 levels by 2030 as "subsequent indicative contribution"
- possible use of international mechanisms
- supplemented "for clarification purposes only":
  - » GHG emissions intensity of GDP: -66% (2025) and -75% (2030) w.r.t. 2005
  - » per capita emissions: 6.2 tCO_2-eq (2025) and 5.4 tCO_2-eq (2030)
  - » zero illegal deforestation by 2030
  - » restoring and reforesting 12 mio ha of forests by 2030

DOMESTIC POLICIES

Brazil generates more than 80% of its electricity from renewable sources and aims at keeping this share until 2030. Hydropower is traditionally of great importance, and other renewable sources are projected to increase their share. Brazil is a key player in the development of biofuels. In 2008, bioethanol demand exceeded petrol demand. A biodiesel target is set at 20% for 2020.

In 2012, a scheme was approved under which business and residential consumers can earn credits for their electricity bill for feeding in excess photovoltaic electricity. Additionally, Brazilian utilities get a tax discount of 80% on electricity generated from solar power.

Energy efficiency policies include mandatory efficiency labels, energy efficiency standards for buildings and equipment, and energy efficiency programs targeting electricity and fossil fuels. Utilities are obliged to invest 0.25% of their revenues into measures to improve energy efficiency.

A main focus of the Brazilian climate policy is avoiding deforestation and reducing other net emissions from land use and land use change, since the related net emissions amounted to 61% of total GHG emissions in 2005. The National Plan on Climate Change from 2008 sets the goal to stepwise reduce deforestation; a reduction of 40% by 2009 compared to 2005 is followed by a 30% reduction every four years until 2017. Due to the vastness especially of the Amazon forests, nationwide enforcement of forest conservation laws is a major challenge. A reform of the forest code in 2012 has earned criticism by environmental NGOs for weakening forest protection.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

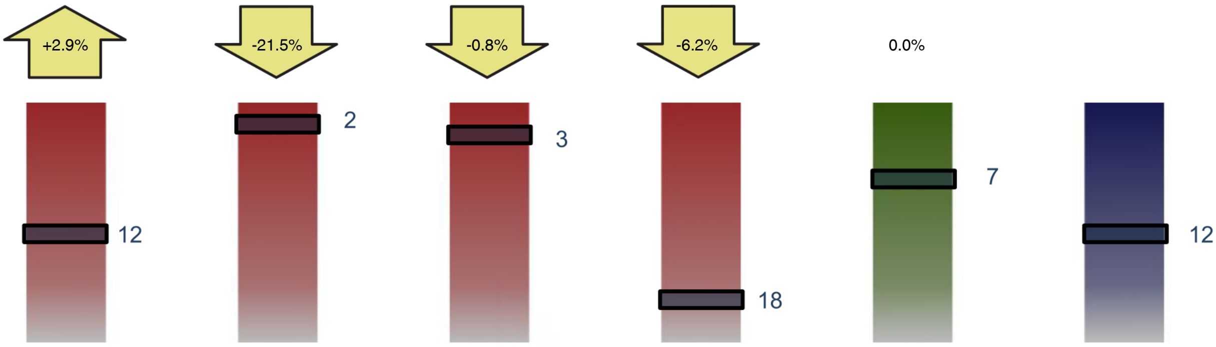
Canada

	Value°	Rank§
Population:	35 mio.	18
Annual population growth:	+1.2%	9
GDP per capita:	52'733 US$/capita	2
Fossil fuel resources:	787 tC/capita	4

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	714 Mt	24.6 t/cap	0.18 koe/$2005	22.8 %	34.1 %	1.28 US$/l



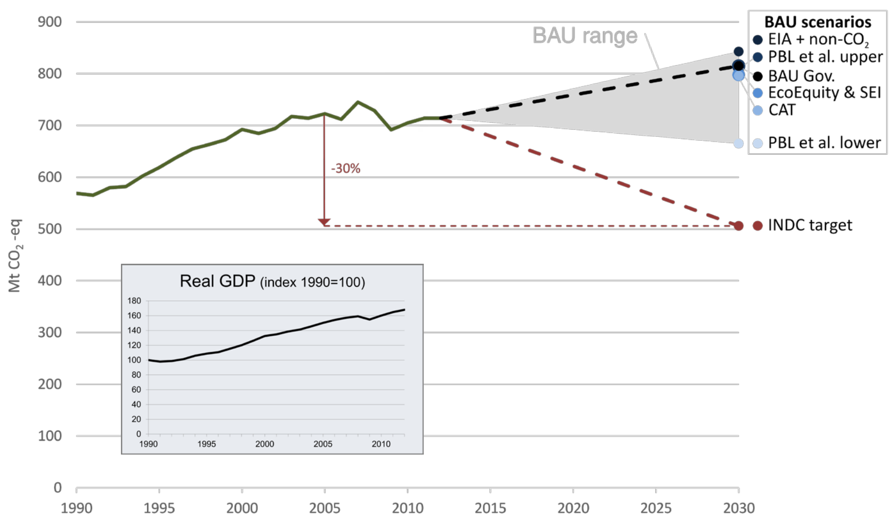
Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* This graph excludes emissions from land use, land use change and forestry (LULUCF), eventhough the INDC target includes them. For sources of business as usual (BAU) scenarios see "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -30% GHG emissions relative to 2005 levels by 2030
- international mechanisms may be used

DOMESTIC POLICIES

In December 2011, Canada withdrew from the Kyoto Protocol (KP) and repealed the Act that had been setup to implement the KP targets. Attempts to pass new comprehensive climate legislation had no success. Canada harmonizes its regulatory framework with the United States to avoid competitive disadvantages under the North American Free Trade Agreement (NAFTA).

Since 2010, Canada requires a minimum average renewable fuel content of 5%. In 2012, it implemented performance standards on coal-fired power plants. It is estimated that, as a consequence, 75% of coal-fired power plants will need to retrofit carbon capture and storage (CCS) to continue operations after 2025. Recently, tighter regulations for new heavy duty trucks, aligned with the US emission standards, have entered into effect.

Several Canadian Provinces introduced more ambitious climate legislation: There is a cap-and-trade emissions trading scheme in the three Provinces Ontario, Quebec, and British Columbia, which encompass about 75% of the Canadian population. British Columbia and Quebec also have a carbon tax and vehicle fuel efficiency standards that are aligned with Californian regulations. Ontario passed a Green Energy and Green Economy Act that promotes energy efficiency and renewables (through a feed-in tariff) with the targets to reduce emissions by 15% in 2020 and 80% in 2050 w.r.t. 1990. Alberta has set a target of reducing emissions intensity by 50% by 2050 by improving energy efficiency, introducing CCS and renewable energy. Nova Scotia has an absolute cap on emissions from electricity generation.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data. For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

Chile

	Value°	Rank§
Population:	17 mio.	below 20
Annual population growth:	+0.9%	btwn. 9 & 10
GDP per capita:	15'187 US$/capita	btwn. 11 & 12
Fossil fuel resources:	11 tC/capita	btwn. 15 & 16

§ relative to the 20 largest emitters (Chile is not one of them)

INDICATORS

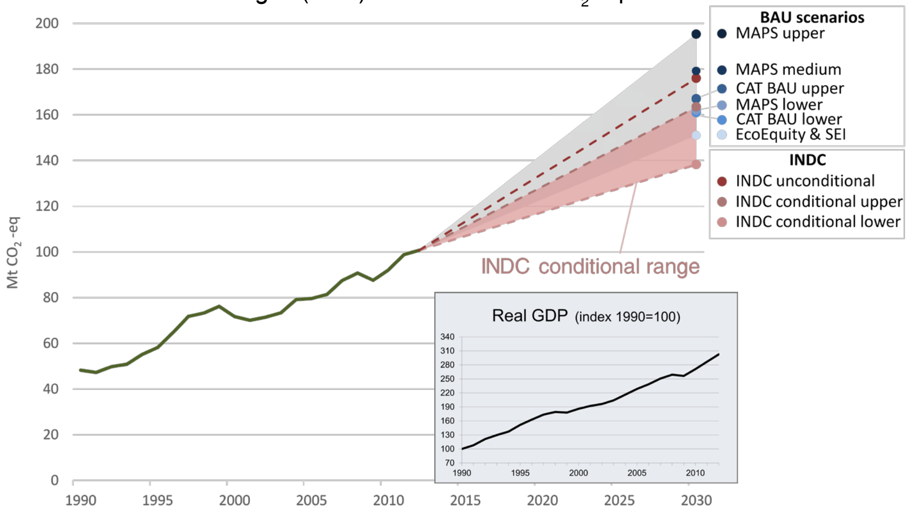
	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	101 Mt	5.4 t/cap	0.10 koe/$2005	60.4 %	21.9 %	1.40 US$/l
Change	+41.1%	+32.0%	-10.3%	+14.7%	+0.5%	
Rank	below 20	between 18 & 19	between 9 & 10	between 15 & 16	between 14 & 15	same as 10

Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC



* The absolute emission levels of the INDC targets are calculated with the minimum growth rate required for compliance (4.8% per annum, calculated from a statement in the INDC).
For sources of business as usual (BAU) scenario projections see "Sources for Country Fact Sheet Information". LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -30% of emissions intensity of GDP relative to 2007 by 2030, conditional on economic growth
- -35-40% of emissions intensity of GDP relative to 2007 in 2030 with an additional condition of foreign financing
- use of international mechanisms
- emissions from land use, land use change and forestry excluded from the intensity target
- separate targets for the forestry sector, e.g. afforestation of 100'000 ha

DOMESTIC POLICIES

A number of policies are in place that aim at increasing energy efficiency and the deployment of renewable energies; for the residential sector, these include minimum insulation requirements enacted starting from 2000, as well as feed-in tariffs for small electricity generation installations of up to 100 kW and tax credits for the installation of solar heating systems on new buildings.

Since 2010, electricity producers with an installed generation capacity of more than 200 MW are required to supply a minimum of 5% of the electricity from renewable sources. From 2015, this share will increase annually up to a level of 10% in 2024. There are laws that support concessions for explorative geothermal drilling.

The Chilean Government may negotiate voluntary clean production targets with specific units in selected economic sectors. Such targets have been agreed with units in agriculture, construction, tourism and mining. For the mining sector, which is of crucial importance for the Chilean economy, a voluntary working group was established in 2006 to encourage companies to discuss approaches regarding energy savings.

A carbon price, which will come into force in 2018, has been enacted in Chile for thermal power plants with a capacity of 50 MW and more at US$5 per tonne of CO_2.

Chile had a National Climate Change Action Plan for the period 2008-2012. It was among the first countries to present Nationally Appropriate Mitigation Actions (NAMAs) to the UNFCCC. In 2014, Chile presented a National Climate Change Adaptation Plan.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

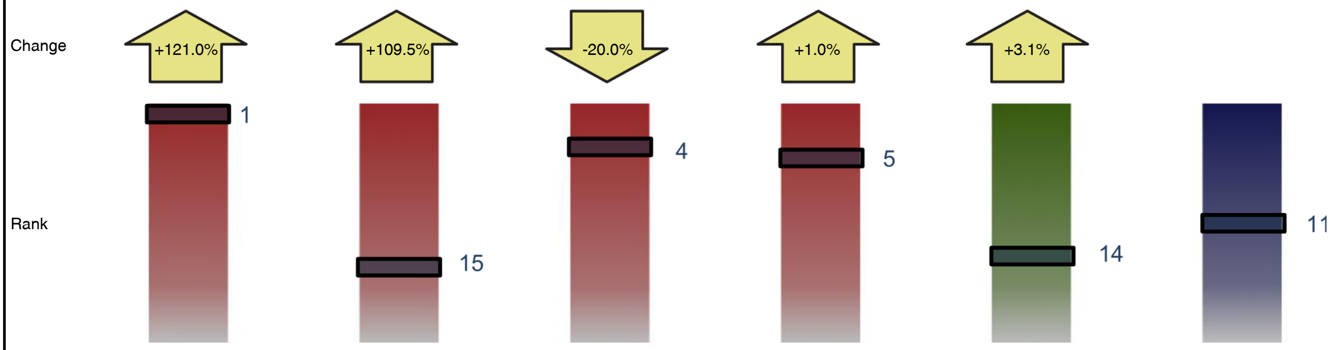
China

	Value°	Rank§
Population:	1'351 mio.	1
Annual population growth:	+0.5%	13
GDP per capita:	6'265 US$/capita	18
Fossil fuel resources:	65 tC/capita	12

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	10'975 Mt	7.9 t/cap	0.17 koe/$2005	80.9 %	22.6 %	1.33 US$/l
Change	+121.0%	+109.5%	-20.0%	+1.0%	+3.1%	
Rank	1	15	4	5	14	11



Legend: Ranking among the 20 largest emitters

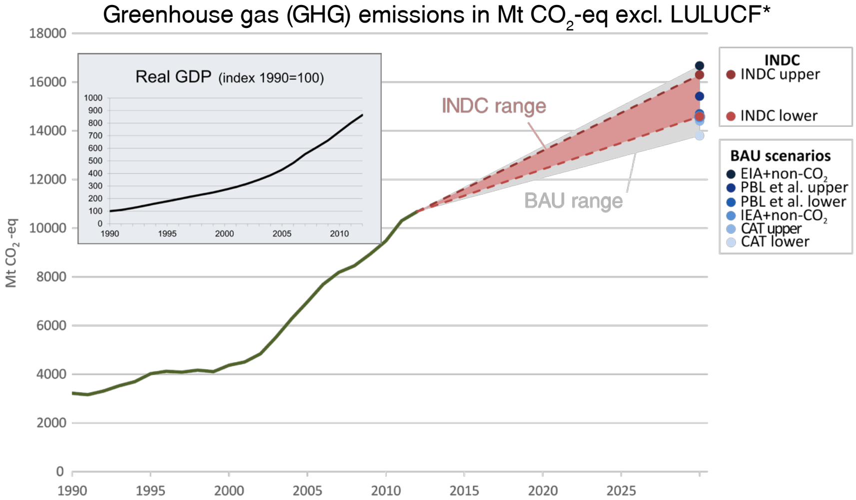
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The emissions of the INDC target are calculated using the GDP growth assumptions as stated for China in the World Energy Outlook 2014 by IEA. The INDC target only refers to CO_2 emissions. In this graph, however, other GHG emissions are included. This graph excludes emissions from land use, land use change and forestry (LULUCF), although the INDC target includes them. For sources of business as usual (BAU) projections see sheet "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -60 to -65% of CO_2 emissions intensity of GDP relative to 2005 by 2030
- CO_2 emissions to peak around 2030
- share of non-fossil fuels in primary energy consumption around 20% by 2030
- around 4.5 billion m³ increase of forest stock volume by 2030

DOMESTIC POLICIES

China adopted its first National Climate Change Programme in 2007 and a Climate Change Resolution in 2009. Existing climate-related laws focus on energy efficiency. China's 12th Five Year Plan (March 2011) formulates targets for carbon and energy intensity of GDP (reductions of 17% and 16%, respectively, by 2015 relative to 2010). According to data from the International Energy Agency, CO_2 emission intensity from energy-related emissions decreased by 14.6% between 2005 and 2010. The intensity targets of the Five Year Plan have been broken down to Provincial and Municipal levels. In 2012, the Shenzhen Special Economic Zone was the first in China to pass local legislation to reduce GHG emissions.

The 12th Five Year Plan also calls for an increase of non-fossil energy (from 8.3% in 2010 to 11.4% by 2015) as well as an extension of the forested area.

In 2014, China introduced an Energy Development Strategy Action Plan. It targets an increase of non-fossil fuels in the total primary energy mix to 15% by 2020 (from 9.8% in 2013) and puts a ceiling to annual coal consumption by 2020 (4.2bn tons compared to 3.6bn tons in 2013).

Several Provinces have launched pilot emissions trading systems in 2013. In September 2015, China announced plans for a carbon emissions cap-and-trade system, which will come into effect in 2017. It will pool regional carbon markets and will cover carbon-intensive industries, such as power generation, papermaking, and manufacturing of building materials, steel, chemicals and non-ferrous metals, although details on the coverage have not yet been disclosed.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability
Sustainable Economics in Research and Practice

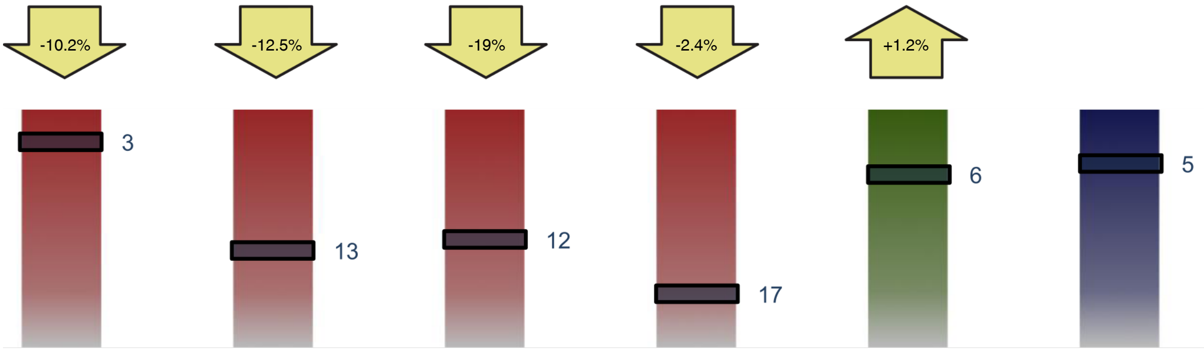
EU-28

	Value°	Rank§
Population:	505 mio.	3
Annual population growth:	-0.1%	18
GDP per capita:	34’115 US$/capita	9
Fossil fuel resources:	85 tC/capita	11

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	4'399 Mt	8.2 t/cap	0.09 koe/$2005	50.5 %	37.7 %	1.87 US$/l
Change	-10.2%	-12.5%	-19%	-2.4%	+1.2%	
Rank	3	13	12	17	6	5



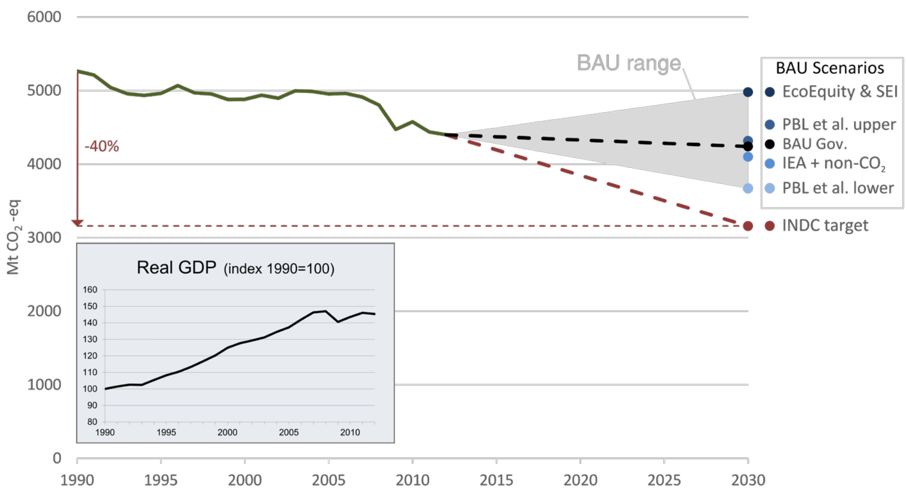
Legend: Ranking among the 20 largest emitters — % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The Government’s business as usual (BAU) scenario as included in the 6th National Communication to the UNFCCC (2014) includes existing measures. For sources of other BAU projections see sheet “Sources for Country Fact Sheet Information”.

Intended Nationally Determined Contribution (INDC):

- -40% GHG emissions relative to 1990 levels by 2030
- no use of international mechanisms

DOMESTIC POLICIES

For 2020, the EU has embraced the so-called “20-20-20”-targets; cutting the GHG emissions by 20% compared to 1990, increasing the renewable share in final energy use to 20% and increasing energy efficiency by 20%. These targets will be tightened for 2030: GHGs are to be reduced by 40%, while the renewable energy share and energy efficiency are both aimed to be increased by 27%. The EU possesses a long-term roadmap for a low-carbon economy, which sets out a path for GHG reductions up to 2050 in the order of 80-95% compared to 1990.

The EU Emissions Trading System (ETS) entered into force in 2005. The current third phase of the EU ETS (2013-2020) sets an EU-wide cap for emissions from large industrial sources and aviation. Covering about 45% of total GHG emissions, the cap is tightened by 1.74% per year until 2020. Auctioning is becoming the dominant allocation method. With the exception of aviation, its share in allocations will be between 70% and 100% in 2020, depending on the sector. The auctioning of 900 million allowances was postponed until 2019-2020 to raise allowance prices.

For non-ETS emissions, the Member States made quantitative reduction commitments for 2020 under an Effort Sharing Decision (ESD). While cutting non-ETS emissions by 10% compared to 2005, the ESD allows 13 countries to further increase their GHG emissions. The implementation of the targets under the ESD is fully yielded to the sovereign Member States of the European Union.

The EU has issued legal frameworks to promote renewable energy and sustainability of bioenergy supply. It regularly tightens emission performance standards for new passenger cars and light commercial vehicles.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: “Sources for Country Fact Sheet Information”

Econability — Sustainable Economics in Research and Practice

India

	Value°	Rank§
Population:	1'237 mio.	2
Annual population growth:	+1.3%	6
GDP per capita:	1'481 US$/capita	20
Fossil fuel resources:	37 tC/capita	13

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	3'014 Mt	2.3 t/cap	0.12 koe/$2005	79.4 %	23.1 %	1.06 US$/l
Change	+64.5%	+50.6%	-6.6%	-3.8%	+0.8%	
Rank	4	20	6	7	13	14

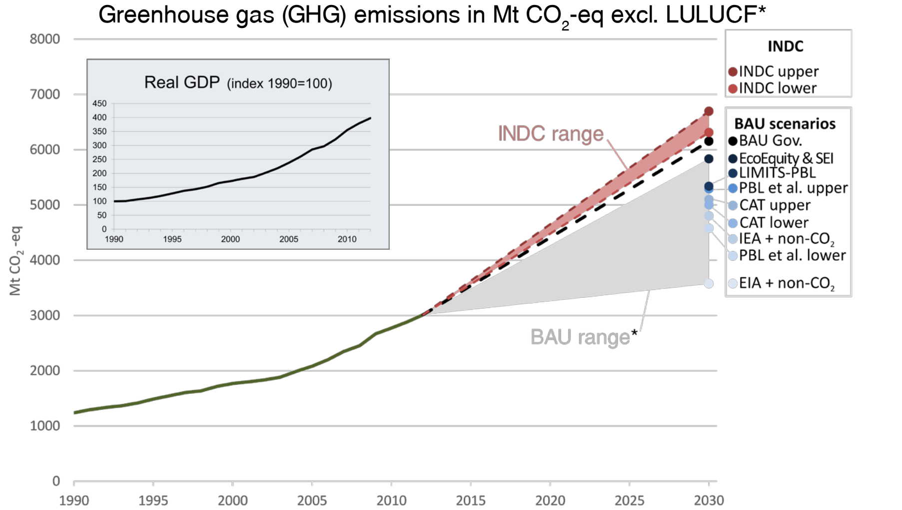
Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* PBL et al. and Limits-PBL only offered projections incl. LULUCF emissions. From these the Gov. projection for LULUCF has been subtracted. The absolute emissions under the INDC emissions intensity targets are calculated with OECD economic growth projections. Business as usual (BAU) scenario range excludes the Government BAU scenario. For sources of BAU scenarios see "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -33 to -35% of emissions intensity of GDP relative to 2005 by 2030
- +40% non-fossil fuel electric power capacity by 2030, conditional on technology transfer and low cost international finance
- +2.5-3.0 Gt CO_2-eq carbon sink through additional forest and tree cover by 2030

DOMESTIC POLICIES

The National Action Plan on Climate Change (NAPCC) from 2008 is structured into eight National Missions to be accomplished until 2017 including missions on Solar (increase photovoltaic capacity by 1 GW per year), Enhanced Energy Efficiency, Green India (increase forest cover from 23% to 33% of the territory), and Strategic Knowledge (research fund). India has announced a blending target for bio-diesel and bio-ethanol of 20% by 2017. In electricity generation, there are capacity targets for renewables of 175 GW by 2020 (100 GW of which are envisaged to be solar) and for nuclear energy of 63 GW by 2032. The renewable energy targets were orignally planned for 2022, but andvanced by two years in 2015.

Regulations and/or tax incentives address a number of relevant areas such as energy conservation in buildings, solar and wind power. The State Electricity Regulatory Commissions (SERCs) are obliged to purchase a minimum share of electricity from renewable sources. A trading system with Renewable Energy Certificates has been introduced to minimize the costs of these obligations. In 2010, India introduced a coal tax of 50 Rupees per ton (roughly 1 US$/t) with the revenues earmarked for a National Clean Energy Fund. This tax was increased to 200 Rupees in 2015.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data. For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

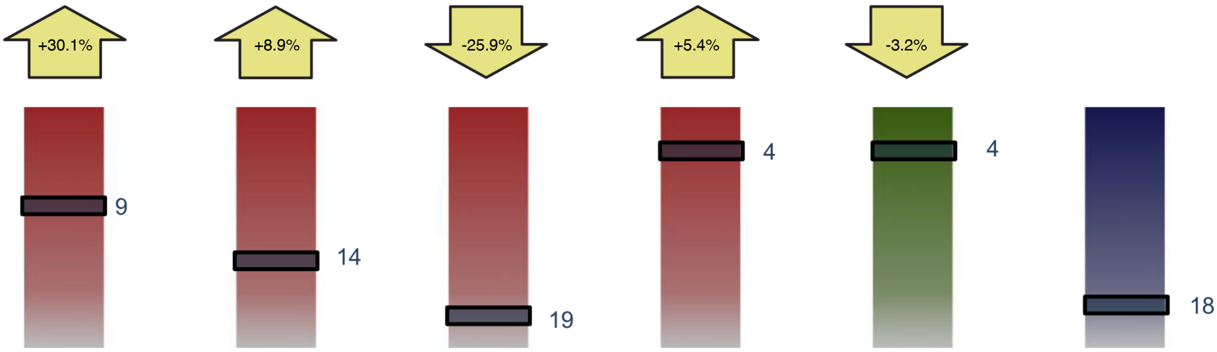
Indonesia

	Value°	Rank§
Population:	247 mio.	5
Annual population growth:	+1.2%	7
GDP per capita:	3'718 US$/capita	19
Fossil fuel resources:	93 tC/capita	9

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	761 Mt	8.0 t/cap	0.05 koe/$2005	87.9 %	51.4 %	0.47 US$/l
Change	+30.1%	+8.9%	-25.9%	+5.4%	-3.2%	
Rank	9	14	19	4	4	18



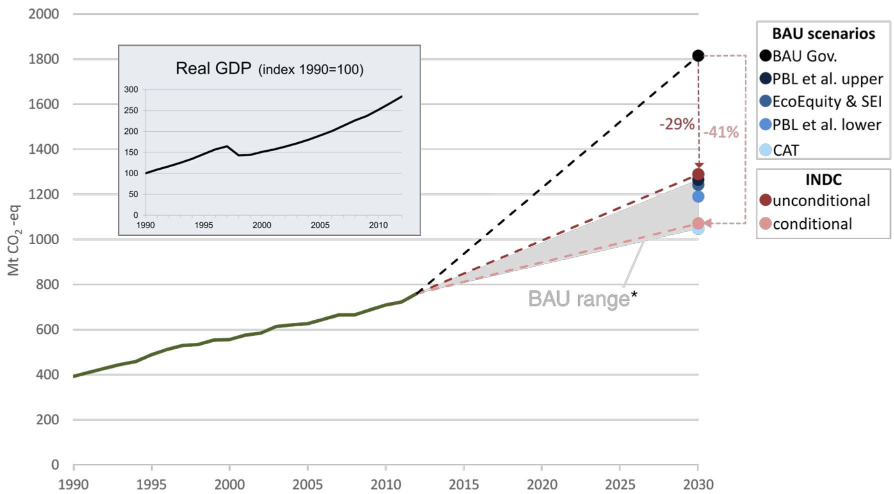
Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The INDC target emissions are calculated from the Government business as usual (BAU) excl. land use, land use change and forestry (LULUCF), the INDC, however, includes them. The BAU range excludes the Government BAU. For sources of BAU projections see sheet "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -29% GHG emissions relative to a business as usual (BAU) scenario in 2030
- up to -41% GHG emissions relative to BAU in 2030, conditional on international support
- gases covered: CO_2, CH_4, N_2O

DOMESTIC POLICIES

Deforestation and forest degradation is the main source of GHG emissions in Indonesia. Net emissions from land use, land use change and forestry accounted for 60% of GHG emissions in 2000. The majority of logging activities are illegal. In many cases, deforestation occurs on carbon-rich peat lands, leading to further carbon release, methane emissions and peat fires. Supported by Norway, Indonesia put a halt to the allocation of new forestry licenses and peat land development for two years starting in 2011. The moratorium was extended for an additional two years in 2013.

In 2015, the National Medium Term Development Plan was released, which sets the green economy as Indonesia's growth foundation. A target for GHG emission reduction from key sectors, such as forestry, agriculture, energy and transportation is included.

Indonesia has set a renewable energy target of 25% by 2025 and 31% by 2050. Increasing the capacity of geothermal energy is one important means to meet this target. The other is an objective to supply 5% of energy demand with biofuels in 2025. Opposition to these initiatives is coming from the potential conflict with forest conservation objectives: 80% of geothermal sources are located in conservation forests; in many cases, lands are deforested for palm oil plantations.

Indonesia grants tax exemptions and other fiscal incentives for imports of energy saving equipment. It also provides loans with reduced interest rates on investments in energy conservation. Further initiatives deal with restructuring prices, tariffs and taxes for various energy sources.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Iran

	Value°	Rank§
Population:	76 mio.	11
Annual population growth:	+1.3%	4
GDP per capita:	7'300 US$/capita	17
Fossil fuel resources:	472 tC/capita	6

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	715 Mt	9.3 t/cap	0.11 koe/$2005	94.7 %	6.8 %	0.23 US$/l
Change	+47.5%	+31.1%	+26.1%	-1.4%	0.0%	
Rank	11	9	9	1	19	19

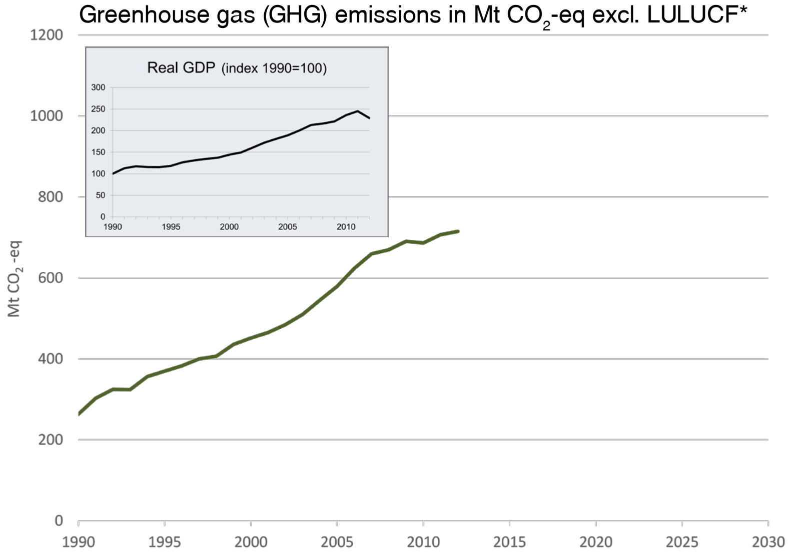
Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The INDC target cannot be represented in this graph. Due to a lack of information on the business as usual (BAU) scenario, absolute target emissions are unknown. LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -4% GHG emissions by 2030 compared to a business as usual (BAU) scenario
- -12% GHG emissions by 2030 compared to BAU, conditional on the termination of sanctions, financial support, technlogy transer, capacity building, etc.

DOMESTIC POLICIES

Iran encourages fuel substitution from oil to natural gas. It has the second largest natural gas reserves in the world.

The 5th Five-Year National Development Plan from 2009 encourages diversification of energy supply and sets the goal of a generation capacity of 5 GW of renewable energy by 2015. It creates the possibility for the Government to support renewable energy projects. A feed-in tariff for renewable energy has been established. Utilities are obliged to purchase renewable energy through long-term contracts.

Domestic energy prices are generally below world market prices, although recently some fuel prices have almost doubled. In 2013, the Ministry of Energy introduced a 30 IRR/kWh (0.1 UScent/kWh) fee on electricity. The revenue is designated to be exclusively used for renewable electricity and rural grid projects.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

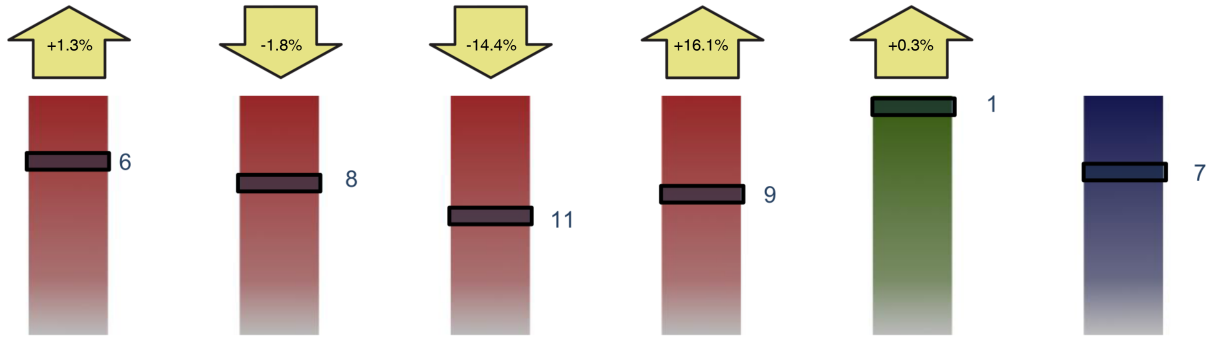
Japan

	Value°	Rank§
Population:	128 mio	8
Annual population growth:	-0.2%	19
GDP per capita:	46'679 US$/capita	4
Fossil fuel resources:	2 tC/capita	18

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	1'345 Mt	9.5 t/cap	0.09 koe/$2005	72.9 %	68.6 %	1.81 US$/l
Change	+1.3%	-1.8%	-14.4%	+16.1%	+0.3%	
Rank	6	8	11	9	1	7



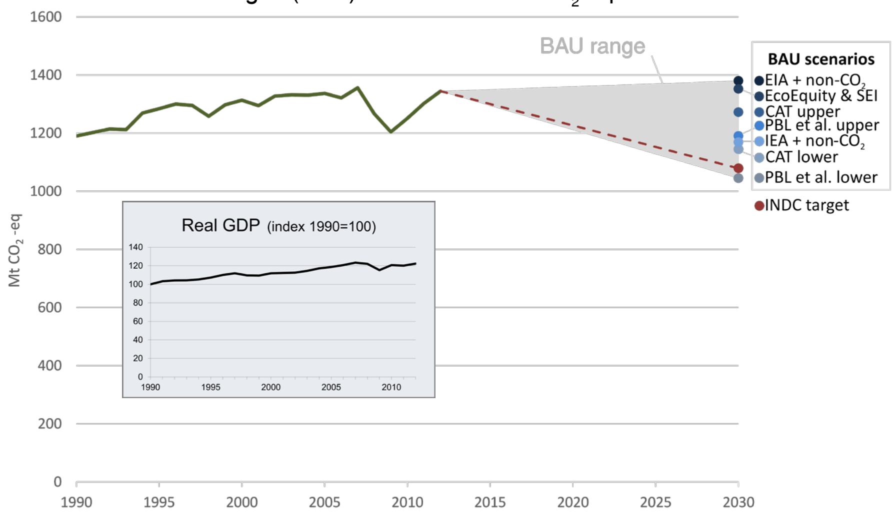
Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The graph excludes emissions from land use, land use change and forestry (LULUCF), eventhough the INDC target includes them. For sources of BAU projections see sheet "Sources for Country Fact Sheet Info".

Intended Nationally Determined Contribution (INDC):

- -26% GHG emissons relative to 2013 by 2030
- reductions and removals from the Joint Crediting Mechanism (JCM) included

DOMESTIC POLICIES

In 2012, a carbon tax on the use of fossil fuels was established. It adds to the pre-existing tax regime on crude oil and coal imports. The tax rates gradually increase, beginning in October 2012. By April 2016, it will reach JPY 289 (EUR 2.1) per ton of CO_2. It is intended to dedicate the revenue to measures aimed at reducing energy related CO_2 emissions.

A feed-in tariff scheme to promote electricity generation from renewable sources came into effect in July 2012. A mandatory emissions trading scheme for GHG emissions in the Tokyo Metropolitan Area was launched in 2010. Participation in an existing nationwide cap and trade system is voluntary.

The Energy Conservation Act of 1979 stipulated efficiency standards for vehicles, appliances and buildings. The legal framework was revised and strengthened in 2008. The Low Carbon City Promotion Act went into force in 2012 and aims at classifying buildings with respect to CO_2 emissions in order to provide incentives for energy savings.

In the aftermath of the 2011 earthquake, most nuclear power plants were shut down. In 2014, the Abe Administration announced a plan to reinstate nuclear power generation to the former level. Two reactors were restarted by October 2015.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

Korea, Rep. of

	Value°	Rank§
Population:	50 mio.	17
Annual population growth:	+0.5%	15
GDP per capita:	24'454 US$/capita	11
Fossil fuel resources:	1.8 tC/capita	19

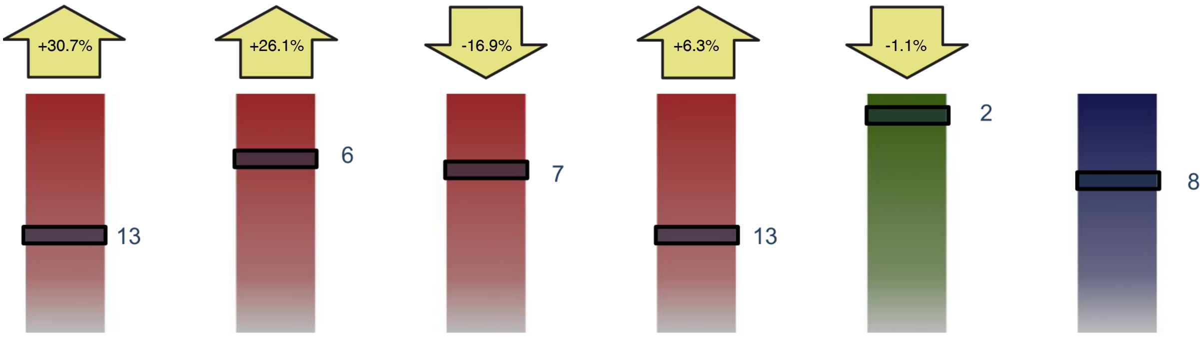
§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	693 Mt	13.2 t/cap	0.12 koe/$2005	68.6 %	63.8 %	1.72 US$/l

Change

Rank

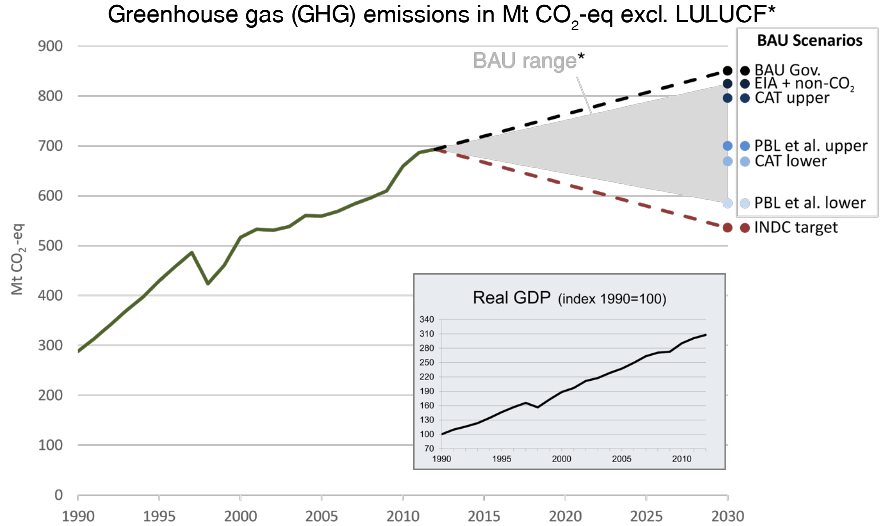


Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC



* The business as usual (BAU) scenario range only includes BAU scenarios from non-Government sources. Government BAU as included in the INDC includes existing measures. For sources of other BAU projections see sheet "Sources for Country Fact Sheet Info".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -37% GHG emissions relative to a business as usual scenario
- international mechanisms will partly be used
- inclusion of emissions from land use, land use exchange and forestry will be decided upon later

DOMESTIC POLICIES

The Energy Vision 2030 formulates the objectives to reduce energy intensity by 46% compared to 2007 and to achieve a renewable energy share of 11%. Policies include mandatory emission cuts for large emitters under the threat of penalties. In January 2014, the Ministry of the Environment announced the GHG Emissions Reduction Roadmap 2020, which includes abatement policies and measures in seven sectors (industry, transportation, buildings, public sector, agriculture, waste, and power generation).

In 2015, a domestic cap-and-trade emissions trading scheme (ETS), which follows the EU model, was launched. It covers about two thirds of national emissions and encompasses both direct and indirect emissions. The first phase is scheduled until 2017. During this first phase, all allowances are distributed free of charge and over-allocation seems to be an issue.

The electricity sector in Korea still relies heavily on fossil fuels, particularly coal. Therefore, a number of policies have been put in place to start tapping the large emission reduction potential in that sector; Korea used to possess a renewable energy feed-in tariff, which was superseded by the Renewable Portfolio Standard, which requires electricity suppliers to fulfil increasing generation ratios from renewable energies (10% in 2022). For the residential sector, subsidies for the installation of renewable energy equipment, such as PV panels or geothermal heat pumps, are available.

Korea has gradually put into effect fuel economy standards for passenger vehicles. Since 2015, all new cars are covered by this legislation. Starting from 2016, it will also be extended to light trucks.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Mexico

	Value°	Rank§
Population:	119 mio.	9
Annual population growth:	+1.2%	8
GDP per capita:	9'819 US$/capita	15
Fossil fuel resources:	19 tC/capita	15

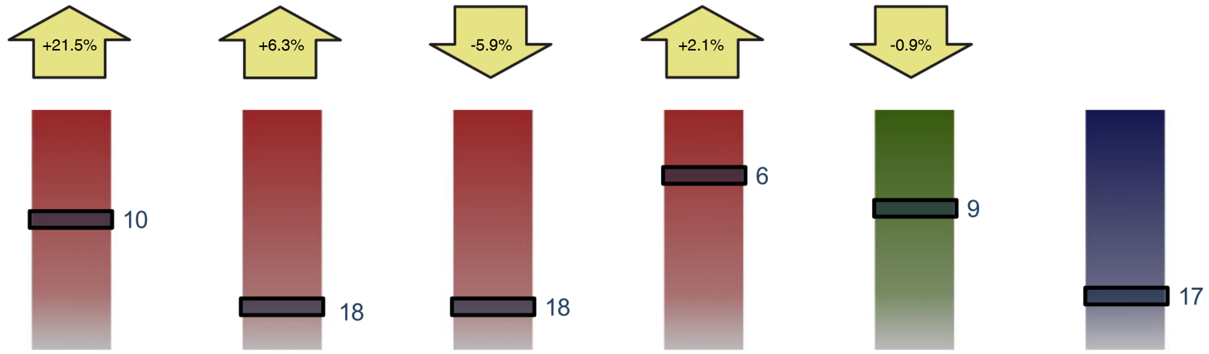
§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	724 Mt	6.2 t/cap	0.06 koe/$2005	80.7 %	33.2 %	0.86 US$/l

Change

Rank



Legend: Ranking among the 20 largest emitters

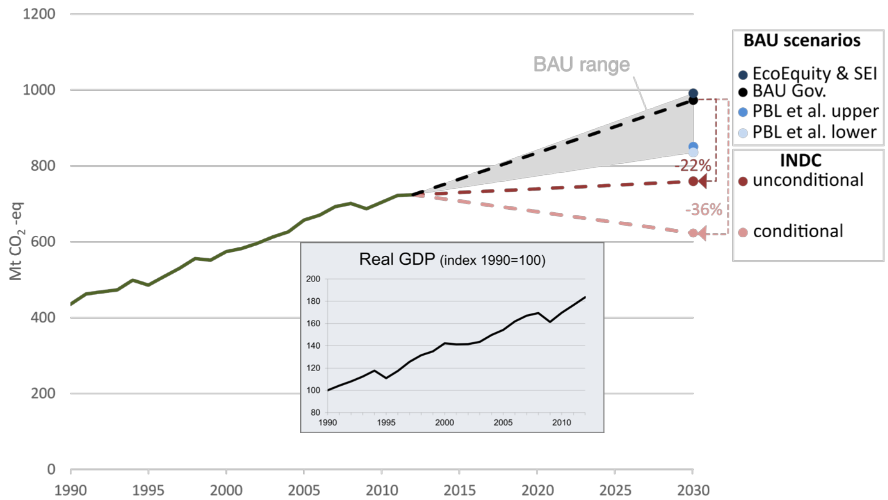
% increase/decrease over the last decade
(in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* For sources of business as usual (BAU) scenario projections see sheet "Sources for Country Fact Sheet Info".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -25% of GHG and Short Lived Climate Pollutants emissions relative to a business as usual scenario (BAU) in 2030
- the target implies:
  - » GHG emissions reduction relative to BAU in 2030: -22%
  - » around -40% of GHG emissions intensity from 2013 to 2030
  - » a net emissions peak starting from 2026
- -40% of GHG and Short Lived Climate Pollutants emissions relative to BAU (GHG emissions: -36%), conditional on international agreement with i.a. international market mechanisms and border tax adjustment

DOMESTIC POLICIES

The General Law on Climate Change was adopted in 2012. It entails institutional reforms and emphasizes adaptation. The 2013 National Climate Change Strategy formulates a 10-20-40 vision, which sets goals for the next 10, 20 and 40 years also for mitigation. Objectives for the next 10 years include 35% electricity generation from clean sources.

In 2007, a law was passed to promote bioenergy. In 2009, a renewable energy fund of 3 billion Mexican Pesos (about 225 million US$) was created. The Second Special Programme on Climate Change 2014-2018 contains strategies and measures required to achieve a 50% GHG emissions reduction in 2050 relative to 2000, including the increased deployment of renewable energies. In this respect, Mexico enacted a Special Programme for the Deployment of Renewable Energies that sets out a plan for reaching a 23% renewable energy share in electricity generation by 2018.

In 2014, Mexico introduced a carbon tax on fossil fuels, which can be avoided by the purchase of CDM credits.

Mexico has created a framework to prevent deforestation and forest degradation. The concept of Environmental Services Payments to forest owners is central in this respect, and it is connected to the international REDD+ mechanism, which Mexico has prepared itself for. Emphasis is made on the principle "who conserves is paid".

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

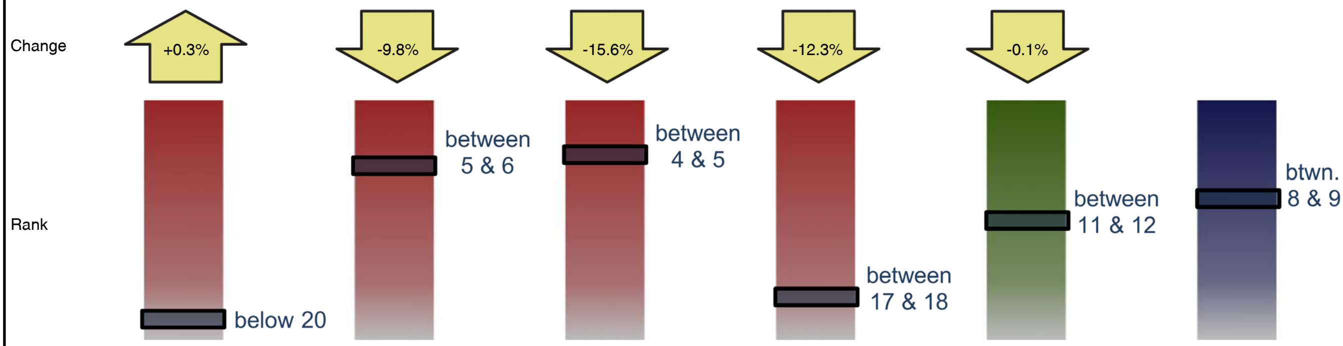
New Zealand

	Value°	Rank§
Population:	4 mio.	below 20
Annual population growth:	+0.5%	btwn. 12 & 13
GDP per capita:	39'574 US$/capita	btwn. 7 & 8
Fossil fuel resources:	102 tC/capita	btwn. 8 & 9

§ relative to the 20 largest emitters (New Zealand is not one of them)

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	77 Mt	13.3 t/cap	0.16 koe/$2005	24.0 %	31.3 %	1.51 US$/l



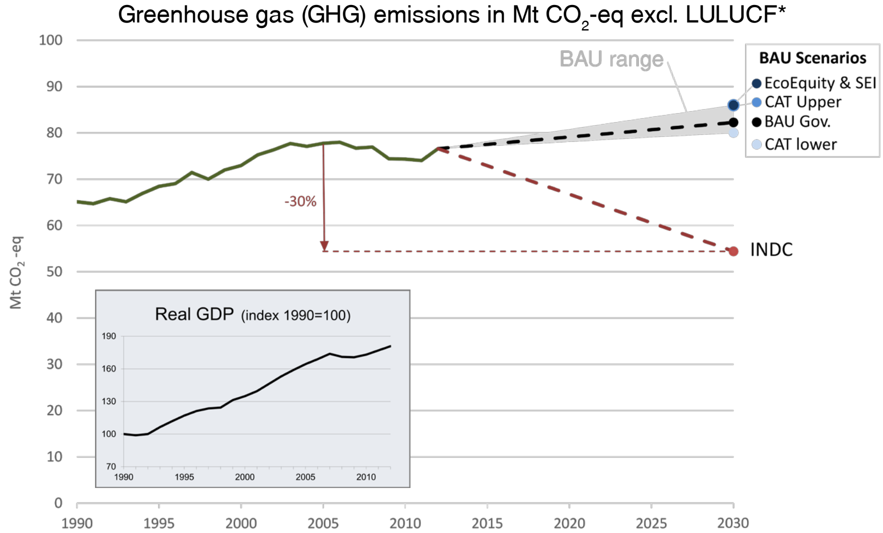
Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* Government business as usual (BAU) scenario as included in the 6th National Communication (2013) to the UNFCCC includes existing measures. For sources of other BAU projections see sheet "Sources for Country Fact Sheet Info".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -30% GHG emissions relative to 2005 levels by 2030 (-11% relative to 1990)
- use of international mechanisms

DOMESTIC POLICIES

New Zealand proclaimed a national target for 2050 of a 50% reduction in GHG emissions relative to 1990 and pursues to generate 90% of its electricity generation from renewable sources in 2025 (2014: 79.9%).

In 2008, an uncapped Emissions Trading Scheme (ETS) was started. Today, it covers the sectors forestry, transport, energy, industrial processes, synthetic gases, and waste. Coverage is exceptionally high, even if the original aim to include virtually all of the country's GHG emissions in the system has been abandoned. Carbon credits can be obtained from forest sinks, and they can be imported without limit from Kyoto markets (ERUs, CERs, RMUs) and potentially other markets that will be linked in the future. Under the prevailing low prices, importing international carbon offsets has become the most common method of compliance for entities regulated under New Zealand's ETS. Free allocations of emission units have been made to eligible businesses with exposure to foreign trade. Since 2013, however, firms in electricity generation, liquid fossil fuels, waste and synthetic gases are no longer eligible for free allowances. On the other hand, obligations for agriculture have been postponed for an indefinite time, except for emissions reporting.

Promotion of renewable energy is mostly confined to support for research, feasibility studies and pilot programmes. Energy efficiency is tackled jointly with Australia via common labelling and energy standards for consumer products. An insulation program for residential homes ended in 2013 after paying shares of retrofitting costs for about 230'000 homes. Grants and subsidies are available to help finance energy-efficiency initiatives in the residential sector.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Norway

	Value°	Rank§
Population:	5 mio.	below 20
Annual population growth:	+1.3%	btwn. 4 & 5
GDP per capita:	131’441 US$/capita	above 1
Fossil fuel resources:	392 tC/capita	btwn. 7 & 8

§ relative to the 20 largest emitters (Norway is not one of them)

INDICATORS

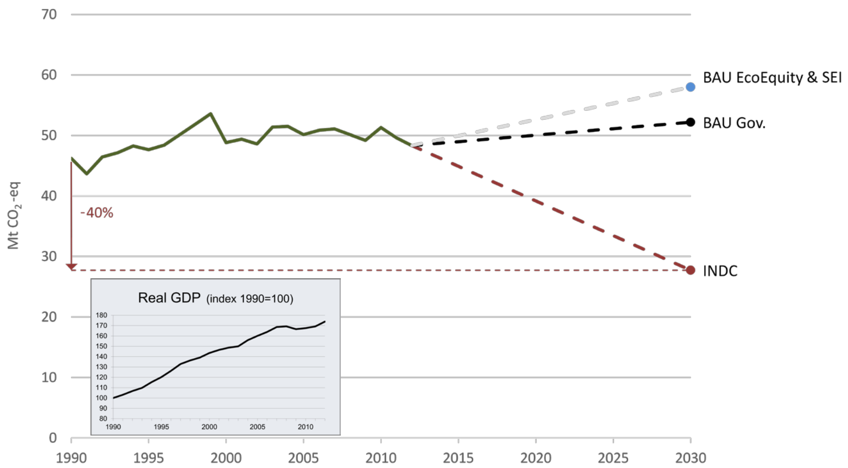
	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	48 Mt	4.8 t/cap	0.08 koe/$2005	3.3 %	28.0 %	2.44 US$/l
Change	-0.6%	-9.7%	-9.6%	+3.0%	+2.1%	
Rank	below 20	between 19 & 20	between 16 & 17	below 20	between 12 & 13	above 1

Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF
+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* Government business as usual (BAU) scenario as included in the 6th National Communication (2014) to the UNFCCC includes existing measures. For source of other BAU projection see sheet “Sources for Country Fact Sheet Information”.
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- at least -40% GHG emissons relative to 1990 levels
- target will be translated into an emissions budget covering the period 2021-2030
- use of international mechanisms
- target to be pursued in association with the EU or individually

DOMESTIC POLICIES

Norway pursues to become a 100% carbon neutral economy in 2030. The objective is conditional on an ambitious international agreement and shifts into an unconditional carbon neutrality target until 2050, if the conditions are not met.

In 2005, Norway started an Emissions Trading System (ETS), which was designed similarly to the EU-ETS. Since 2008, both are linked, and full harmonization was put into force in 2013. In 2014, the Norwegian ETS covered just over half of the country’s GHG emissions.

A green certificate system promotes renewable electricity generation, which is already very high in Norway (123% of electricity consumption in 2012) due to well developed hydropower. In 2012, Norway and Sweden established a common market for green certificates.

A carbon tax has been raised since 1991, which also covers petroleum extraction activities on the continental shelf and overlaps with the ETS for many installations. A carbon capture and storage (CCS) project, which had been designed to capture 1 million tons of CO_2 per year, was cancelled in 2013 because of high costs.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: “Sources for Country Fact Sheet Information”

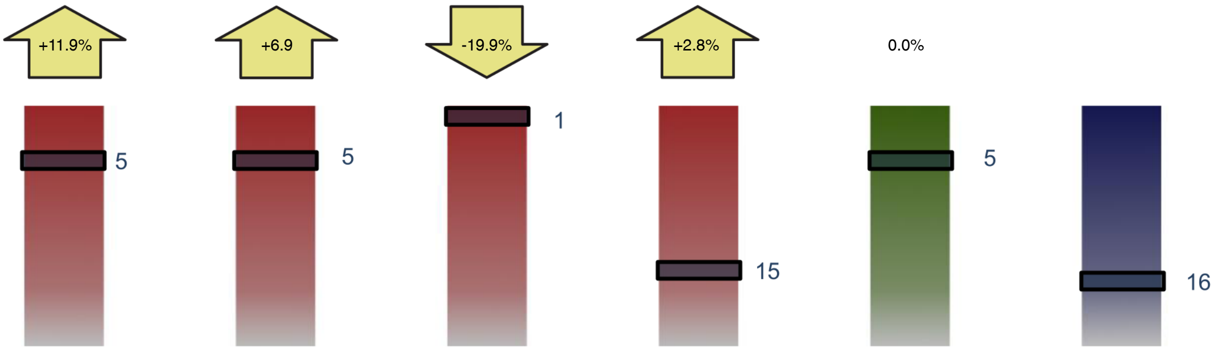
Russia

	Value°	Rank§
Population:	143 mio.	7
Annual population growth:	+0.2%	17
GDP per capita:	14'079 US$/capita	12
Fossil fuel resources:	1'052 tC/capita	3

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	2'322 Mt	15.7 t/cap	0.24 koe/$2005	67.4 %	49.4 %	1.00 US$/l
Change	+11.9%	+6.9	-19.9%	+2.8%	0.0%	
Rank	5	5	1	15	5	16



Legend: Ranking among the 20 largest emitters

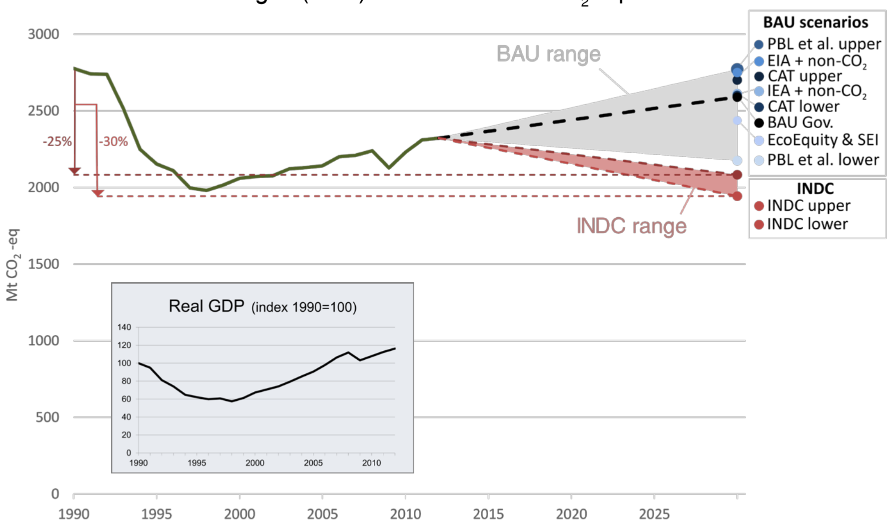
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* This graph excludes emissions from land use, land use change and forestry (LULUCF), although the INDC target includes them. For sources of business as usual (BAU) scenarios see "Sources for Country Fact Sheet Information".

Intended Nationally Determined Contribution (INDC):

- -25 to -30% GHG emissions relative to 1990 levels by 2030 (long-term indicator)
- conditional on the outcome of the negotiating process, including the maximum possible account of absorbing capacity of forests
- no use of international mechanisms

DOMESTIC POLICIES

The Climate Doctrine from 2009 is a declaration on strategic guidelines in Russian climate policy. It calls for research as well as measures for mitigation and adaptation and recognizes the importance of participating in international efforts. Stated objectives of the Climate Doctrine are to put a price on CO_2 emissions, to (mildly) reduce the share of natural gas in primary energy supply (mostly by increasing the share of nuclear energy, but also of renewable energy), to increase energy efficiency, and to incentivize technology development and deployment.

Government Decree No.1-r from 2009 sets a target share for renewables in electricity generation, excluding large hydro, of 4.5% in 2020. However, in 2014, this target was lowered to 2.5% by Government Decree No. 321. Several laws and regulations have been implemented to improve energy efficiency and conservation, notably the Thermal Performance of Buildings Code in 2003 and the Federal Energy Efficiency Law 261-F3 in 2009. Russia is the world's largest CO_2 emitter from flaring. In 2009, limits for gas flaring were established.

In September 2013, a Presidential Decree established a legally binding and unconditional national target of -25% GHG emissions by 2020 relative to 1990. To implement the target, an action plan was presented in 2014, which consists of three pillars: Emissions reporting at a corporate level; creation of support instruments for mitigation projects; and compilation of long-term mitigation scenarios.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

Saudi Arabia

	Value°	Rank§
Population:	28 mio.	19
Annual population growth:	+1.9%	1
GDP per capita:	25'946 US$/capita	10
Fossil fuel resources:	1'316 tC/capita	2

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	527 Mt	18.6 t/cap	0.04 koe/$2005	69.8 %	0.5 %	0.11 US$/l
Change	+73.4%	+33.8%	+6.9%	-11.3%	0.0%	
Rank	16	3	20	12	20	20

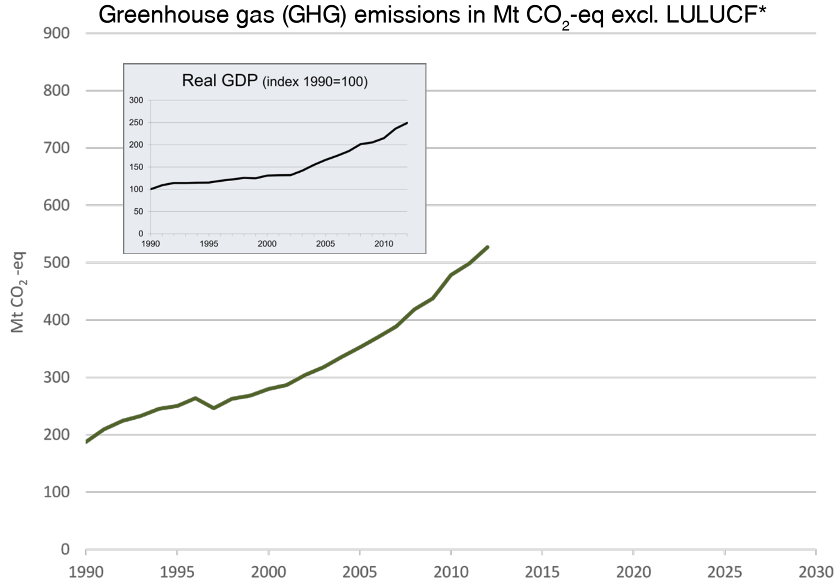
Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

Mitigation co-benefits of up to 130 million tons of CO_2-eq by 2030 annually through contributions to economic diversification and adaptation

DOMESTIC POLICIES

In 2010, a Royal Decree established the King Abdullah City for Atomic and Renewable Energy. It is responsible for research and planning, e.g. concerning the introduction of a sustainable energy mix and the mapping of renewable energy resources.

In 2011, Saudi Arabia announced plans to construct 16 nuclear power reactors over the following twenty years. They are projected to provide 15% of power in 2040. Saudi Arabia also has the objective to achieve a share of renewable energy in electricity generation of 23% in 2030 (10% in 2020), starting from 0% in 2009.

Saudi Arabia strives to diversify its economy to reduce dependence on fossil fuel exports. The National Energy Efficiency Programme (NEEP) combines many activities and measures to enhance energy efficiency. Saudi Arabia is a member of the Global Gas Flaring Reduction Partnership, which is led by the World Bank.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

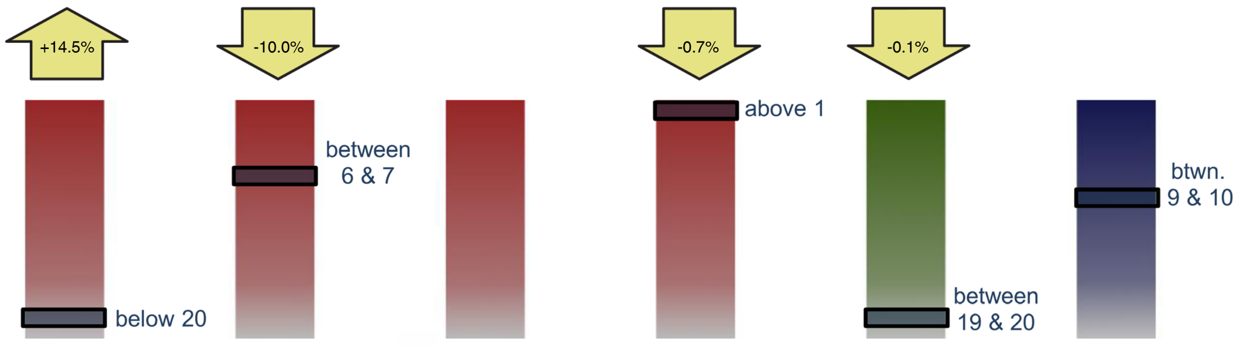
Singapore

	Value°	Rank§
Population:	5 mio.	below 20
Annual population growth:	+2.5%	above 1
GDP per capita:	54'578 US$/capita	btwn. 1 & 2
Fossil fuel resources:	none	-

§ relative to the 20 largest emitters (Singapore is not one of them)

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	56 Mt	10.6 t/cap	data missing	96.4 %	3.3 %	1.47 US$/l
Change	+14.5%	-10.0%		-0.7%	-0.1%	
Rank	below 20	between 6 & 7		above 1	between 19 & 20	btwn. 9 & 10



Legend: Ranking among the 20 largest emitters

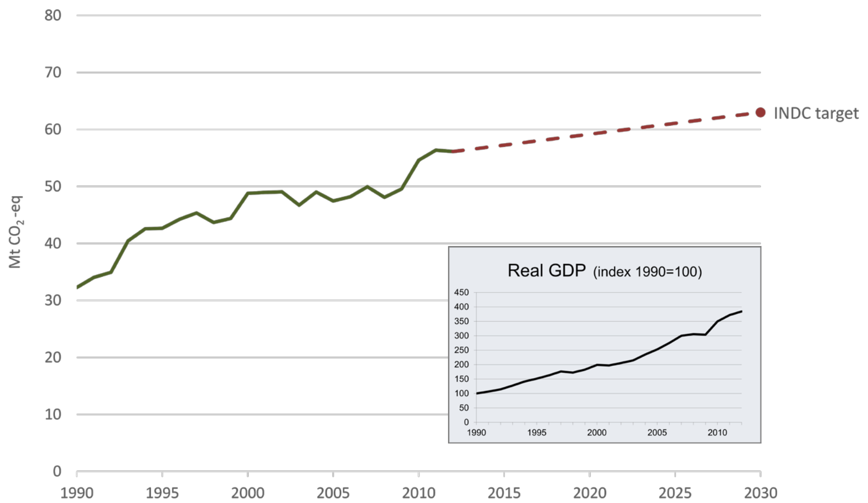
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* Singapore targets emission intensity. The represented absolute emission levels are only valid using the GDP projections of IMF until 2020 and OECD (2021-2030).
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -36% of GHG emissions intensity of GDP relative to 2005 levels by 2030
- GHG emissions peak around 2030
- target to be achieved domestically, but the potential of international market mechanisms will be studied

DOMESTIC POLICIES

According to its National Climate Change Strategy 2012, Singapore “has embarked on policies and measures that will reduce our emissions by 7% to 11% below 2020 BAU levels”. The 2009 Sustainable Singapore Blueprint sets a national target for improving energy efficiency by 20% from 2005 levels by 2020 and by 35% in 2030.

Singapore switched its dominant fuel for electricity generation from oil to natural gas. Consequently, the share of natural gas in electricity generation raised from 19% in 2000 to more than 80% today. Renewables, mainly in the form of solar PV, are promoted through support for research and development. The Government plans to have 350 MWp operational by 2020 (from around 40 MWp in mid-2015). Since the possibility to deploy other renewables is limited, abatement measures focus on increasing efficiency. The 2013 Energy Conservation Act obliges large industrial energy consumers to establish energy efficiency plans. In the building sector and for residential appliances efficiency standards are in force. For the manufacturing industry, there are energy efficiency incentives.

The size of the vehicle fleet is regulated by quota since 1990. Today, the annual growth rate of the quota is 0.5%. There is electronic road pricing, and vehicle registration fees are very high. However, since 2013, owners of new and imported used cars with CO_2 emissions of no more than 160 g/km receive rebates of Singapore Dollars 5'000 to 20'000, which approximately corresponds to EUR 3'300 to 13'300; moreover, for cars emitting more than 210 gCO_2/km, a surcharge of the equal amount must be paid. Furthermore, since 2014, Singapore requires new diesel vehicles to meet the Euro V emission standard, and new gasoline vehicles have to meet the Euro IV standard. Through the Land Transport Master Plan from 2013, Singapore intends to achieve a 75% modal share of public transport by 2030 with the help of increased capacity and an extended transport network.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: “Sources for Country Fact Sheet Information”

South Africa

	Value°	Rank§
Population:	52 mio.	16
Annual population growth:	+1.5%	3
GDP per capita:	7’592 US$/capita	16
Fossil fuel resources:	424 tC/capita	7

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	463 Mt	8.9 t/cap	0.19 koe/$2005	93.8 %	7.6 %	1.40 US$/l
Change	+25.5%	+9.1%	-4.9%	+0.1%	0.0%	
Rank	18	11	2	2	18	10

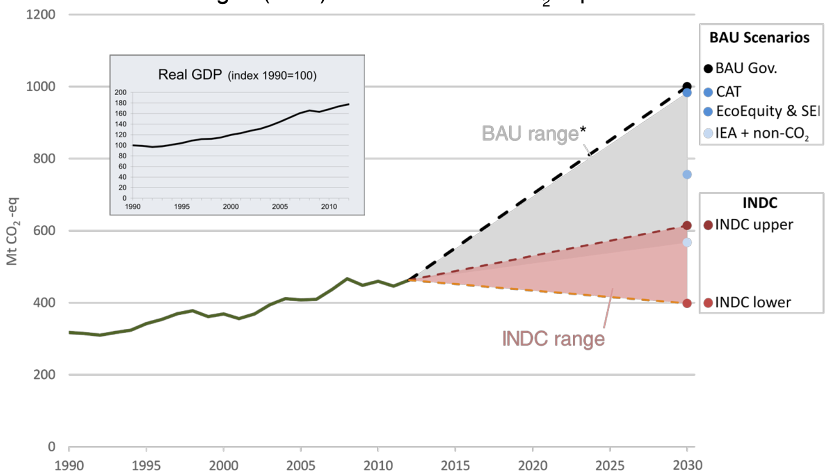
Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The INDC targets are depicted including land use, land use change and forestry (LULUCF) emissions, while historical figures and the BAU scenarios exclude them (<1% of gross emissions). The Government BAU is an approxmative value from a graph in the 2nd National Communication. For sources of BAU scenarios see “Sources for Country Fact Sheet Information”. The business as usual (BAU) scenario range excludes the Government BAU.

Intended Nationally Determined Contribution (INDC):

- GHG emissions in a range between 398 and 614 Mt CO_2-eq by 2025 and 2030
- GHG emissions peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter
- assumes effective implementation of developed countries’ commitments

DOMESTIC POLICIES

The National Climate Change Response Policy from 2011 established a general framework for domestic climate policy. The emissions targets were incorporated in the latest update of the Integrated Resource Plan for Electricity in 2013, which anchored mitigation in energy policy more firmly.

In 2010, a CO_2 tax on passenger vehicles was introduced, adding 75 Rand (about 5 EUR) to the vehicle price for every gram of CO_2 per kilometer the vehicle emits over 120 g/km.

The Government plans to introduce a carbon tax of 120 Rand (about 8.5 US$) per ton starting in 2016 or 2017. During the first phase until 2020, various tax breaks are designated, in order to allow businesses to adapt, decreasing the effective tax to 6-48 Rand (0.4-3.2 EUR). The tax breaks include an economy-wide 60% tax-free threshold. Furthermore, trade-exposed sectors and companies performing well against emission intensity benchmarks can earn additional tax free allowances. The waste and land use sector were completely excluded from the first phase.

In 2009, the Government planned a renewable energy feed-in tariff. However, this was abandoned in favor of a competitive tender bidding process. This policy was deemed a success, as 3’922 MW of renewable capacities were committed through the program in 2014 and prices dropped significantly over the bidding phases.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data. For details and exceptions, see: “Sources for Country Fact Sheet Information”

Econability Sustainable Economics in Research and Practice

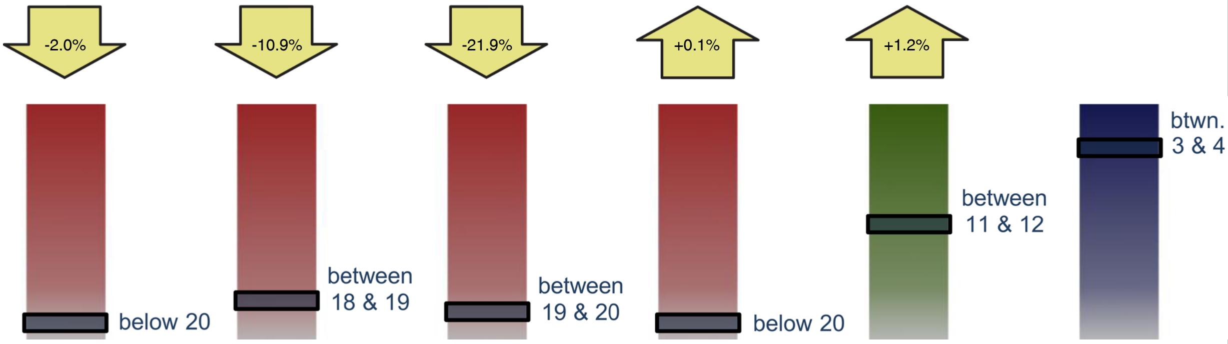
Switzerland

	Value°	Rank§
Population:	8 mio.	below 20
Annual population growth:	+1.1 %	btwn. 9 & 10
GDP per capita:	83'295 US$/capita	above 1
Fossil fuel resources:	none	-

§ relative to the 20 largest emitters (Switzerland is not one of them)

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	51 Mt	6.0 t/cap	0.05 koe/$2005	1.7 %	31.6 %	1.97 US$/l
Change	-2.0%	-10.9%	-21.9%	+0.1%	+1.2%	
Rank	below 20	between 18 & 19	between 19 & 20	below 20	between 11 & 12	btwn. 3 & 4



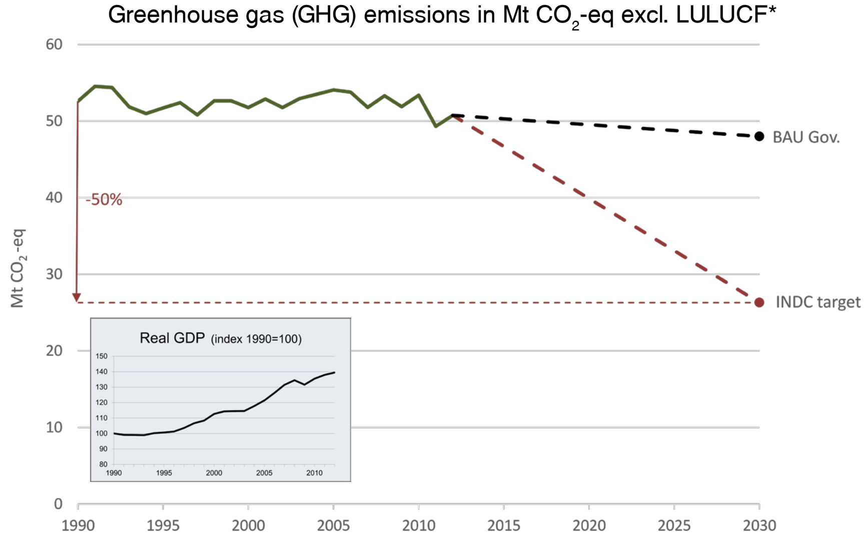
Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* Government business as usual (BAU) scenario as included in the 6th National Communication (2013) to the UNFCCC corresponds to the WOM scenario, a projection including policies and measures as of 2010 and a moderate further evolution.
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

- -50% GHG emissions relative to 1990 levels by 2030
- target corresponds to an average of -35% GHG emissions over the period 2021-2030
- -35% GHG emissions relative to 1990 levels anticipated by 2025
- international mechanisms will partly be used

DOMESTIC POLICIES

The CO_2 Act constitutes the legal framework for Switzerland's climate policy from 2013 to 2020. This revised CO_2 Act took over from the previous CO_2 Act, which had been in force since 2000. The CO_2 Act stipulates that by 2020, domestic GHG emissions must be reduced by 20% relative to 1990 levels. The main instruments and measures are:

- CO_2 levy on thermal fuels, with an exemption offered to companies that make specific CO_2 reduction commitments;
- Emissions trading scheme (ETS) for energy intensive companies (link to EU-ETS in negotiation);
- Buildings program to channel a third of the revenues of the CO_2 levy into energy-oriented refurbishment and renewable energies;
- Obligation of fossil fuel importers to partially compensate for related emissions at the domestic level;
- Binding CO_2 emission target value of an average of 130g CO_2/km by 2015 on new passenger cars;
- Obligation for operators of fossil fuel thermal power plants to compensate in full for the CO_2 emissions.

The initial package of measures of the Energy Strategy 2050, approved by the Federal Council in September 2013, includes inter alia a raise of the CO_2 levy, more stringent emission targets for vehicles, and additional financing for feed-in tariffs for renewables.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data. For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability – Sustainable Economics in Research and Practice

Turkey

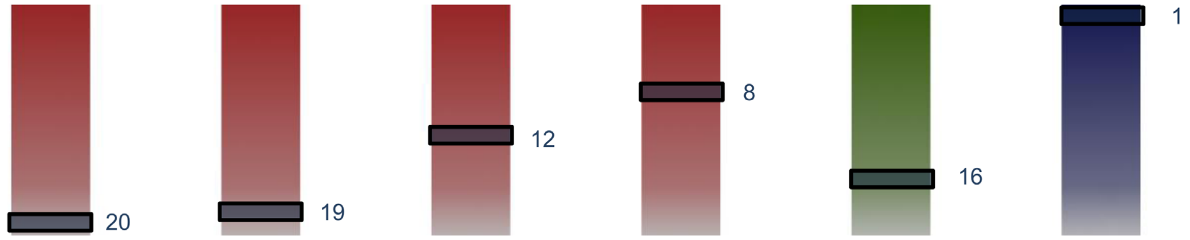
	Value°	Rank§
Population:	73 mio.	12
Annual population growth:	+1.3%	5
GDP per capita:	10'661 US$/capita	14
Fossil fuel resources:	87 tC/capita	10

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	420 Mt	5.3 t/cap	0.09 koe/$2005	74.6 %	15.0 %	2.44 US$/l
Change	+44.0%	+31.0%	-16.5%	-5.5%	+1.5%	

Rank



Legend: Ranking among the 20 largest emitters

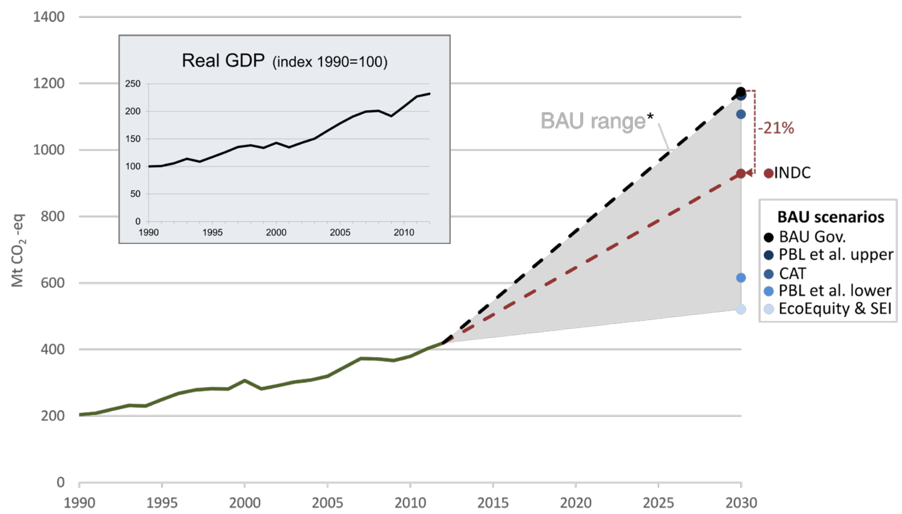
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The business as usual (BAU) scenario range excludes the Government BAU. For sources of BAU scenarios see "Sources for Country Fact Sheet Information".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

-21% GHG emissions compared to business as usual levels by 2030

DOMESTIC POLICIES

The National Climate Change Strategy 2010-2020 lists intended policies and measures for greenhouse gas emission control in the areas energy, transportation, waste, and land use. The Climate Change Action Plan 2011-2023 builds open the framework of the National Climate Change Strategy and defines various short, medium and long term measures. For example, GHG emissions from coal power plants will be decreased until 2023 through efficiency measures. Forestation and land use are also addressed, through avoided deforestation and other measures. There are also several targets for the transportation sector, such as an increase in rail transportation for both passengers and freight.

The Renewable Energy Law from 2005 promotes electricity generation from renewable sources. It obliges retailers to purchase a certain ratio of their electricity from renewable sources. It also promotes renewable sources in other ways, e.g. by facilitating the use of state-owned land and by securing grid connection priority.

The Strategic Plan 2015-2019 of the Ministry of Energy and Natural Resources encompasses 16 goals in total; among them are energy efficiency and savings, as well as the efficient use of raw material.

Turkey has the highest motor fuel prices among the 20 largest GHG emitters.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

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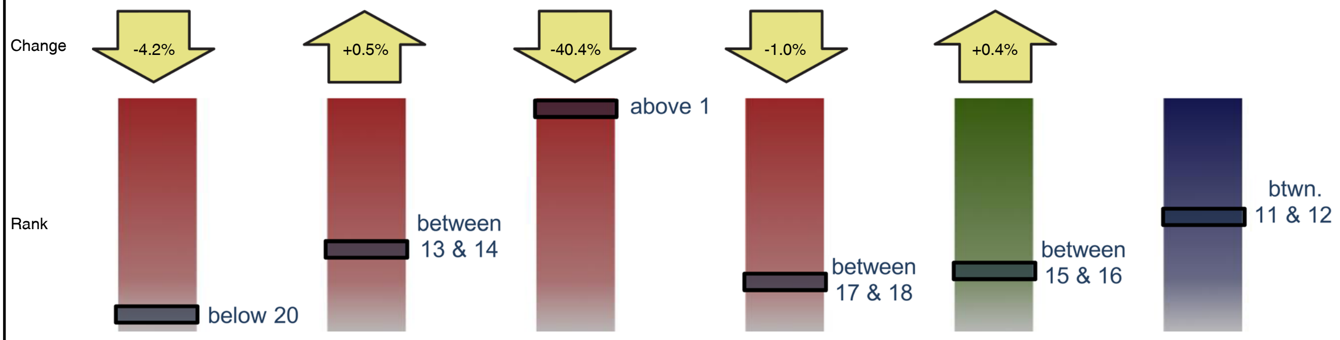
Ukraine

	Value°	Rank§
Population:	46 mio.	btwn. 17 & 18
Annual population growth:	-0.2%	btwn. 19 & 20
GDP per capita:	3'855 US$/capita	btwn. 18 & 19
Fossil fuel resources:	553 tC/capita	btwn. 5 & 6

§ relative to the 20 largest emitters (Ukraine is not one of them)

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	390 Mt	8.0 t/cap	0.31 koe/$2005	48.0 %	16.8 %	1.30 US$/l

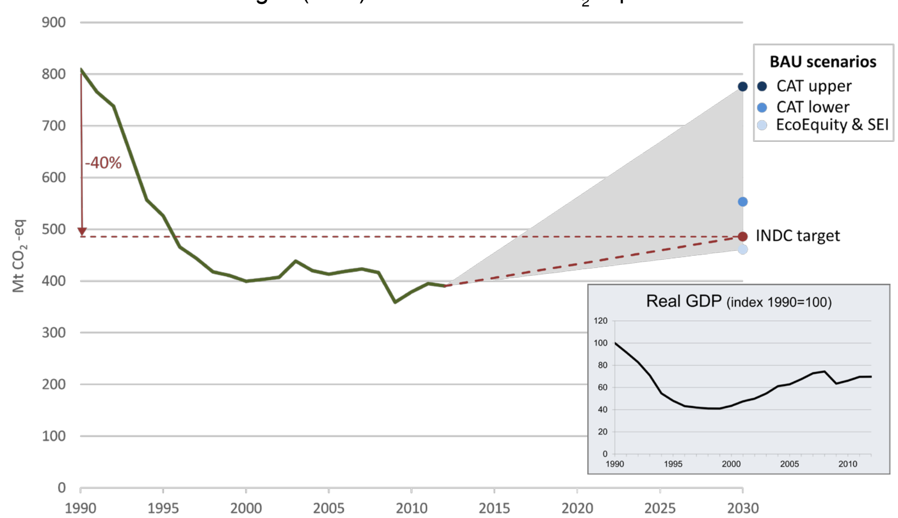


Legend: Ranking among the 20 largest emitters. % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF
+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* For sources of business as usual (BAU) scenarios see "Sources for Country Fact Sheet Information".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

Limit GHG emission levels in 2030 to 60% of 1990

DOMESTIC POLICIES

Several energy efficiency programs have been implemented with foreign financing, e.g. for banks, institutions in education, and public buildings in Kiev.

In 2011, the UNFCCC suspended Ukraine from carbon trading because of failure to meet the reporting requirements.

In 2008, Ukraine introduced renewable electricity feed-in tariffs, guaranteeing access to the grid for wind power, biomass, photovoltaic, geothermal, and small scale hydro power. Feed-in tariffs were last amended in 2015 to also include small scale wind power (up to 30 kW).

In 2013, the 2030 energy strategy was approved. It entails energy efficiency programmes to reduce energy intensity by 20% by 2016 and 50% by 2030 compared to 2008. The energy strategy also targets increasing the share of renewable energy in final energy consumption to 11% in 2020 (compared to 5.5% in 2009).

31 Dec 2015

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° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

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United Arab Emirates

	Value°	Rank§
Population:	9 mio.	below 20
Annual population growth:	+3.1%	above 1
GDP per capita:	40’444 US$/capita	btwn. 7 & 8
Fossil fuel resources:	1’770 tC/capita	btwn. 1 & 2

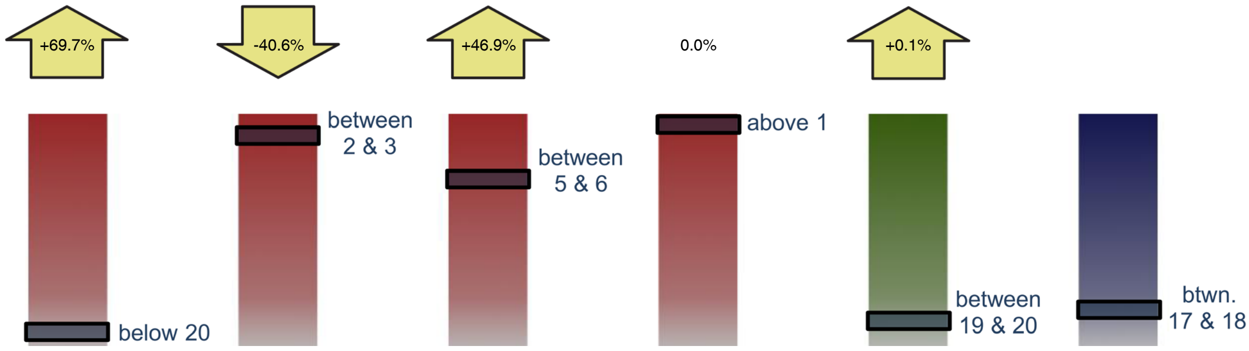
§ relative to the 20 largest emitters (UAE are not one of them)

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	216 Mt	23.5 t/cap	0.13 koe/$2005	100.0 %	3.8 %	0.56 US$/l

Change

Rank



Legend: Ranking among the 20 largest emitters

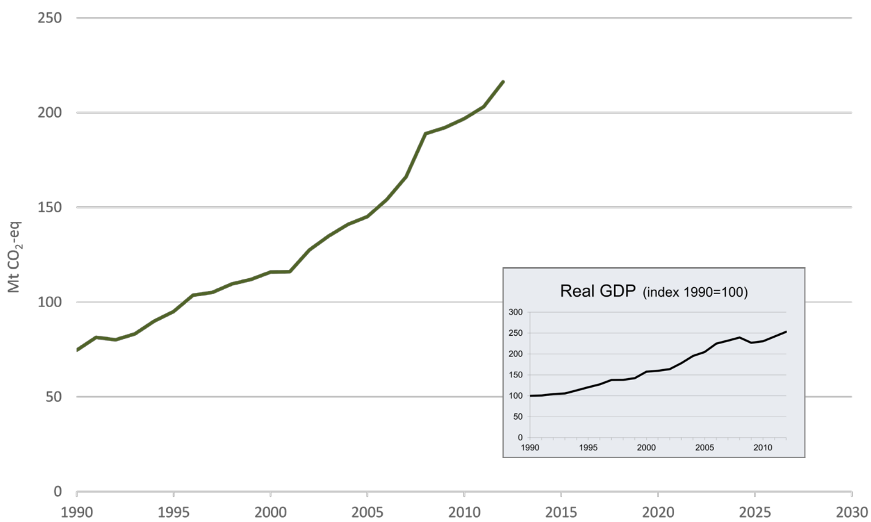
% increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

Increase the share of clean energy to 24% of the total energy mix in 2024

DOMESTIC POLICIES

In 2015, four nuclear power reactors are under construction with a joint capacity of 5.6 GW. The first unit is planned to be online by 2017.

The Masdar City Initiative plans to build the largest carbon-neutral city in the world, featuring i.a. smart grids, solar power supply and electric vehicles.

In August 2015, the UAE removed heavy subsidies from transport fuels, aligning the price with international markets.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

° Generally 2012 data.
For details and exceptions, see: “Sources for Country Fact Sheet Information”

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USA

	Value°	Rank§
Population:	312 mio.	4
Annual population growth:	+0.8%	11
GDP per capita:	51'457 US$/capita	3
Fossil fuel resources:	572 tC/capita	5

§ among the 20 largest emitters

INDICATORS

	Total CO_2 emissions~	GHG emissions# per capita	Energy intensity in manufacturing	Electricity from coal, gas & oil	Forest area	Motor fuel price+
Value°	6'235 Mt	18.5 t/cap	0.10 koe/$2005	68.4 %	33.3 %	1.01 US$/l
Change	-6.7%	-15.5%	-22.8%	-3.8%	+0.4%	
Rank	2	4	10	14	8	15

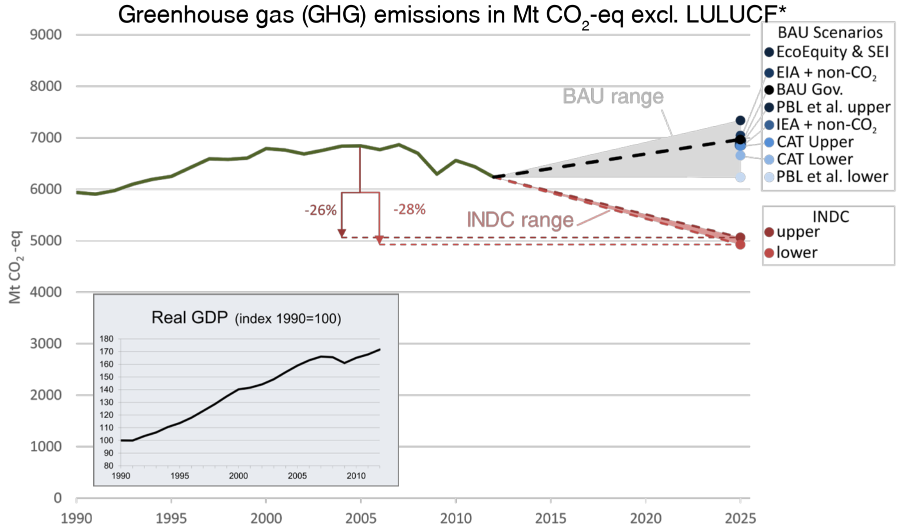
Legend: Ranking among the 20 largest emitters; % increase/decrease over the last decade (in percentage points if the indicator is in percent)

~ excl. land use, land use change and forestry (LULUCF)
# incl. LULUCF

+ Average of 50% diesel and 50% gasoline. Rank 1 = highest price
** of value added

INDC

Greenhouse gas (GHG) emissions in Mt CO_2-eq excl. LULUCF*



* The Government's business as usual (BAU) scenario as included in the 6th National Communication (2014) to the UNFCCC includes existing measures. For sources of other BAU projections see sheet "Sources for Country Fact Sheet Information".
LULUCF: Land use, land use change and forestry.

Intended Nationally Determined Contribution (INDC):

-26 to -28% GHG emissions relative to 2005 levels in 2025

DOMESTIC POLICIES

Environmental policy in the United States is often fostered by sub-national rather than federal initiatives. One example is the Regional Greenhouse Gas Initiative, a cap-and-trade system for the electricity sector which nine US states are connected to. California's Global Warming Solutions Act from 2006, which includes a cap-and-trade system covering 85% of the state's total GHG emissions, is its most notable climate change directive. All over the USA, 21 states have GHG emission targets and 30 states pursue renewable energy targets.

Under the Obama administration, climate change increasingly became a federal issue. For example, the American Recovery and Reinvestment Act of 2009 allocated US$ 94 billion for research and development as well as incentives to renewable energy technologies, smart grids, low emission vehicles, public transport, and energy efficiency. The Clean Air Act of 2009 requires the Environmental Protection Agency through several amendments to take action against sources responsible for approximately half of the US GHG emissions; most notably, power plants are required to curb GHG emissions by 30% until 2030. In 2013, the Obama administration declared the Climate Action Plan, which aims to cut GHG emissions with a focus on electricity generation, transportation, and energy efficiency.

In November 2014, the USA announced their emission reduction target of 26-28% below 2005 levels until 2025 together with China. The two countries also expressed their intention to increase collaboration in climate change mitigation. To that end, the US-China Climate Change Working Group has been established with the aim of launching initiatives in the area of vehicles and energy efficiency. China and the US have also decided to collaborate in carbon capture and storage (CCS) and energy efficiency research, as well as to promote trade of green goods, amongst others.

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° Generally 2012 data.
For details and exceptions, see: "Sources for Country Fact Sheet Information"

Econability Sustainable Economics in Research and Practice

Sources
for Country Fact Sheet Information

INDICATORS

Population (in millions): World Development Indicators (http://data.worldbank.org/indicator/all, retrieved Jun. 2015), World Bank, data for 2012.

Annual population growth (in %): World Development Indicators, World Bank, data for 2012.

GDP per capita (in US$): World Development Indicators, World Bank, data for 2012.

Fossil fuel resources (in tons of carbon per capita): Calculated from: "Proven crude oil reserves in 2012", "Proven natural gas reserves in 2012" and "Recoverable coal in 2011" from US International Energy Statistics, Energy Information Agency. Population from World Development Indicators, World Bank. Conversion factors from the Swiss "Gesamtenergiestatistik", Swiss Federal Office of Energy, and from IPCC.

Total CO_2 emissions (in Mt, excl. land use, land use change and forestry (LULUCF)): CAIT (http://cait2.wri.org, retrieved May 2015), World Resrouces Institute, data for 2012.

GHG emissions per capita (in tons per capita, incl. LULUCF): GHG emissions from CAIT, World Resrources Institute, divided by population from World Development Indicators, World Bank, data for 2012. CAIT methodology states: "*LULUCF data are useful as reference only and may not coincide with LUCF emissions reported by countries to the UNFCCC [...] More generally, users should note that the errors and uncertainties associated with these (and other LUCF) estimates may be significant.*" Change in % over the last decade concerns the period 2002 to 2012 with identical sources used for 2002 and 2012 data in each country.

Energy intensity in manufacturing (in toe per 1000 US$ of value added): World Energy Council, data for 2012. Change in % over the last decade concerns the period 2002 to 2012.

Electricity from coal, gas & oil (in % of total electricity generation): World Development Indicators, World Bank, data for 2011. Change in percentage points taken between data for 2011 and 2001.

Forest area (in % of land area): World Development Indicators, World Bank, data for 2012. Change in percentage points taken as difference between data for 2012 and 2002.

Motor fuel price at the pump (in US$/l): World Development Indicators, World Bank, data for 2012. Average of 50% diesel and 50% gasoline.

INDC

Historical data: GHG emissions (excl. LULUCF) from CAIT (data retrieved from website http://cait2.wri.org in June 2015), World Resrouces Institute. Data exclude LULUCF, because of severe uncertainties for many countries, particularly developing countries. Countries for which inclusion of LULUCF data would draw a distinctively different picture (e.g. concerning emissions trajectory or emissions totals) are Brazil, Indonesia and, to a lesser extent, Mexico, Australia, Canada and Russia.

Business as usual (BAU) emissions:

- International Energy Agency (IEA). "World Energy Outlook 2014".
- US Energy Information Administration (EIA). "International Energy Outlook 2013".
- PBL et al., 2015. "Enhanced Policy Scenarios for Major Emitting Countries".
- LIMITS public scenario database (LIMITS-PBL). https://tntcat.iiasa.ac.at/LIMITSPUBLICDB/dsd?Action=htmlpage&page=about#contents
- EcoEquity & SEI. Climate Equity Reference Calculator. http://calculator.climateequityreference.org
- The Climate Action Tracker (CAT), 2015. http://climateactiontracker.org/countries.html

For a few countries with an INDC target for 2025, some BAU scenarios were linearly interpolated from the 2020 and 2030 data points. For improved readability, 2030/2025 BAU projections are connected with the historical data point for 2012 by a straight line, irrespective of the year of publication of the BAU scenario. Consequently, BAU lines do not follow the actual BAU trajectories, but illustrate the BAU emission values for 2030/2025.

Business as usual emissions as estimated by the Government: National Communications to the UNFCCC. For improved readability, the 2030/2025 BAU projection is connected with the historical data point for 2012 by a straight line, irrespective of the BAU scenario's year of publication. Consequently, the BAU line does not follow the actual BAU trajectory, but illustrates the BAU emission value for 2030/2025.

INDC submissions were considered as available from http://www4.unfccc.int/submissions/INDC/Submission%20Pages/submissions.aspx. For improved readability, the absolute INDC target emission value is connected with the historical data point for 2012 by a straight line. The line does not suggest the actual trajectory of the future emissions, but helps illustrating the target emission values for 2030/2025 implied by the INDC.

GDP: World Development Indicators (GDP in real terms, i.e. constant LCU), World Bank, index normalized to 100 in 1990.

Support has been provided by the Swiss Federal Office for the Environment FOEN.

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Word Nuclear Association: http://www.world-nuclear.org/info/Country-Profiles/

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