# Instruments to increase climate policy ambition before 2020 – economic and political implications in selected industry and emerging countries

Pre2020 climate policy ambition

Berlin, 06 June 2014

*DRAFT VERSION*

Environmental Research of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
Project No. 3713 41 103

Authors

Nadine Braun
Ecofys

Niklas Höhne
Ecofys

Markus Hagemann
Ecofys

Thomas Day
Ecofys

Sean Healy
Öko-Institut e.V. (Aether)

Katja Schumacher
Öko-Institut e.V.

Vicki Duscha
ISI Fraunhofer

**Head Office Freiburg**
P.O. Box 17 71
79017 Freiburg
**Street address**
Merzhauser Strasse 173
79100 Freiburg
Tel. +49 761 45295-0

**Office Berlin**
Schicklerstrasse 5-7
10179 Berlin
Tel. +49 30 405085-0

**Office Darmstadt**
Rheinstrasse 95
64295 Darmstadt
Tel. +49 6151 8191-0

info@oeko.de
www.oeko.de

Partner

# Table of Contents

# List of Figures

# List of Tables

# 1 Summary

The objective of this research paper is to analyse the current efforts of country activities towards the 2020 2°C target, in order to identify best practices and their possible impact on emission reduction in 2020.

A first scan of policies in countries with high greenhouse gas emissions and countries with remarkably ambitious climate change mitigation strategies (see Table 1) revealed that thematic areas with notable coverage in domestic climate policy are: general strategies and targets, renewable energy support schemes for electricity, product standards and codes for energy efficiency in buildings, and direct subsidies and fuel quotas for renewables in Transport.

**Table 1: Result of country policy analysis: most popular policy instruments and percentage coverage**

<table>
<tr><th></th><th>Changing Activity</th><th>Energy efficiency</th><th>Renewables</th><th>Low carbon (other than renewables)</th><th>Non-energy</th></tr>
<tr><td>General</td><td colspan="5">Strategies and targets: 69%</td></tr>
<tr><td rowspan="2">Electricity</td><td></td><td>Performance standards 22%</td><td>Support schemes (e.g. feed-in tariff) 49%</td><td>Tax exemptions 6%</td><td rowspan="2"></td></tr>
<tr><td colspan="4">Carbon pricing schemes 25%</td></tr>
<tr><td rowspan="2">Industry</td><td>Strategies 6%</td><td>Voluntary agreements 24%</td><td>Fuel quota 36%</td><td>CCS support schemes <3%</td><td rowspan="6">Regulation (Not evaluated)</td></tr>
<tr><td colspan="4">Carbon pricing schemes: 31%</td></tr>
<tr><td rowspan="2">Buildings</td><td>Programmes 8%</td><td>Product standards and building codes 55%</td><td>Tax exemptions 40%</td><td>Not evaluated</td></tr>
<tr><td colspan="4">Energy taxes: (Not evaluated)</td></tr>
<tr><td rowspan="2">Transport</td><td>Modal shift programmes 14%</td><td>Vehicle standards 23%</td><td>Direct subsidies and fuel quota 50%</td><td>E-mobility programmes 14%</td></tr>
<tr><td colspan="4">Energy taxes: (Not evaluated)</td></tr>
<tr><td>AFOLU</td><td>Strategies 28%</td><td></td><td></td><td></td><td>Regulations/planning 39%</td></tr>
</table>

Scale: 0% 25% 50% 75% 100%

From this, along with initial indications of mitigation potential, we identified four areas where ambition could be significantly enhanced by 2020.

## 1.1 Renewable Energy Support (RES)

Renewable energy support measures are becoming popular in many industrialised and developing countries across the world not only for their decarbonisation potential, but also for the multiple co-benefits that they entail, including increased rural electrification, improved energy security, decreased dependence on depleting resources and volatile fossil fuel markets, and improved local air quality and associated health benefits. Coverage of these policies is already above 50% globally.

This study has found that the most ambitious industrialised country policies may lead to a 2-3% annual reduction in national emissions intensity of the electricity production. Meanwhile, emissions intensity improvements might be even better in the short term for less developed countries, since the process of optimising the energy mix is still at an early stage; Morocco for example, has achieved 4% annual emission intensity reductions in recent years.

Analysis of best practice policies in this study showed that market instruments such as Feed-in Tariffs (FIT) and purchase guarantees are the most popular policy instruments in industrialised countries, whilst public sector investment remains the primary means of increasing renewable energy shares in many developing countries, owing to the weak penetration of markets and the lack of an attractive environment for private sector investment. This remains a key barrier for renewable energy development in developing countries. Other common barriers for countries worldwide include poor grid infrastructure, both in terms of its unsuitability and its insufficiency, and regulatory issues, particularly regarding the ability to obtain planning permission. The policy instruments in the best practice policies discussed, as well as the work of established and emerging International Cooperative Initiatives are focussed on the mitigation of these barriers.

Targets for electricity generation from renewable energy are contributing significantly to the GHG emission reductions in the four considered countries Germany, the United Kingdom, China and Morocco. This study has found that the adoption of these best practice policies in other countries by 2020 could lead to further emission reductions of 0.9 to 3.7 $GtCO_2$/a below current reference scenario.

## 1.2 Light duty vehicle standards

Improvements in the fuel efficiency and emissions intensity of light duty vehicles is promoted not only by national climate change mitigation ambition, but also by increasing consumer demand; through significant cost savings at the pump and local air quality improvements, consumers and urban dwellers may benefit greatly from development in this sector. Furthermore, net oil importing nations have an incentive to improve the fuel efficiency of their vehicle fleets in order to reduce their expenditure and dependency on volatile international oil markets.

With this in mind, the best practice policies featured in this study (EU, Japan, US and China) are forecast to effect fuel-efficiency improvements of 4-7% annually between 2015 and 2020. The most ambitious target for 2020 is the EU's target of 26.3 km/l for the light duty vehicle fleet, which might rise to 36.8 km/l in 2025. These targets are forecast to translate to a reversing emissions trend for light duty transport in industrialised countries, in the region of -2% annually. The indications for emerging and developing nations are for continued, yet stunted, emissions growth, due to the anticipated boom of car ownership and kilometres driven in these countries; this study finds for example, a medium term emissions trend of +4% per year in China.

Our analysis of best practice policies shows that standards with flexible compliance mechanism are the most common policy instruments in this sector. The level of ambition that can be reached is highly dependent on supporting policies, in particular domestic fuel taxes or subsidies, and also on the establishment of stringent compliance regulation. Global coverage of such policies can be enhanced, as current only around a quarter of countries have such policies.

This study finds that adoption of the best practice policies of peers by all countries can initiate a further emissions reduction of 0.4 to 0.6 $GtCO_2e/a$ below reference by 2020. Importantly, the global net growth in emissions in the light duty vehicle sector can be stopped and reversed.

## 1.3 Methane from fossil fuel production

The policy to reduce APG flaring to 5% in the analysed country Russia, can lead to a significant decrease in flaring emissions. If the target is met, 2020 emissions in this area decrease by over 80% from the 2010 level according to our calculations. If the top-5 APG flaring countries adopt similar policies an emission reduction of about 100 $MtCO_2e/a$ below the reference could be achieved in 2020. Global implementation of similar policies could result in an even bigger emission reduction.

## 1.4 Electric appliances

Improvements in the fuel efficiency of electric appliances are of key importance to climate change mitigation objectives, consumer cost savings and improved household comfort. Many countries already adopt standards of this kind.

The best practice policies in EU, Japan and South Korea show a preference for standards and labelling instruments in this sector, whilst tax incentives are also widely used as supporting measures. International Cooperative Initiatives are playing an important role in the dissemination of knowledge and best practices for appliance energy efficiency, whilst the global nature of the appliance market is also likely to ensure that energy efficiency gains in these best practice countries are also diffused elsewhere.

Global data on activity rates for appliance use, as well as energy efficiency gains, is critically low. In the EU, where suitable data recently became available, policy measures have led to energy efficiency gains of approximately 1.5% per year since 2000. Due to the increasing rate of appliance use, the emissions trend continues to increase at a stunted rate of +1% per year.

## 2 Methodological approach

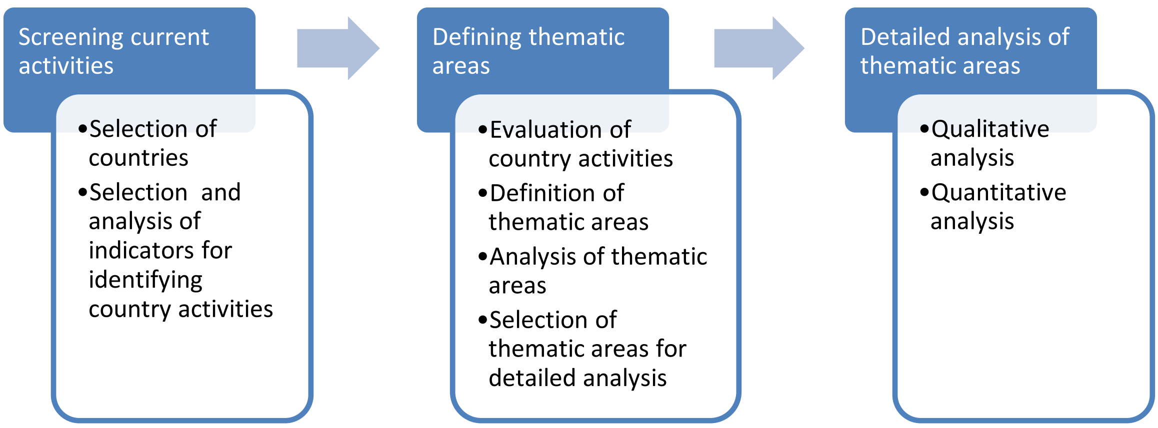
Our analysis includes three steps as illustrated in Figure 1.

The **first step** was to generate an overview of the current status of activities in a selected sample of countries. The analysis is structured along indicators that support the screening of the countries, and a matrix containing two layers (reduction potential and the policy activities) was produced.

Based on this output, the **second step** identified a list of potential areas for greenhouse gas mitigation (hereon referred to as "thematic areas", e.g. fuel efficiency standards, low energy buildings). For each of these thematic areas, additional aspects were considered, such as the co-benefits or the role of the respective area in relevant forums to support discussions with and within BMUB and UBA. Based on this, a final set of thematic areas were selected for detailed analysis in the subsequent steps. The detailed methodology for the **screening of current activities** is described in section 0 and the results of these methodological steps are given in section 3.

The **third step** consists of an in-depth evaluation of the selected thematic areas, including a qualitative assessment of the policy objectives, ambition, implementation barriers and co-benefits, and a quantitative assessment of the achieved and projected emission reductions of existing best practice policies. We then quantitatively estimated the global emission reduction potential of these policies by scaling these to a global level. Further methodological details for the qualitative and quantitative analysis are given in section 0. Results and discussion from the evaluation are given in section 4.

**Figure 1: General methodological steps**




Source: Own illustration

The approach applied in this paper uses elements of the "Climate Action Tracker country assessment", which was developed to qualitatively and quantitatively evaluate country policies for their ability to induce a paradigm shift towards reaching a low carbon world by 2050 and to estimate emission reductions induced by these policies by 2020 and 2030 (Höhne et al. 2011). The indicators developed there form the basis for the first step of our methodological approach.

## 2.1 Screening of current activities

The first step covers the selection of countries as well as the definition and analysis of indicators for country activities, based on desk research and existing databases.

### 2.1.1 Selection of countries

The aim of this step is the selection of a representative sample of countries that will be part of the subsequent country screening. The countries, presented in full in Table 24, were selected based on two main criteria:

- Countries with high greenhouse gas emissions in 2010: The top-30 emitters are of great significance to mitigation policy, and it is assumed that many of these countries will already have policies in place to reduce their emissions.
- Countries with ambitious domestic strategies or policies: In addition, Ethiopia, Costa Rica and the Maldives have been included for their highly ambitious carbon-neutral strategies, whilst Norway, Switzerland, Denmark, New Zealand and Chile are also of particular interest due to their comprehensive climate policy frameworks.

The EU is included as a single entity here, although a number of relevant individual member states are also included separately. In total a number of 35 countries were selected.

### 2.1.2 Indicators for policy evaluation

This step provides an overview of where mitigation action is happening. At this stage we focus on the presence of action and not its intensity. We developed a set of indicators to indicate the existence of a policy in each area (Table 2).

The approach builds on the methodology developed for the Climate Action Tracker country assessment (Höhne et al., 2011), and was adjusted to fit the context. The original Climate Action tracker methodology contains a set of indicators for combinations of policy area and sector (see Table 2) that are qualitatively described in the analysis for each country.

**Table 2: Structure of indicators by policy area and sector**

| | 1.Changing activity[1] | 2.Energy Efficiency | 3.Renewable Energy | 4.Low Carbon | 5.Other / Non Energy |
|---|---|---|---|---|---|
| 1. Electricity | | | | | |
| 2. Industry | | | | | |
| 3. Buildings | | | | | |
| 4. Transport | | | | | |
| 5. AFOLU[2] | | | | | |

Source: Own illustration adapted from Climate Action Tracker methodology. Greyed out boxes are non-applicable combinations

Policy and activity identification was achieved through the review of policy databases (see Appendix II, Section 6.3 for data sources) and a country by country literature analysis and the existing expert knowledge within the team. The results of the country analysis were merged into a

[1] Changing activity refers to: Incentives and barriers that indirectly reduce emission by changing behaviour or by introducing new technology concepts (see Appendix I, section 6.2.)

[2] Agriculture, Forestry and Other Land Use (AFOLU)

summary matrix highlighting the trends per policy area and sector. Each combination of sector and policy area was rated according to the prevalence of existing instruments in all countries. The results of this analysis are presented in section 3.

### 2.1.3 Selection of thematic areas and specific case studies for evaluation

The output of the country analysis - the summary matrix – was evaluated based on the sector reduction potential and the country activity coverage (i.e. occurrence of instruments). The aim of this analysis is twofold:

1. To identify areas that have a lot of action ongoing in a relatively large number countries, but for which a large reduction potential still exists in other countries. These actions have proven themselves to be working across different contexts and could therefore be relatively easily scaled up in others.
2. To identify areas where only limited action is happening but successful best practice policies exist that could also be implemented in other countries. These areas have not proven themselves across different contexts, put provide a high potential for scale-up.

Based on this analysis and our own expert knowledge we identified a number of distinct thematic areas for potential qualitative and quantitative evaluation. These thematic areas are not necessarily limited to the specific combinations of policy areas and sectors previously highlighted, but instead could cover multiple sectors and/or could cover a subsection of the policy area/sector combinations.

Within the selected thematic areas, policy case studies in specific countries were selected based on expert knowledge within the team on the following criteria:

- Success of policy implementation
- Different types of instrument
- Potential for, and relevance to, global coverage
- Data availability

The results of the thematic area and case study selection are presented in section 3.

## 2.2 Analysis of selected thematic areas

### 2.2.1 Qualitative Analysis

- The detailed qualitative analysis of each selected thematic area aims to uncover the best policy practices supporting implementation of mitigation activities, and to discuss the barriers as well as the benefits of implementation.

A review of the literature, supplemented by interviews if deemed necessary, was conducted in order to describe the best practice policies implemented in the selected countries for each thematic area and to also establish the motivation for these policies and the effectiveness of their implementation. The following questions are addressed in the qualitative analysis:

- What are the best practice policies per thematic area in Annex I or Non-Annex I countries?
- What are the social, economic and environmental co-benefits of implementing best practice policies? What kind of support is required to implement supporting incentives on a global level?
- What are the existing and potential barriers for implementation and increased ambition, and how can they be removed?
- What is the status of the thematic area in the international climate policy environment?
- What is the future outlook for the best practice policies looking ahead at potential challenges that may need to be overcome in order to ensure continued effectiveness?

Specific methodological considerations for each thematic area are given within the corresponding sections of section 4.

### 2.2.2 Quantification of reductions

This section describes the approach to estimating potential emission reductions and scaling up best practice policies to a global level.

Our methodology consisted of two distinct steps.

#### 2.2.2.1 Step 1: Estimate the impact of proposed thematic areas in selected countries

In the previous methodological steps, a number of countries were selected for each thematic area, and a key performance indicator for each thematic area was defined (see results section 3). The quantitative analysis then determines a maximum impact for each indicator of the policies in the thematic area. Between two and four countries were evaluated for each thematic area; the resulting range represents the differences in national circumstances and is carried over to the calculations undertaken on a global level.

#### 2.2.2.2 Step 2: Estimate the global reduction potential

The key performance indicators are used to determine the potential impact of the policies on a global level, in particular the global emission reduction potential.

We applied the improvements of best practices of the key performance indicator from the country cases to their respective regions and then aggregated the impact on the global level.

#### 2.2.2.3 Tools

We used a simple tool to estimate the reductions.

We calculated two basic scenarios, a reference scenario and a scenario showing the maximum global impact.

The reference scenario serves as a reference point to judge the emission reductions achieved. It will also be used to calculate the emission levels of those emissions that are not covered by the thematic areas. We included two different reference scenarios:

- Frozen technology scenario – This scenario assumes that the technology will be the same as today and no further (autonomous) efficiency improvements will be achieved.
- With existing policies scenario (External scenarios, e.g. WEO) – This scenario assures some autonomous efficiency improvements that are achieved through existing implemented policies as well as other effects. Since we will use an existing scenario, we cannot be sure what is included in the baseline and what not.

In the implementation we included a delay factor that allows to take account of the fact that policies require some time before they become effective (i.e. from the initial policy design to policy implementation). The factor will be determined for each thematic area separately.

Aside from presenting the results for each thematic area and sector separately, we also calculated the effect on global emissions of all thematic areas combined. For this purpose we take account of interactions between the energy supply and demand sectors in a simplified manner by assuming that energy efficiency measures affecting the absolute energy use will be achieved first and measures affecting the fuel mix (e.g. RE) will be introduced second.

Transparent assumptions and particular methodological considerations for each thematic area are given in the results section.

## 3 Results of screening of current activities

The results of the policy screening are provided in Table 3. They include the aggregated results for 1,200 policies of 36 countries. The table provides the most popular policy instruments. The percentages indicate the coverage of all elements necessary to support one area and of all countries.

The table illustrates that overarching climate policies exist in a lot of countries, while the picture for policies per thematic area is very mixed.

Almost all countries gave overarching climate laws or strategies and/or overarching renewable and efficiency targets. With 69% this is the highest score for all areas analysed.

A number of thematic areas stand out thereby: renewable energy support schemes in the electricity sector, building and product standards in the building sector as well as subsidies and quotas in the transport sector already play an important role to date in many countries. All areas have a coverage of around 50%. For renewables in electricity generation, the policy instruments used are diverse, including feed in tariffs, quotas and tax exemptions. For energy efficiency in buildings the preferred instruments are product standards and building codes, which are very common. Many countries use fuel quota and subsidies to increase the use of biofuels in transport.

In addition, general carbon pricing mechanisms are emerging, they already now cover 25 to 30% of the countries. This includes emissions trading schemes and $CO_2$ taxes, both often applicable to electricity generation and industry.

Energy taxes in buildings and transport are likely to play an important role, but they were not surveyed in this study.

On the other hand some areas are still largely lacking in most countries. Examples are more structural measures (first column in Table 3) related to long lasting, recyclable products in industry, urban development programmes in buildings, and modal shift in transport. Dedicated support to low carbon energy other than renewables is also limited, with electromobility programmes emerging.

### Table 3: Result of country policy analysis: most popular policy instruments and percentage coverage

| | Changing Activity | Energy efficiency | Renewables | Low carbon (other than renewables) | Non-energy |
|---|---|---|---|---|---|
| General | Strategies and targets: 69% | | | | |
| Electricity | | Performance standards 22% | Support schemes (e.g. feed-in tariff) 49% | Tax exemptions 6% | |
| | Carbon pricing schemes 25% | | | | |
| Industry | Strategies 6% | Voluntary agreements 24% | Fuel quota 36% | CCS support schemes <3% | Regulation (Not evaluated) |
| | Carbon pricing schemes: 31% | | | | |
| Buildings | Programmes 8% | Product standards and building codes 55% | Tax exemptions 40% | Not evaluated | |
| | Energy taxes: (Not evaluated) | | | | |
| Transport | Modal shift programmes 14% | Vehicle standards 23% | Direct subsidies and fuel quota 50% | E-mobility programmes 14% | |
| | Energy taxes: (Not evaluated) | | | | |
| AFOLU | Strategies 28% | | | | Regulations/planning 39% |

Scale: 0% 25% 50% 75% 100%

After evaluating the policy activity we also consider the mitigation potential per area, Table 4 provides an overview of the reduction potential of different thematic areas as provided by different studies.

Again certain thematic areas stand out somewhat regarding their potential. These include, most notably, renewable energy (in particular solar and wind energy), reducing deforestation but also fossil fuel subsidy reform. However it can also be concluded from the table that there a lot of areas with very similar potentials. This implies that action will be necessary across a wide remit of thematic areas. For the analysis here this implies that the mitigation potential is not such strong selection criteria as we originally envisioned it to be.

## Table 4: Overview of mitigation potential by initiative (Source UNEP emissions gap report 2013)

| Topic | | Wedging the gap | UNFCCC technical paper | IEA energy / climate map | Number of initiatives |
|---|---|---|---|---|---|
| Energy efficiency | Buildings heating and cooling | 0.6 | 2 | 0.5 | 25 |
| | Ban of incandescent lamps | 0.5 | | 0.5 | |
| | Electric appliances | 0.6 | | | |
| | Industrial motor systems | | | 0.4 | |
| | Cars and trucks emission reductions | 0.7 | | 0.2 | |
| Renewable energy | Boost solar photovoltaic energy | 1.4 | 1 – 2.5 | | 17 |
| | Boost wind energy | 1.2 | | | |
| | Access energy through low emission options | 0.4 | | | |
| Limiting inefficient coal use in electricity generation | | | | 0.7 | 0 |
| Methane and other climate pollutants | Methane from fossil fuel production | * | 1.1 | 0.6 | 7 |
| | Other methane and other climate pollutants | | | | |
| | Efficient cook stoves | * | | | |
| Fluorinated greenhouse gases | | 0.3 | 0.5 | | 3 |
| Fossil fuel subsidy reform | | 0.9 | 1.5 – 2 | 0.4 | 1 |
| International transport | | 0.2 | 0.3 – 0.5 | | 4 |
| Agriculture | | 0.8 | 1.3 – 4.2 | | 1 |
| Reduce deforestation | | 1.8 | 1.1 – 4.3 | | 15 |
| Waste | | | 0.8 | | 1 |
| Companies | Top-1000 companies emission reduction | 0.7 | | | 4 |
| | Supply chain emission reductions | 0.2 | | | 1 |
| | Green financial institutions | 0.4 | | | 1 |
| | Voluntary offset companies | 2.0 | | | 0 |
| Voluntary offsets consumers | | 1.6 | | | 0 |
| Major cities initiative | | 0.7 | | | 3 |
| Sub-national governments | | 0.6 | | | 2 |
| **Total** | | 9.7** | Not added | 3.1 | |

Based on the analysis of the policy activity (Table 3) and the mitigation potential (Table 4) we identified a number of thematic areas that were taken for closer consideration. These are summarized in Table 5. The highlighted thematic areas on the left part of the table fulfil the 1st criteria mentioned in Section 2.1.3: they have a relatively large emission reduction potential and a lot of action ongoing that can be replicated in other countries or be improved in the countries where (weak) action already exists. The thematic area highlighted on the right side of the table satisfies the second criteria in Section 2.1.3: There is only limited, however, relatively successful action ongoing but a relatively high mitigation potential exists.

## Table 5: Extended list of possible thematic areas (indicative mitigation potential in brackets)

| High current activity rate | Low current activity rate |
|---|---|
| *Support schemes for electricity generation with renewable energy (up to 2.5 $GtCO_2e$)*<br>*Electric appliances and lighting (up to 0.6 $GtCO_2e$)*<br>*Fuel efficiency standards for light duty vehicles (up to 0.7 $GtCO_2e$)*<br>Carbon pricing mechanism (n.a.)<br>Reduce deforestation (up to 4.3 $GtCO_2e$) | *Methane from fossil fuel production (1.1 $GtCO_2e$)*<br>Limiting inefficient coal use in power (up to 0.7 $GtCO_2e$)<br>Zero energy buildings<br>Fossil fuel subsidy reform (up to 2 $GtCO_2e$)<br>Increase efficiency (industrial motors) and use of renewables in Industry (up to 0.4 $GtCO_2e$)<br>Waste (1 $GtCO_2e$)<br>Fluorinated gases (0.5 $GtCO_2e$)<br>E-Mobility (n.a.) |

To achieve a balance, four thematic areas were chosen (Table 6) for further analysis. The table provides a reason for the choice of each of these thematic areas.

**Table 6: Selected thematic areas and their rational for selection**

| Selected thematic area | Rationale for selection |
|---|---|
| Support schemes for electricity generation from renewable energy | High activity rate (about half of the analysed countries have implemented a support scheme)<br>High mitigation potential (UNEP gap report 2013: 2.5 $GtCO_2e$)<br>Short term implementation still possible, with long term transformational effect |
| Electric appliances and lighting | High activity rate (about half of the analysed countries have implemented a support scheme)<br>High mitigation potential (UNEP gap 2013: 0.6 $GtCO_2e$ in 2020)<br>Often cost neutral in the long term; potential to increase ambition till 2020 |
| Fuel efficiency standards for light duty vehicles (0.7 $GtCO_2e$) | Medium activity rate (about a quarter of the analysed countries have implemented a support scheme)<br>High mitigation potential (UNEP gap 2013: 0.7 $GtCO_2e$ in 2020)<br>Often cost neutral in the long term; potential to increase ambition till 2020 |
| Methane from fossil fuel production (1.1 $GtCO_2e$) | Low activity rate (only few countries have measures implemented)<br>High mitigation potential (UNEP gap 2013: 1.1 $GtCO_2e$ in 2020)<br>Low cost option |

We selected example countries (Table 7) for the evaluation based on the following criteria:

a) High level of ambition
b) Good data availability
c) Representative for the global situation

In parallel we identified an indicator for each thematic area that could then be used to estimate the global emission reduction potential. The indicator aims on the one hand to reflect the development in the thematic areas in the best way possible and on the other hand to allow for easy integration into a calculation tool for the calculation of the global impact. The indicator will then be used in the calculation of the global emission pathway.

**Table 7: Overview of the countries selected per thematic area**

| Thematic area | Description of measures | Countries with best practice policies |
|---|---|---|
| Fuel efficiency standards for light duty vehicles | Reduce the specific fuel consumption of new vehicles entering the fleet | US, China, Japan, EU |
| Electric appliances and lighting | Reduce electricity use of new appliances | EU, South Korea, Japan |
| Methane from fossil fuel production | Reduce flaring of emissions; reduce leakage rate of pipelines | Russia, United Arab Emirates, Norway, US. |
| Support schemes for RES-E | Increase share of RES in the Electricity supply | China, Germany, UK, Morocco. |

Source: own evaluation

# 4 Results per thematic area

## 4.1 Renewable Energy Support (RES)

### 4.1.1 Germany: Feed in Tariff

The German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG), which was enacted in 2000 and subsequently amended in 2004, is the main policy instrument to promote renewables in the electricity sector. The EEG replaced electricity feed-in legislation (Stromeinspeisungsgesetz, StrEG) enacted in 1990 (IEA 2007) and has been mainly responsible for the country's successful efforts to progress towards ambitious RE targets (i.e. Germany expects to exceed the target set under the Directive 2009/28/EC of 18 % of gross final energy consumption originating from RE sources by 2020. It is also envisaged that at least 35 % of electricity production will come from RE sources by 2020) (BMU, 2013).

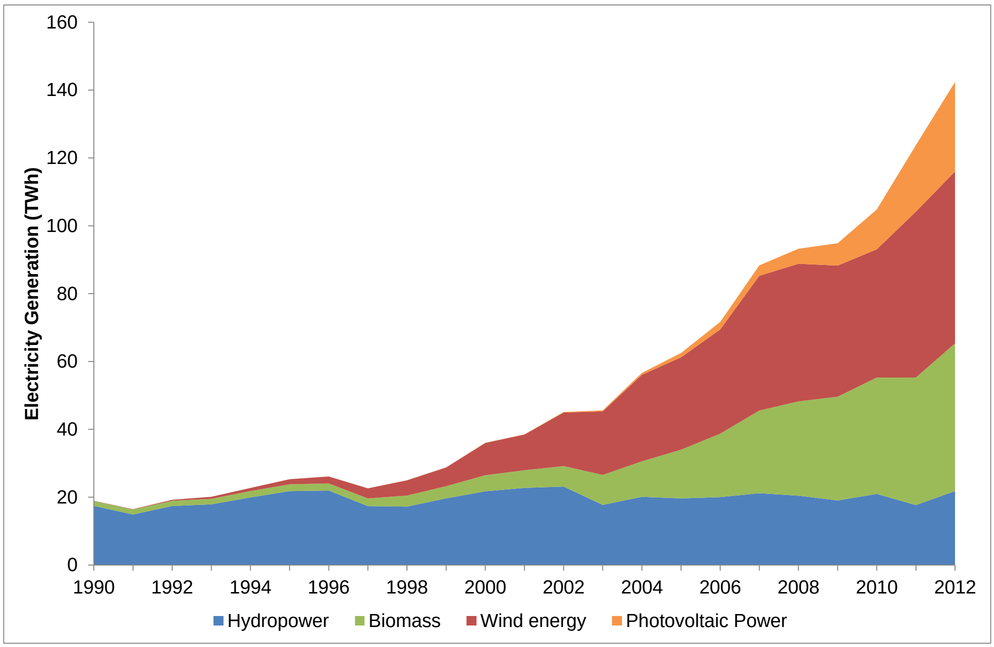
The EEG provides a guaranteed rate for electricity production based upon a feed in tariff (FIT) schedule that is differentiated according to the RE source, location, size of the installation and technology. 'The relative differentiation of tariffs is based on equalisation of cost across all technologies; rates are set so that producers should make the same profit regardless of the cost of each technology, and therefore be indifferent towards investing in any particular technology' (IEA, 2007). The amount paid depends upon the year in which the installation was built, with rates guaranteed for a period between 15 and 30 years subject to the technology.[3] The tariffs also

[3] For example, all onshore wind developments receive the same FIT payment for the first five years, which was set in the 2012 EEG at 8.93 € cents/kWh. Following the initial payment, onshore wind projects with the strongest wind resources receive a lower payment (i.e. base payment) of 4.87 € cents/kWh for the remaining 15 years of the FIT contract. Onshore wind developments with less strong resources receive the initial payment for a longer period before this is eventually replaced by the base payment. However, the FIT payment for offshore wind developments was set at a higher rate in the 2012 EEG with an initial payment of 15.0 € cents/kWh and a basic payment of 3.5 € cents/kWh (refer to http://www.erneuerbare-energien.de/fileadmin/ee-import/files/english/pdf/application/pdf/eeg_2012_verguetungsdegression_en_bf.pdf).

decline annually according to a fixed digression rate that takes into account the technical development of each technology.[4]

In 2012, RE shares of electricity supply in Germany reached 23.5 %, compared to only 3.4 % in 1990 and the country is making good progress towards its 2020 target of 35 % (BMU, 2013). Figure 2 illustrates the considerable increase in electricity generation from wind (i.e. increase from 10 TWh in 2000 to 51 TWh in 2012), solar (i.e. increase from 0.1 TWh in 2000 to 26 TWh in 2012) and biomass (i.e. increase from 5 TWh in 2000 to 44 TWh in 2012) technologies that have been incentivised by the feed in tariff policy in Germany.

**Figure 2: Development of electricity generation from renewable energies in Germany**




Source: BMU (2013)

Although the feed in tariff policy has undoubtedly encouraged the development of RE in Germany, the debate over the cost effectiveness of the policy is ongoing in the country with some commentators arguing that the EEG surcharge[5] is imposing excessive costs on German households and businesses – especially given that Germany already has amongst the highest electricity prices in the EU (Futon, 2012). However, from the other perspective the costs of the policy may have been over emphasised (BMU, 2009) and the co-benefits overlooked.[6] For example, the growing share of renewables sold on the electricity spot market is also putting downward pressure on wholesale market prices when the production of solar and wind is high.

[4] The degression rate for onshore wind was set at 1.5 % in the 2012 EEG, however the degression rate for offshore wind was set at 0 % until 2017 (refer to http://www.erneuerbare-energien.de/fileadmin/ee-import/files/english/pdf/application/pdf/eeg_2012_verguetungsdegression_en_bf.pdf).

[5] The differential costs between the guaranteed remuneration payments made to the plant operators and the revenues on electricity market are passed through to the so-called privileged and non-privileged power consumers based on different rates.

[6] The policy measure is associated with many co-benefits that include job creation in the renewable energy sector, which has experienced an increase from 160,500 people employed in 2004 to 381,600 people in 2011 (BMU, 2013). The shift to renewables is also associated with enhanced energy security with less dependence on fossil fuels that is equivalent to a saving of 322.5 TWh of primary energy from the use of renewables in 2012 (BMU, 2013).

In order to ensure that the policy remains cost effective in the long term several important reforms were introduced in the EEG 2012.

- In response to the strong growth in the volume of FIT contacts increasing the size of the EEG surcharge, the 2012 EEG lowered FIT payments for onshore wind and solar PV generators and accelerated FIT digression schedules for biomass, onshore and offshore wind, geothermal and solar PV (Futon, 2012).
- A new 'market premium option' has been introduced providing FIT eligible generators with the possibility of selling electricity directly into the spot market, with the spot market revenue being supplemented with a FIT payment that varies inversely with the average monthly electricity price. It is envisaged that this reform will incentivise investment in more competitive renewable electricity (Futon, 2012).
- In order to minimise upside volume surprises (i.e. experienced by the price development of solar PV) a 52 GW capacity threshold on the cumulative amount of PV that is eligible for FIT payments under the EEG has been introduced – above this threshold incentives will not be recoverable from the EEG surcharge (Futon, 2012).

It is evident with these reforms that the EEG is evolving from a policy measure that primarily focused on scaling up domestic RE generation (i.e. 2000 to 2009) to subsequent phases of the policy where adjustments have been necessary in order to respond to the declining costs of renewables (i.e. 2009 to 2011) and the challenges of incorporating greater volumes of RE into the wholesale market (i.e. 2012 onwards). The policy has therefore, to a certain extent, removed some of the previous inflexible (and potentially expensive) guarantees for RE investment and is now gradually moving towards a model whereby there is more emphasis on market forces to promote the development of renewables. The viability of the policy may ultimately depend upon the future distribution of the EEG surcharge[7], and wider reforms to the electricity market to incorporate RE into the electricity grid.

### 4.1.2 China: Renewable Energy Law

In 2005 the Renewable Energy Law was passed by the Chinese government, which created a framework based upon four mechanisms to promote the growth of China's RE supply (Schuman, 2010):

- A national renewable energy target;
- A mandatory connection and purchase policy;
- A feed in tariff system;
- A special fund for renewable energy development.

Following the introduction of the Renewable Energy Law, the State Council's energy department announced in 2007 mid and long term national targets for RE production with the aim of achieving 15% of the country's primary energy consumption from non-fossil sources such as RE and nuclear power by 2020 (Schuman, 2010). In order to achieve this target, the Renewable Energy Law included provisions that required grid companies to both connect and purchase all of the RE power generated within their coverage area. The Law also directed the establishment of a set of feed in

[7] At present the EEG benefits industrial consumers who are sheltered from the full costs of the EEG surcharge and also benefit from the downward pressure on wholesale market prices due to increased renewables generating electricity.

tariffs for different RE technologies, which guarantee an electricity price above the market rate that the grid company will pay the generator of RE.[8]

To ensure that the feed in tariffs provided an appropriately priced incentive that was cost effective, China firstly operated several feed in tariff programmes on a project by project basis through competitive bidding. Following this experience, a nationwide program was launched for the wind sector in 2009 with a comprehensive feed in tariff schedule that eliminated the need for further bidding on feed in tariffs. The tariff schedule is comprised of four tiers 'with the highest tariffs[9] available for projects in regions with the least abundant wind resources.' (Schuman, 2010) A nationwide feed in tariff is also available for electricity generated from solar PV[10] and biomass-fired power plants[11] following similar learning phases through feed in tariff bidding.

The Renewable Energy Law also established in 2006 a Renewable Energy Development Special Fund (financed through a central government budget allocation for renewable energy), which would support the following activities (Schuman, 2010):

- Research in the science and technologies associated with developing and deploying RE, setting standards and demonstration projects;
- RE program for basic rural energy needs;
- Establishing stand-alone electricity projects in remote areas and islands;
- Exploration of RE resources, evaluation, and relevant information system;
- Encouraging the localization of production for equipment used in the deployment of RE.

It is evident from Figure 3 that the country has experienced a rapid growth in the generation of gross electricity from RE between 2005 and 2011 (albeit from a low starting point) following the introduction of the Renewable Energy Law.[12]

[8] 'The additional cost of the feed-in tariff over and above the cost of conventional power is paid by a national surcharge on end-users of electricity' (Schuman, 2010).

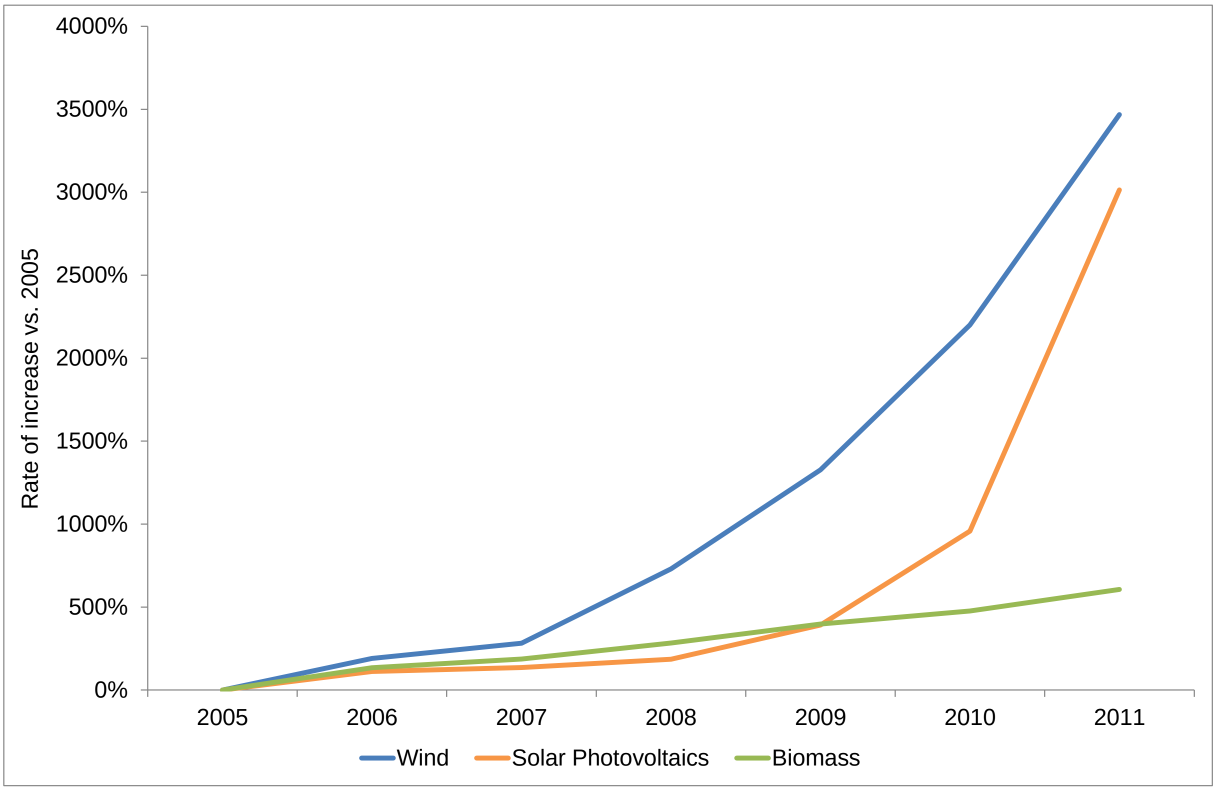
[9] 'The national feed-in tariff is divided into four tiers ranging between 0.51 to 0.61 RMB/kWh' (Schuman, 2010).

[10] 'The development of solar PV power generation projects nationwide divides solar projects into two categories: Projects approved prior to July 1, 2011, which have completed construction and have achieved commercial operation prior to December 31, 2011. These projects are entitled to a tariff of RMB 1.15 (approximately U.S. $0.177) per kWh. Projects approved after July 1, 2011 (or approved prior to that date but which cannot be completed before the end of 2011). These projects are entitled to a tariff of RMB 1 (approximately U.S. $0.154) per kWh' (Wigmore et al, 2011).

[11] 'China announced a national feed-in tariff for biomass-fired electricity in July 2010, set at 0.75 RMB ($0.11) per kilowatt hour' refer to http://switchboard.nrdc.org/blogs/bfinamore/china_as_the_worlds_number_one.html.

[12] For example, wind power has increased from 2,028 GWh of gross electricity generation in 2005 to 70,331 GWh in 2011. A similar rate of increase has also been experienced by solar PV growing from 84 GWh of gross electricity generation in 2005 to 2,532 GWh in 2011. The growth in gross electricity generated from primary biomass has been relatively lower over the period than for wind and solar PV – however nevertheless the technology has increased from 5,200 GWh in 2005 to 31,500 GWh in 2011 (IEA, 2014).

**Figure 3: Rate of increase in gross electricity generation from RE compared to 2005**




Source: IEA (2014), Own Calculation

However, with regards to progress towards the RE target set in the Renewable Energy Law the current proportion of renewable energy production as a share of primary energy consumption was only 7 % in 2011.[13] Progress towards the 2020 target has been hindered by the failure to fully implement on the ground the mandatory obligations placed on grid companies to connect all renewable projects and purchase the power produced. Long delays have been experienced with connecting renewable energy capacity in the country[14] due in part to the lack of resources and incentives to invest in the grid infrastructure necessary to facilitate the growth in renewables (Schuman, 2010). In order to improve the implementation of the RE support measures the following reforms were made to the 2009 amendments to the Renewable Energy Law:

- 'Adding measures intended to improve implementation of the mandatory connection and purchase policy, such as a quota system, a priority dispatch system, and technical standards for interconnection to the grid'(Schuman, 2010);
- 'Streamlining the RE fund that provides financial incentives for the deployment of renewable energy and importantly subsidises grid companies for the costs of integrating RE that they cannot recover from electricity sales to consumers'(Schuman, 2010);
- 'Increasing central government oversight of provincial and local renewable energy development planning to help with the co-ordination of transmission extensions'(Schuman, 2010).

13 Calculated based on data provided in the BP Statistical Review of World Energy 2013 (refer to http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf

14 'More than 30 % of China's wind capacity was not connected to the grid at the end of 2009' (Schuman, 2010).

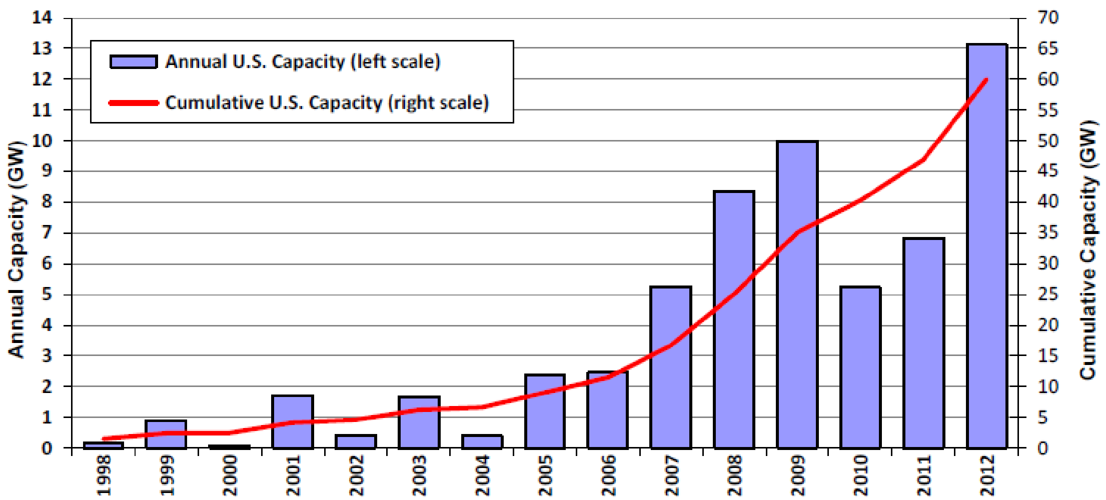
China has made considerable progress in recent years to increase their RE capacity following the introduction of the Renewable Energy Law, although based on their experiences with implementing the various RE support policies it is evident that additional effort will be required in order to achieve the ambitious targets that the government has set and take advantage of the co-benefits of increasing renewables (i.e. air quality improvements, energy security). 'The amendments to the Renewable Energy Law demonstrate that China's central government is committed to overcoming some of the barriers that have stood in the way of achieving this goal' (Schuman, 2010). The future success of the policy will depend upon the ability of the transmission grid to incorporate increasing amounts of renewable energy into the electricity system that will require responsive policy design and strong enforcement.

### 4.1.3 USA: Production Tax Credit

In 1992 the Energy Policy Act introduced for the first time production tax credits (PTC), which provided a financial incentive in the form of a tax credit for each kilowatt-hour of electricity produced by a qualified project during the first ten years of operation for a range of RE technologies (Brown, 2012). Depending upon the RE technology, a corporate tax credit of either 1.1 cents/kWh (i.e. applicable for landfill gas, open-loop biomass, municipal solid waste resources, qualified hydropower and marine and hydrokinetic projects) or 2.2 cents/kWh (i.e. applicable for electricity from wind, closed-loop biomass and geothermal resources) is received by project developers in accordance with the PTC policy (EPA, 2013). The PTC, which is adjusted annually for inflation, has expired and been renewed on several occasions and most recently in January 2013 with the passage of the American Taxpayer Relief Act of 2012.

When the Energy Policy Act was signed in 1992, the motivation for introducing the PTC was primarily to lower the cost of RE technologies by encouraging more innovative designs and applications that would ultimately lead to an accelerated development of RE technologies. As Figure 4 illustrates, the wind industry in particular has benefitted from the introduction of the PTC policy with the cumulative total capacity reaching over 60,000 MW in 2012, which coincided with the largest annual addition of new capacity in wind power of 13,131 MW. The growth in electricity generation from wind power has been substantial in the United States between 1998 and 2012, due in part to improvements in the cost and performance of wind power technology that has been incentivised by the PTC policy (U.S. Department of Energy, 2013).

**Figure 4: Development of wind power in the United States between 1992 and 2011**




Source: U.S. Department of Energy (2013)

Although the PTC policy has certainly encouraged the development of RE technologies over the last two decades the financial incentives for the long term investment in renewables has been insufficient due to the uncertainty that has arisen from the numerous occasions when the PTC policy has expired and then subsequently been renewed. For example, the American Wind Energy Association (AWEA) has previously argued that ‘the expiring nature of production tax credits has created a volatile U.S. wind market with new installations ramping up just before the credits expire[15], the following year having very little new wind development’ (Brown, 2012). However, it is also important to acknowledge other barriers to RE deployment in the USA such as the continued low natural gas prices, modest electricity demand growth and limited near-term renewable energy demand from state RPS[16] policies (US Department of Energy, 2013).

At present, the PTC policy expired at the end of 2013 – however a provision within the American Tax Relief Act of 2012 allowed for qualified projects under construction before January 1st 2014 to also be eligible for financial support (KPMG, 2013). The provision represented a substantial change from the prior placed in services rule that applied to such projects and will allow for more RE projects to be financially supported in the absence of an extension to the PTC policy (Deloitte, 2013). At the time of writing, the Expiring Provisions Improvement Reform and Efficiency (EXPIRE) Act was approved by the Senate Finance Committee and will be subsequently debated on the floor of the Senate – if passed the bill will allow wind developers to be eligible for the PTC policy if they begin construction before the end of 2015 (Schueneman, 2014). The Committee Chairman Ron Wyden emphasised that this will be the last time that the Senate Finance Committee consider extensions to tax provisions as the priority in the future will be on tax reform to address the existing limitations of the policy measure.

Many advocates of the PTC refer to the associated co-benefits of the policy, such as the creation of 30 000 jobs from the 470 facilities that support the increasing the share of RE in the utility generation mix (Brown, 2012). Further environmental benefits (i.e. health benefits from lower levels of air pollution) and enhanced energy security (due to less dependence on foreign fossil fuels) arising from the PTC are not quantified in the literature but are also important co-benefits to consider when evaluating the impact of the policy measure.

The future outlook of the policy remains very uncertain with current efforts to extend the PTC policy until 2015 currently only serving as a stop gap before a more fundamental reform of the policy measure takes place. In the future the PTC could be allowed to expire, be extended or phased out over time. According to Brown (2012) an argument for the expiration of the PTC could be that it would encourage wind developers to adopt certain behaviour (i.e. maximise turbine performance, minimise manufacturing costs) that will be necessary to improve the competitiveness of the industry on an unsubsidised basis. However, this option is not the preference of President Obama who recently announced in his 2015 federal budget proposal his intention to make the PTC permanent (KPMG, 2014) to overcome the political uncertainty that has previously hindered the implementation of the policy, although it remains to be seen if Obama’s budget will be successfully passed by Congress.

[15] ‘The wind PTC has expired three times since 2000 (in 2000, 2002, and 2004), and the wind industry experienced precipitous drops in annual wind capacity installations in each of those years’ (Brown, 2012).

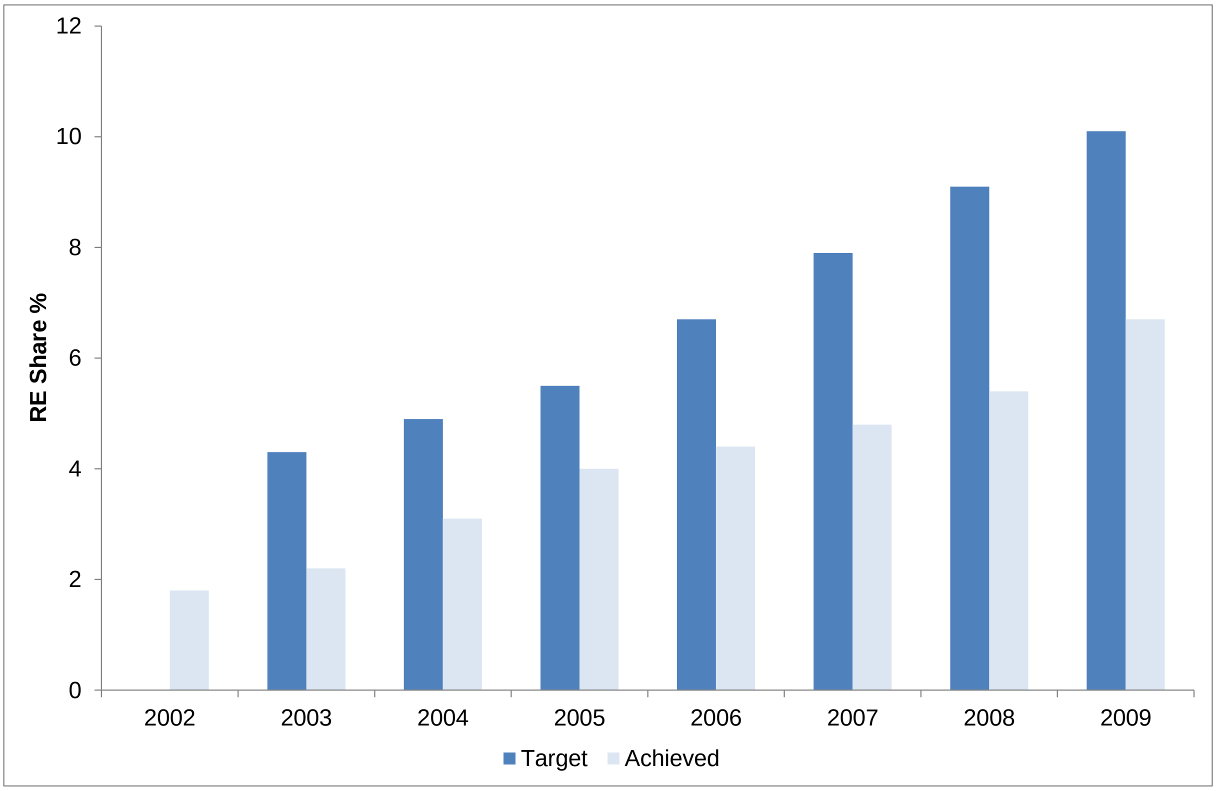
[16] A Renewables Portfolio Standard (RPS) is ‘a policy that requires a certain percentage of electricity sold or generated within a defined geographical area be derived from qualified renewable energy resources’ (Brown, 2012).

### 4.1.4 United Kingdom: Renewables Obligation

The Renewables Obligation is the main policy measure of the UK government to encourage the growth of electricity generation from renewable sources. The policy measure, which came into effect in England, Wales and Scotland in 2002 and in Northern Ireland in 2005, places an obligation on licensed suppliers of electricity in the UK to ensure that a share of their supply to customers originates from eligible sources of renewable energy. Annually the obligation is set by the UK and the devolved administrations as a certain number of Renewables Obligation Certificates (ROCs) per MWh of electricity supplied to customers. Based upon the reported renewable generation, ROCs are issued to accredited generators by Ofgem (i.e. the National Regulatory Authority). In order to comply with the Renewables Obligation licensed suppliers are required to either present the ROCs acquired from generators, make a fixed 'buy out' payment per ROC or a combination of both (Ofgem, 2014).

The motivation for this policy measure is to adhere to the terms of the Renewables Directive (2009/28/EC), whereby the UK government has accepted a legally binding EU target of obtaining a 15% share of energy from renewable sources in gross final consumption of energy by 2020. Given that only 1.3 % of the UK's gross final energy consumption originated from renewable sources in 2005, the target set in the Renewables Directive is very challenging and the UK government expects that approximately 30 % of electricity demand will need to be sourced from renewables in 2020 to meet the EU target ("National Renewable Energy Action Plan for the United Kingdom").

**Figure 5: Renewables Obligation Performance 2002-2009**




Source: Woodman & Mitchell (2011)

However, the implementation of the Renewables Obligation in the early phase was associated with slow progress - failing to meet any of the annual targets (i.e. obligation level) set between 2002 and 2009. Obtaining planning permission and access to networks are often cited as barriers to the deployment of renewable development in the UK, although it became evident through the implementation of the Renewables Obligation that limitations in the design of the policy may also have been responsible for the lower than expected growth rates. Design limitations of the policy included (Woodman and Mitchell, 2011):

Technology neutral: The UK government were initially reluctant to try and pick 'winners' and therefore adopted a neutral approach whereby all technologies received one ROC/MWh of electricity generated. However, this approach favoured more mature technologies (i.e. onshore wind) than other less mature technologies (i.e. wave, offshore wind) and left certain renewable options with insufficient incentives compared to the associated risk.

Uncertainty in ROC value: If suppliers approached the target for any year's obligation, the value of the ROC declined (i.e. due to the lower demand and this reflected greater compliance with the Renewables Obligation). If the target was met, the value of the ROC would reduce to zero as there would be no demand at all. The uncertainty with the ROC value was problematic for developers seeking funding for renewable energy projects.

In order to address these limitations, the Renewables Obligation was reformed in 2009 to (Woodman and Mitchell, 2011):

Differentiate renewable technologies based upon a banding system, which results in less mature technologies such as offshore wind receiving more ROCs than more mature technologies and therefore more funding to encourage faster rates of deployment.[17]

Prevent a ROC price crash if the annual Renewable Obligation is met, by introducing the concept of 'headroom' i.e. setting the obligation for a period based upon the expected level of renewable generation plus a further proportion of ROCs expected to be issued in the relevant period.[18]

In April 2010 the scheme was also extended to 2037 in England, Wales and Scotland (it was extended to 2037 in Northern Ireland in 2013), which provides greater long-term certainty to investors and this should further incentivise renewable deployment in the UK (Ofgem, 2014).

Following these reforms to the Renewables Obligation, 11.2% of the total electricity supplied in the UK was supplied by renewable technologies in 2012-13, equivalent to 35 TWh of renewable generation (Ofgem, 2014). The shift to renewable energy also has positive co-benefits with regards to both local air quality and energy security. It is evident that the Renewables Obligation has encouraged the increased deployment of renewables in the UK; however it is questionable whether or not an alternative policy measure would have been more successful and cost effective. Indeed the recent reforms to the Renewables Obligation have transformed the policy from a traditional quota obligation and tradable certificates scheme into a hybrid policy instrument with similarities to a feed in tariff (i.e. price certainty, differentiated by technology) demonstrating the need to address limitations with the original scheme.

The future success of the Renewables Obligation will depend upon the intervention of the UK government with regards to the banding system for ROCs along with the on-going removal of important barriers to renewables deployment such as planning permission and access to

[17] The Government has reviewed the banding levels for appropriate incentives for the period 2013-2017. These bands include a reduction in the tariff for onshore wind to 0.9 ROCs/MWh and an increase for small wave and tidal stream projects, under 30 MW, to 5 ROCs/MWh

[18] Headroom works by providing a set margin between the predicted generation (supply of ROCs) and the level of the obligation (demand for ROCs). This helps reduce the possibility of supply exceeding the obligation in any given year and therefore reducing the market value of a ROC (DECC, 2014)

networks.[19] The banding of technologies in the Renewable Obligation has proved to be highly contentious, with the previous Environmental Minister Chris Huhne criticising the decision to reduce the ROC subsidy for onshore wind arguing that this increase the cost of meeting the UK's renewable energy target (Huhne, 2014). However, there is political pressure to reduce the growth of onshore wind in the UK due to public opposition (Mason, 2014) and a debate over the impact of EU regulation on the increasing costs of electricity bills may further undermine the UK government's attempts to meet its obligations.

### 4.1.5 Quantitative assessment

#### 4.1.5.1 Methodological assumptions for RES thematic area

##### 4.1.5.1.1 Country-level quantification

To quantify the effect of renewable electricity targets, our approach follows these steps:

1. 2010 electricity generation per country by energy carrier (coal, natural gas, oil, renewable, nuclear) is taken from IEA Energy Balances (IEA, 2012a)
2. Total electricity generation in 2020 is based on 2010 generation and growth from Current Policies Scenario (CPS) of IEA World Energy Outlook 2012 (IEA, 2012b) by region. Total electricity generation is taken to be the same in each scenario (Frozen, Reference, Average, Policies).
3. The carrier mix in electricity generation in 2020 without target is determined.
   i. Frozen technology pathway: RES carriers maintain at the 2010 production level. Remaining 2020 generation is split over other carriers by their 2010 share.
   ii. Reference pathway: Share per energy carrier is based on regional projections on the growth rate per carrier from the World Energy Outlook 2012 Current Policies Scenario (IEA, 2012b). This scenario already includes some policies affecting renewable electricity generation.
   iii. Average pathway: Average of the Frozen Technology and Reference pathways.
4. As some countries have a generation target and others have a capacity target, the share of renewables in the Policies pathway is determined based on two different approaches:
   i. Generation target: The share of renewables in the carrier mix is based on the target.
   ii. Capacity target:
      - Regional load hours per technology and region are calculated from 2010 capacity and generation from the IEA World Energy Outlook 2012 (IEA, 2012b).
      - Electricity generation in 2020 is calculated by multiplying the capacity target with the load hours for each technology. For renewable technologies for which no target is adopted, the installed capacity is assumed to stay at the current level.
5. The energy carrier mix in the Policies scenario is determined using the following steps:

[19] It is envisaged by DECC (2012) that RO banding review will put the UK on track in the most cost effective way to deliver 108 TWh/y of large-scale renewable electricity generation in 2020 consistent with the UK's renewable target set under the Renewables Directive.

i. If the share of renewables in the Average pathway exceeds the share of renewable determined in step 4, this share is applied. Otherwise the result of step 4 is used.

ii. The shares of the other energy carriers are kept at the same ratio as in the Average pathway.

6. The emissions for all three pathways (Frozen, Reference and Policies) are calculated by multiplying the generation per carrier with country-specific emission factors of electricity generation per energy carrier taken from IEA (2012c).

The steps indicated here imply the following assumptions:

1. Electricity generation in 2020 is assumed to be the same in all pathways (i.e. support policies for renewable electricity do not influence total electricity production)
2. In absence of policy targets for a specific renewable energy source, no growth of renewable energy generation is assumed.
3. The technology and regional-specific load hours are assumed to stay constant at the 2010 level.
4. The country-specific emission factors per carrier are assumed to stay constant.

#### 4.1.5.1.2 Regional and global upscaling

Multiple approaches can be taken to upscale the results of the country-level analysis to first a regional and, consecutively, a global level. Three approaches were taken into consideration:

- Approach 1. Emissions trend approach: In this approach the 2010-2020 emissions trends in the selected countries are applied to the 2010 emissions of the other regions.
- Approach 2. Emission intensity approach: This approach takes the total electricity generation (TWh) projections for all regions as the basis for the analysis. The 2020 policy scenario emissions are calculated by applying the 2020 emission factor of electricity generation resulting from the country-level analysis to the electricity generation in the appropriate regions.
- Approach 3. Emission intensity trend approach: This approach takes the 2010-2020 trend in emission intensity of the country-level analysis and applies this trend to the 2010 emission intensity of the regions. The 2020 emissions are calculated by multiplying the resulting 2020 emission intensity with the 2020 electricity generation from the reference scenario.

By applying the overall emission trend, using method approach 1 would implicitly assume that the trend of electricity production is similar in the countries upscaled to, which will not be the case for all regions due to strong differences in electricity consumption worldwide. Method Approach 2 better reflects the regional differences in the growth rate of electricity production. However, this method does not take into account the different fuel mix starting points of the regions. The emission intensity of electricity is highly dependent on the mix of fossil energy sources. Therefore, the use of country specific emission intensities applied to whole regions will not properly reflect the regional differences in electricity mix.

Therefore, we choose to apply method approach 3. This method reflects both the different regional electricity production growth rates and the different starting point in terms of emission intensity. Table 8 indicates which countries are used as basis for upscaling to which regions in the regional approach. In case the emissions in the reference pathway for a region or country grouping are lower than the emissions in the policies pathway, the reference pathway emissions are applied. The World Energy Outlook Current Policies Scenario (IEA, 2012b) is used as a basis for the global upscaling, using the scenarios for the OECD countries, non-OECD countries and Africa. The 2020 Reference emissions are directly taken from the World Energy Outlook Current Policies Scenario. For the Frozen Technology pathway the 2010 emission intensity is applied to the 2020 electricity generation from the Current Policies Scenario.

**Table 8: Approach for upscaling quantitative analysis of RES-E targets**

| Best practice | Region upscaled to | Reason |
|---|---|---|
| Germany | OECD | OECD countries share a similar historical development pattern and face similar challenges, responsibilities and capabilities for increasing their renewable energy shares. |
| UK | n.a. | n.a. |
| China | Non-OECD minus Africa | China is one of the most ambitious countries in the non-OECD group. However, its particular economic situation and technology mix makes it less relevant for African countries than Morocco, which is also available for upscaling. |
| Morocco | Africa | Morocco is one of the most ambitious African countries. Morocco's renewable energy portfolio is made up of a mix of technologies, just as the African continent has high potential for various technologies. |

#### 4.1.5.2 Results of quantitative assessment

RES-E support policies in Germany, the United Kingdom, China and Morocco are quantified. The input data for the quantification are shown in Table 9.

**Table 9: Target input data for quantification of RES-E support**

| Country | 2020 RES-E generation target | 2020 capacity target (GW) | WEO region used for regional growth rates and load hours |
|---|---|---|---|
| Germany | 35% | No target | European Union |
| UK | 31%<br>(UK NREAP, 2009) | No target | European Union |
| China | No target[20] | Wind (onshore): 170; Wind (offshore): 30<br>PV: 47; CSP: 3; Hydro: 420; Biomass: 30<br>(Davidson, 2013 & CNREC, 2012)) | China |
| Morocco | No target[21] | Wind: 2; Solar: 2; Hydro: 2<br>(REN21 MENA, 2013) | Africa |

Figure 6, Figure 7 and Table 10 summarise the results of the quantification. As can be seen from the frozen technology pathway electricity production is projected to increase until 2020 in all countries. The policies pathway represents a reduction below the frozen technology and reference pathway in all countries. However, in China there is no absolute emission reduction due to the

[20] China has no renewable electricity generation target. However, there is a 15% renewable energy in primary energy consumption target for 2020 (Climate action tracker, 2012)

[21] In some sources a 42% generation target is mentioned for Morocco (e.g. IRENA, n.d.). However, this is incorrect as the 42% is in fact a capacity target.

strong increase in electricity production. The policies in the UK, although less ambitious in terms of renewable energy share compared to Germany, lead to the highest emission reduction trend and the lowest emission intensity in 2020. This is due to the different mix of fossil energy carriers (i.e. in the UK there is a high share of gas-fired electricity generation, while in Germany there is a high share of coal-fired electricity generation). In Table 11 the shares of different energy carriers in the different scenarios are shown.

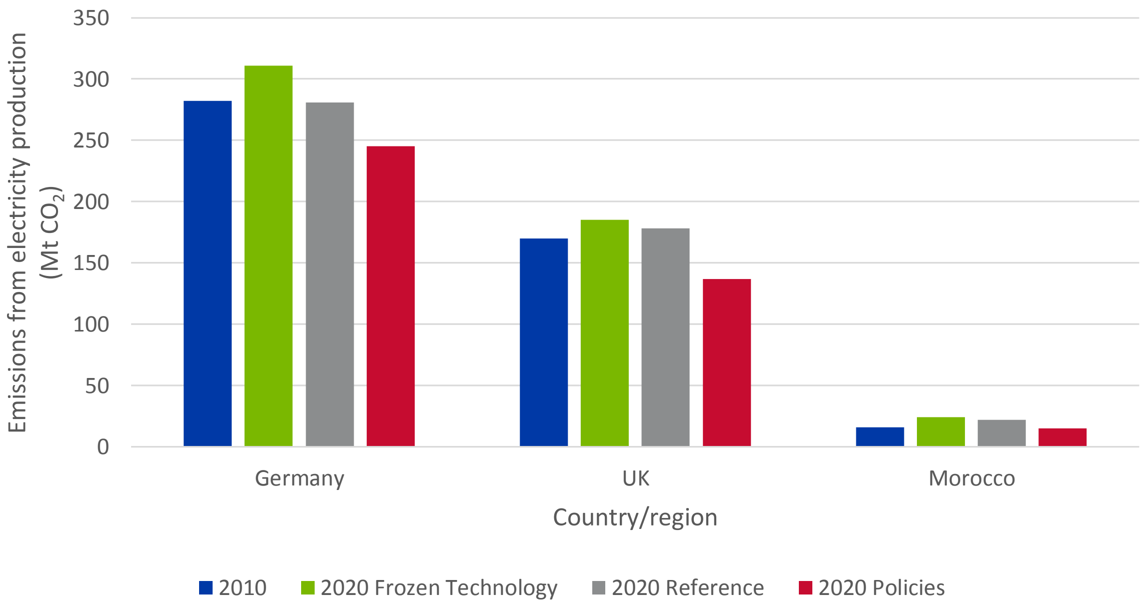



**Figure 6: Results of country-level quantification for RES-E targets (Germany, UK and Morocco)**

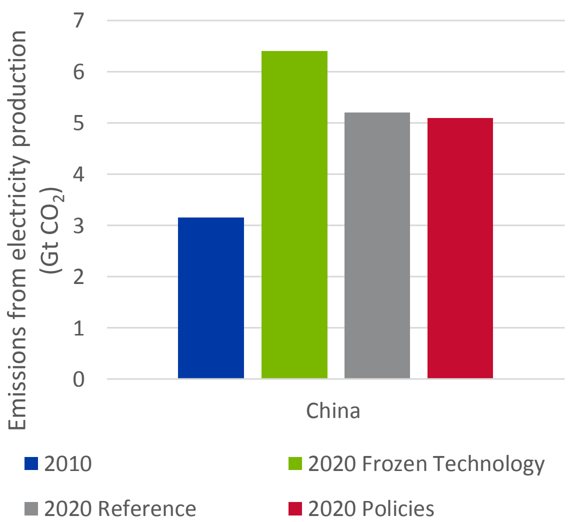



**Figure 7: Results of country-level quantification for RES-E targets (China)**

**Table 10: Results of country-level quantification for RES-E support policies**

| | Germany | UK | China | Morocco |
|---|---|---|---|---|
| 2010 emissions ($GtCO_2$) | 0.28 | 0.17 | 3.2 | 0.02 |
| 2020 emissions policies pathway ($GtCO_2$) | 0.2 | 0.1 | 5.1 | 0.02 |
| 2020 reduction below reference pathway ($GtCO_2$) | 0.04 | 0.04 | 0.97 | 0.01 |
| 2020 reduction below frozen technology pathway ($GtCO_2$) | 0.07 | 0.05 | 1.23 | 0.01 |
| With policies emission trend (% /a) | -1.3 | -2.1 | 4.5 | -0.2 |
| 2010 emission intensity ($gCO_2/kWh$) | 454 | 450 | 750 | 697 |
| 2020 emission intensity with policies ($gCO_2/kWh$) | 367 | 336 | 632 | 464 |
| With policies emission intensity trend (% /a) | -2.1 | -2.9 | -1.7 | -4.0 |

**Table 11: Shares of energy carriers in different pathways**

| Country | Carrier | 2010 | 2020 Frozen Technology | 2020 Reference | 2020 Policies |
|---|---|---|---|---|---|
| Germany | Coal | 44% | 45% | 40% | 35% |
| | Natural gas | 14% | 14% | 14% | 12% |
| | Oil | 1% | 1% | 1% | 1% |
| | Renewables | 18% | 17% | 26% | 35% |
| | Nuclear | 23% | 23% | 19% | 17% |
| UK | Coal | 29% | 29% | 27% | 21% |
| | Natural gas | 46% | 47% | 47% | 35% |
| | Oil | 1% | 1% | 1% | 1% |
| | Renewables | 7% | 7% | 11% | 31% |
| | Nuclear | 16% | 17% | 14% | 12% |
| China | Coal | 78% | 86% | 69% | 68% |
| | Natural gas | 2% | 2% | 3% | 2% |
| | Oil | 0% | 0% | 0% | 0% |
| | Renewables | 19% | 10% | 21% | 26% |
| | Nuclear | 2% | 2% | 7% | 4% |
| Morocco | Coal | 50% | 53% | 50% | 34% |
| | Natural gas | 10% | 10% | 11% | 7% |
| | Oil | 22% | 24% | 16% | 13% |
| | Renewables | 19% | 13% | 23% | 46% |
| | Nuclear | 0% | 0% | 0% | 0% |

For the Policies pathway the trend in emission intensity from the country level analysis is applied to the 2010 emission intensity of the regions according to Table 8. The results are shown in Figure 8. Our upscaling approach suggests that global emissions from electricity generation in 2020 will increase from the 2010 level if the polices adopted in the four countries analysed will be adopted on a global level. Although global emissions are thus not expected to reduce due to these policies, this is a reduction of 3.1 $GtCO_2$ below the frozen technology pathway and a reduction of 0.9 $GtCO_2$ below the reference pathway based on the regional approach. If all countries would adopt the most ambitious pathway (similar to Morocco) global emission could be reduced by of 5.9 $GtCO_2$/a below the frozen technology pathway and 3.7/a $GtCO_2$ below the reference pathway in 2020, which would be a reduction below the 2010 level.

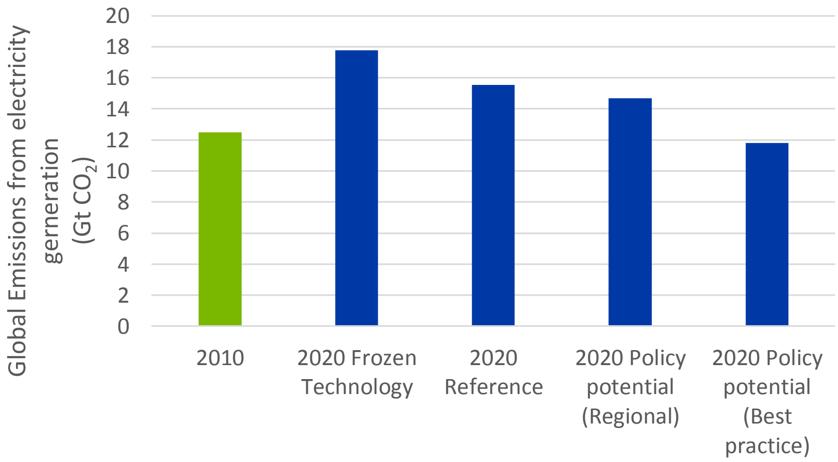



**Figure 8: Global upscaling result for RES-E Support**

This policy potential compares well to earlier estimates of technical mitigation potential from the power sector of 2.2-3.9 $GtCO_2e$ in 2020 (UNEP, 2013).

### 4.1.6 International discussions in related forums

The increased adoption of renewable energy technologies is boosted not only by climate change mitigation ambition, but also by increased global energy security. Many countries see renewable technologies as a key means of increasing domestic energy security through reduced dependence on volatile oil and gas markets. Furthermore, small and medium scale renewable technologies provide potential for the electrification of rural areas in countries where centralised infrastructure is unable to reach large segments of the population, decreasing local dependence on dirty fuels and providing significant benefits for the social and economic development in disadvantaged areas. A further key motivation for the development of renewable energy shares, especially in emerging industrialising countries, is increasing concern over local air pollution and its effects on public health. These reasons, amongst others, make an increasingly attractive business case for the adoption of renewable energy technologies, before domestic pledges to climate change mitigation are even considered.

Given the suppressed demand demonstrated by the low electrification rates across the populations of most developing countries, international discussions are focused on maximising the rational business case for renewable energy, in order to avoid further adoption and path dependency on dirty technologies in emerging and developing countries. The need for decentralised and flexible infrastructure development is understood to be of key importance to the economic viability of small and medium sized energy generation facilities, and this is an area that international donors such as the World Bank, EBRD and EIB are keen to support, along with capacity building at the policy making level in order to support the conditions for renewable energy investment (Harrison et al., 2014).

Three key international cooperative initiatives promote the development of renewable energy supply worldwide:

- The Renewable Energy and Energy Efficiency Partnership (REEP) seeks to address barriers to the natural market development of renewables in order to build clean energy business models, and facilitates information sharing on best practice policies between countries.
- The International Renewable Energy Agency (IRENA) is a centre of excellence for knowledge in policy, finance and technology for renewable energy.
- The 300 GW/a initiative is an awareness raising platform for the future of PV, with a goal to inspire an industrial transformation to meet the goal of 300 GW installed PV capacity by 2025.

### 4.1.7 Summary and recommendations for RES

#### 4.1.7.1 Summary and comparison of case studies

An overview of the RE support policies implemented in Germany, China, the USA and the UK is provided in Table 12.

**Table 12: Summary of qualitative assessment**

| | Germany | China | USA | UK |
|---|---|---|---|---|
| Major policy | Renewable Energy Act (EEG) | Renewable Energy Law | Energy Policy Act | Renewables Obligation |
| Type | Feed in Tariff | Feed in Tariff | Production Tax Credit (PTC) | Renewables Obligation Scheme |
| RE Targets | RE share of 18 % in gross final energy consumption by 2020 (BMU, 2012).<br>RE share of 35 % of electricity production by 2020. | RE share of 15 % of primary energy consumption by 2020 (Schuman, 2010). | Renewable Portfolio Standards only implemented at state level | RE share of 15% in gross final energy consumption by 2020 (Directive 2009/EC/28).<br>RE share of 31 % of electricity production by 2020. |
| Key features | Guaranteed rate for electricity production based upon a feed in tariff schedule differentiated by RE technology, location and size. | Feed in tariffs for RE, which guarantee an electricity price above the market rate that the grid company will pay the generator. | Tax credit for each kWh of electricity produced by a qualified RE project during the first ten years of operation. | Obligation on licensed suppliers of electricity to ensure that a share of their supply to customers comes from RE sources. |
| Complementary Policies | Combined Heat and Power Act (KWKG)<br>Renewable Energies Heat Act | A mandatory connection and purchase policy<br>A special fund for renewable energy | Renewable Portfolio Standards (RPS)<br>Mercury and Air Toxics Standards | Renewable Heat Incentive (RHI)<br>Renewable Transport Fuels Obligation |

| | Germany | China | USA | UK |
|---|---|---|---|---|
| | (EEWärmeG) | development | (MATS) | (RFTO) |
| Barriers | Obtaining planning permission and access to networks. | Lack of resources and incentives to invest in the grid infrastructure to support RE. | Uncertainty in financial incentives from the renewal of the PTC. | Obtaining planning permission and access to networks. |
| Co benefits | Improvement in air quality and energy security | | | |

In terms of overall ambition, Germany is a global leader in the promotion of RE and the country is making good progress towards the achievement of their ambitious RE target for 2020 (18 % share of renewables in final energy consumption). In comparison, the UK has a less ambitious RE target for 2020 (15 % share of renewables in final energy consumption). However, given the low starting point, considerable efforts will be required by the UK to achieve the challenging target. Although the Chinese target for non-fossil fuel use is not directly comparable to the other RE targets (the 15 % share of non-fossil fuels target in primary energy consumption in 2020 refers to both RE and nuclear power), it is important to acknowledge the progress that has been made in a fast growing economy and the challenge that remains in order to achieve the 2020 RE target.

#### 4.1.7.2 Barriers and mitigating policy features

The case studies primarily focus on addressing the market failure and economic barriers via the introduction of financial incentives in the form of either a feed in tariff (i.e. China, Germany), renewables obligation scheme (i.e. the UK) or a production tax credit (i.e. the USA). In particular, the production tax credit (PTC) in the USA demonstrated the importance of long term certainty in the provision of financial incentives, with changes in annual wind capacity directly related to the renewal or expiration of the PTC. In contrast, the financial certainty provided by a feed in tariff schedule is an important factor to explain the success of both the Chinese and German policies. However both countries have experienced implementation barriers as a consequence of the rapid deployment of renewable technologies. For example, China's progress towards their RES target has been delayed due to a lack of capacity to connect renewable energy projects to the grid whilst the social acceptability for supporting RE technology in Germany has been questioned in light of increasing electricity costs in the country. This emphasises the importance of designing a range of complementary polices in order to address all of the barriers associated with RE deployment.

#### 4.1.7.3 Co-benefits

It is evident from the case studies that the co-benefits associated with the deployment of renewable energy have been used to further justify RES support policies in all four countries. However, the promotion of certain co-benefits may be particularly emphasised in order to attain a political consensus for the policy measure. For example, the improvement in air quality has been a major driver for the promotion of clean energy technologies in China in order to overcome an environmental problem that has an increasingly detrimental effect on health. Indeed many commentators consider the smog that settled in January 2013 in Beijing, which had a concentration of particles with a diameter of 2.5 microns or less that was 40 times higher than the level considered safe by the World Health Organisation (The Economist, 2013), as a game changing moment leading to more ambitious environmental policies in the country. While in Germany the creation of employment opportunities was an important driver in the establishment of the German Renewable Energy Act and fast growing German RE industries have encouraged the government to maintain strong promotion policies to further support jobs in the renewable energy sector that have increased from 160,500 in 2004 to 381,600 in 2011 (UBA, 2013).

#### 4.1.7.4 Policy impacts and mitigation potential

Targets for electricity generation from renewable energy are contributing significantly to the GHG emission reductions in the four considered countries Germany, the United Kingdom, China and Morocco. If other countries follow their example, emissions in 2020 could be reduced by a further 0.9 to 3.7 $GtCO_2$/a below current reference scenario.

## 4.2 Light Duty Vehicle Standards

### 4.2.1 U.S: Corporate Average Fuel Economy (CAFE) and GHG standards

In 2010, the United States had the world's second highest rate of car ownership, with 797 motor vehicles registered per 1,000 people (World Bank 2013), and light duty vehicles represented a significant portion of U.S. greenhouse gases, accounting for approximately 17% of national emissions (EPA 2012b). Furthermore, the U.S. is heavily dependent on oil imports; the transportation sector alone consumes approximately 14 million barrels of oil per day (American Energy Independence 2013), of which approximately two thirds is imported (EIA 2013).

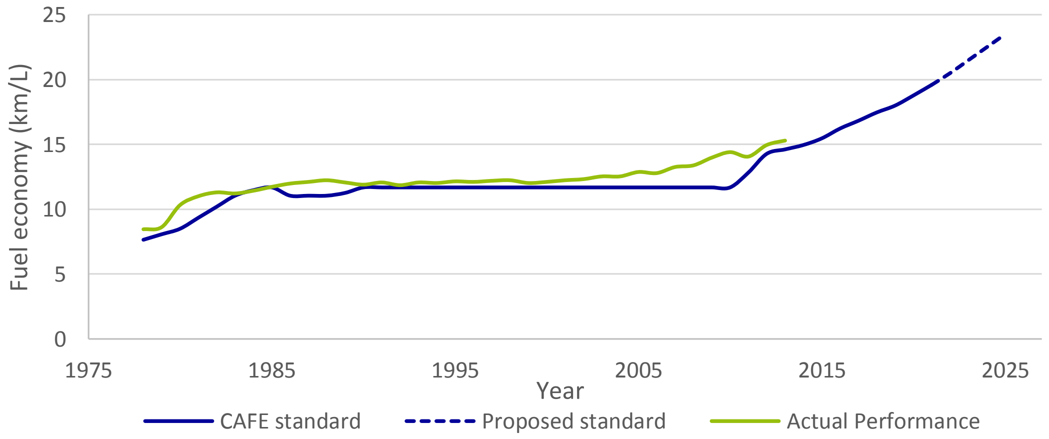
The United States has been regulating fuel economy of vehicles since 1975, with the Corporate Average Fuel Economy (CAFE) standards. However, despite an early start, Figure 9 shows that these standards were relatively static and unambitious during the 1980s and 1990s, and the US vehicle fleet at this time was one of the heaviest and least fuel efficient in the world (ICCT and Dieselnet 2014). In 2009, the U.S. vehicle standards underwent considerable reform. Whilst the original standards had only been attached to fuel economy under the administration of the National Highway Traffic and Safety Administration (NHTSA), the new system saw the NHTSA combine with the Environmental Protection Agency (EPA) to include a greenhouse gas emissions standard; this was also a notable landmark for general climate change mitigation policy in the U.S., since it was also the first time that greenhouse gas emissions were regulated at the federal level (ICCT and Dieselnet 2014). Following the successful implementation of the 2012-2016 phase, a second phase covering the years 2017-2025 was announced in 2012.

The reformed CAFE has the following design features:

- Emission caps are also set for non-$CO_2$ GHG emissions, including HFCs from air conditioning systems, $N_20$ and $CH_4$.
- Whilst the data above refers to averages for the entire vehicle fleet, the specific standards for each vehicle are set according to the vehicle's size, rather than its weight; the vehicle's footprint is determined as the product of the track width and the wheelbase. This has some advantages over a standard based on weight since it encourages the use of light materials in construction design, whereas a weight-based standard effectively penalises and discourages the use of light materials by applying a more stringent standard.
- Flexibility mechanisms are in place to make compliance cost-effective for manufacturers. For example, manufacturers obtain credits for achievement, which they can carry forwards or backwards for compliance in different manufacturing years (C2ES undated).

Figure 9 gives an overview of the development and stringency of the standard during this period.

**Figure 9: CAFE standards and actual performance for light duty passenger vehicles - MY 1978-2025**




Data relates to the average fuel economy of light duty passenger vehicle fleet manufactured in each year. Source: http://www.nhtsa.gov/fuel-economy

Figure 9 shows that under the current standards, the average passenger car is expected to achieve at least 18.8 km/l by 2020, potentially rising to 23.5 km/l in 2025 (NHTSA 2014). The latter part of the standard remains uncertain, since due to legislative restrictions on long term policies in the U.S., the latter years of the 2017-2025 CAFE phase must be reconfirmed during a mid-term policy review.

Data from NHTSA (represented in Figure 9) shows that implementation of the reformed CAFE has generally been successful, with average performance remaining slightly higher than the increased standard for 2012 and 2013. However, the role of the standard in achieving the current performance level is debated; the chart suggests that the most recent performance indicators might be a result of natural improvements in the industry, since the fuel economy appears to have improved at a steady rate over the past ten-to-fifteen years, even before the CAFE was reformed. The graph also indicates that the proposed trajectory of standard stringency may not be much more ambitious than BAU industry development, as the gradient of the standard trajectory is only marginally steeper than the gradient of the actual performance during these years.

The ambition of the U.S. policy and the ease of its implementation may have been negatively affected by the following barriers:

- Lack of strong enforcement and penalisation for non-compliance: In 2010, manufacturers were liable for a fee of $2.33 for every 0.1 km/l under the target standard, times by the total number of vehicles manufactured that year (ICCT 2014). This penalty has only increased 10% since 1983, whilst general inflation during the same period stands at 119% (United States Government Accountability Office 2007). Therefore, a number of manufacturers choose to pay penalties rather than comply with the standards; in particular, major European and Asian manufacturers have consistently paid large penalties each year, whilst increasing their U.S. sales volumes, while domestic manufacturers have complied with the standards and seen their sales decrease over the previous two decades.
- The strength of industry and stakeholders: The reformed CAFE standards, including the latest phase covering 2017-2025, has received wide support from industry and other stakeholders. The EPA reports that 13 major manufacturers representing over 90% of U.S. sales announced their support for the scheme, in addition to the United Auto Workers and several significant consumer organisations and local governments (EPA 2012a). However,

the support of these stakeholders is key to the passing of legislation, and the widespread support is likely a reflection of the relatively low-ambition, and the reluctance of NHTSA to raise the penalties for non-compliance.

- Popularisation of SUVs (large passenger vehicles of 7-10 people): During the 1990s and 2000s, SUV sales boomed, with negative effects for fuel economy and its future prospects. These negative effects derived from the fact that SUVs were categorised in the existing CAFE architecture as light trucks, with very lenient fuel economy standards. Whilst the framework was revised with the CAFE reform, the historical performance of these vehicles was such that improvements to an ambitious standard would have required dramatic industry development and behavioural change (ICCT and Dieselnet 2014).
- Low fuel taxes: Relative to other developed nations, fuel taxes are very low in the U.S. and unlikely to be raised significantly in the near future due to political unpopularity. Therefore, there is little economic incentive to the consumer for fuel efficient vehicles, and the CAFE is thus largely dependent on incentives for manufacturers' compliance.

Despite the barriers discussed, developments in vehicle fuel economy are supported by the following complementary policies (UNEP 2010):

- Gas guzzler tax: Since 1980, passengers vehicles with an extremely low fuel economy (now set at 9.5 km/l) are liable for extra taxes of between USD $1,000 and $7,000. However, SUVs are exempt, despite widespread use as passenger vehicles.
- Cash for Clunkers law: Since 2009, buyers of new cars may receive between USD $3,500 and $4,500 toward the purchase of a new CAFE compliant car when they trade-in some older and less-efficient vehicles.
- Tax credits for purchase of hybrid electric cars: Until 2010, sales of hybrid electric cars were kick-started by making purchasers eligible for a federal income tax credit of up to $3,400.
- Priority lanes and parking: A number of states have launched initiatives giving priority to top-performing fuel efficient and electric vehicles on specific road lanes and free parking areas in the city.
- Labelling and public information: Manufacturers are required by federal law to label cars in the showroom with fuel economy information.

#### 4.2.1.1 Motivation and co-benefits of U.S. CAFE

The EPA have quantified the co-benefits of the CAFE standards relating to consumer cost savings, energy security and health (EPA 2012c):

- Through the decreased consumption of fuel, the revised CAFE standards are estimated to save consumers between USD $6,000 and $7,000 over the lifetime of the vehicle, despite an estimated increase in vehicle cost of approximately $900.
- The U.S. imported approximately 3.2 billion barrels of oil in 2011. The current CAFE standards will save an estimated 600 million barrels of oil by 2030, exceeding the total quantity of imports from Saudi Arabia. Total lifetime savings of cars manufactured in the 2017-2025 phase will be 4 billion barrels.
- Health benefits related to reduced volumes of PM2.5 during the 2017-2025 are estimated at USD $4.3 billion to $5.5 billion, whilst other health benefits in the scale of USD $3.1 billion to $9.2 billion are estimated. Figures are based on a discount rate between 3% and 7%.

This list is for indication purposes only, and is not an exhaustive overview of co-benefits. Further considerations of co-benefits for all countries are given in section 4.2.7.3.

### 4.2.2 EU: Reducing $CO_2$ emissions from passenger cars - Regulation 443/2009/EC

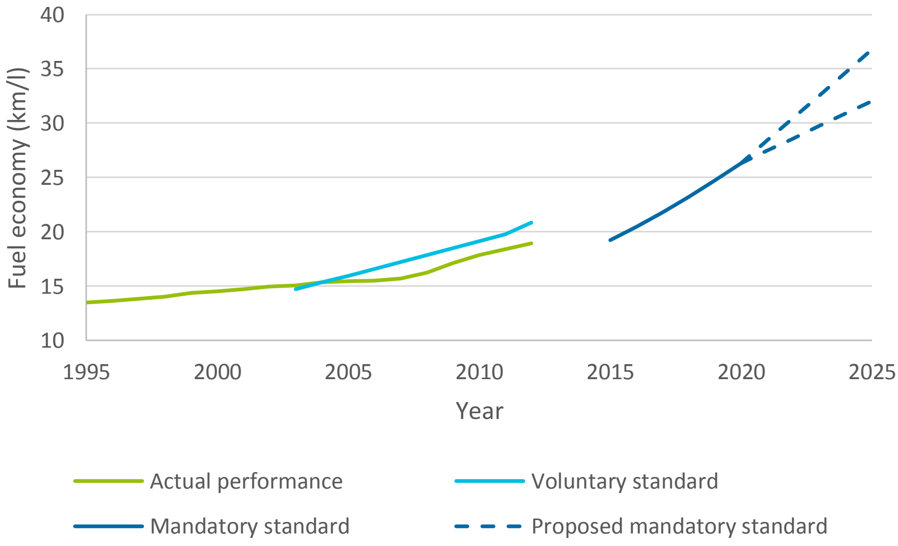
The EU is a major producer, exporter and importer of vehicles, and has one of the largest vehicle fleets in the world, with over 230 million passenger cars in 2010 (European Union 2013); European legislation is therefore highly influential fort he practices of manufacturers, business leaders and policy makers worldwide. Furthermore, road traffic remains a thorn in the EU's greenhouse gas emission reduction plans; passenger cars alone accounted for 12% of EU-wide GHG emissions in 2010, and emissions from the sector increased by 26% between 1990 and 2010, despite the EU's overall emissions declining by approximately 7% (UNEP 2010).

The EU began legislation efforts for passenger vehicle emissions with voluntary emission reduction agreements with car manufacturers in 1995 and 1998. As Figure 9 shows, the voluntary emissions were not entirely successful. Although the first interim target for 2003 was exceeded, subsequent targets were not reached, with only two manufacturers complying with the voluntary agreement (JATO 2009).

In 2009, mandatory standards were introduced through Regulation 443/2009/EC. These standards are based on emissions (measured by $gCO_2$/km) and their translation into fuel economy targets is represented in Figure 10. Standards are set at five year intervals, and manufacturers are required to comply in a phased approach: for example, where the target for 2015 is 130 $gCO_2$/km (or 19.2 km/l), 65%, 75%, 85% and 100% of the manufacturers' fleet must meet this target by 2012, 2013, 2014 and 2015, respectively. The next target for 2020 is 95 $gCO_2$/km (26.3 km/l), whilst the proposed range for a 2025 target is 68-78 $gCO_2$/km (32.1-36.7 km/l) (ICCT and Dieselnet 2014). The EU passenger car standards will therefore become the most stringent in the world by 2020 (ICCT 2014).

The specific target of each vehicle is defined by a weight-based categorisation, although the European Parliament intends to review the possibility of phasing in a size-based vehicle footprint, similar to the U.S. model, from 2020 (ICCT 2014).

**Figure 10: EU standards and actual performance for light duty passenger vehicles - MY 1995-2025**




Data relates to the average fuel economy of light duty passenger vehicle fleet manufactured in each year. Source: http://transportpolicy.net/index.php?title=EU:_Light-duty:_GHG

Figure 10 indicates that the EU was very close to reaching the 2015 standard in 2012. Thereon, the standard requires fuel economy improvements of 6.5% per year to reach the 2020 standards, making it the world's most ambitious policy in terms of both the level of attainment and the rate of improvement.

The EU standards include the following incentives and flexibilities for manufacturers:

- *Super-credits* for vehicles with emissions below 50 $gCO_2$/km. Each vehicles is counted as 3.5 cars for the manufacturers' yearly average in 2012 and 2013, in order to incentivise their production. Super credits are phased out by 2016.
- Manufacturers may choose to pool their fleets to jointly meet the targets, thereby providing flexibility and creating a market for emissions savings between manufacturers.
- Credits for eco-innovation: Manufacturers who develop innovative technologies in areas not tested, such as energy efficient lighting, may apply for credits against their emission standards.
- Stringent penalties: A primary incentive for compliance, the penalties from 2019 will be €120 for each g/km over the target, approximately ten times higher than the U.S. penalties for non-compliance.

The EU also has a comprehensive set of complementary incentives and policies in place:

- Import restrictions for vehicles not meeting EU criteria (EU Council Directive 92/53).
- High fuel taxes in most EU member states, relative to other regions.
- Buy back schemes for older, inefficient cars in some member states, including large programmes in France and Italy.
- Mandatory labelling of emissions and fuel economy on all car brochures and showrooms across the EU.

- The Green Car Initiative intends to mobilise €5 billion for R&D in the automotive sector.
- The European Commission encourages member states to adopt national taxation policies to promote the purchase of fuel efficient vehicles.

#### 4.2.2.1 Motivation and co-benefits of E.U. vehicle emissions regulation

Whilst co-benefits for all countries are elaborated in section 4.2.7.3, Brannigan et al. (2012) have quantified some of these benefits for the EU standards:

- Under business as usual, energy security is forecast to decrease (worsen) by 40%. This may be largely mitigated by stringent adoption of the vehicle standards, along with a package of other transport measures indicated in the report; this scenario is estimated to lead to only a 3% decrease in energy security. This relates to EUR 8 billion in energy security cost savings in 2050.
- Continued improvements to the standards stringency may lead to cost savings of up to EUR 45 billion in 2050, through decreased air pollution in cities. Furthermore, where standards lead to decreases in average vehicle weight, a lower frequency and severity of road traffic incidents is likely.

### 4.2.3 Japan: Top Runner Fuel Efficiency Standards for Light Duty Vehicles

Japan has historically been a global leader for fuel efficiency and emissions for light duty vehicles; Japan's new vehicle fleet has been the world's most fuel efficient since 2000, and was approximately 14% more fuel efficient than the EU in 2011 (ICCT 2014). However, due to the size of Japan's existing vehicle fleet, this remains an key area for mitigation action; in 2011, vehicle emissions accounted for 220 Mt$CO_2$, or 18.5% of total national $CO_2$ emissions (IEA 2013).

The Japanese standards for vehicle fuel efficiency are set based on best achieved industry practices within the country. Fifteen weight ranges between 800 kg and 2,500 kg are defined, and the most fuel efficient vehicle in production within each weight range is designated the top-runner. Thereon, the performance of the top-runner is defined as the new standard, and manufacturers must ensure that the average fuel economy of their production fleet in each weight category meets the new target within a defined time period. This process has resulted in the average fuel efficiency standards given in Table 12.

**Table 13: Average standards and achieved performances of new production light duty passenger vehicles in Japan**

| | Actual performance | | Standard | |
|---|---|---|---|---|
| Year | 2007 | 2010 | 2015 (set 2007) | 2020 (set 2011) |
| Fuel economy (km/L) | 17.3 | 21 | 20 | 23.4 |

Data relates to the average standard and performance across all weight categories for newly produced light duty passenger vehicles.
Source: TransportPolicy.net, 2013.

Table 12 indicates that the standards have, to date, been successfully implemented; the 2015 standard, set in 2007, was comfortably achieved and exceeded by 2010. The ease with which the industry is achieving these targets suggests that the top-runner programme may be made even more ambitious by shortening the time-frame given to achieve the targets defined. The following list gives an overview of some of the factors that have facilitated successful implementation of the standards, and the potential and existing barriers that have been mitigated:

- Industry competition: The top-runner approach naturally rewards early-movers and therefore ensures progression through natural competitive market forces. Potential political and capacity barriers are made less significant since achievement of the standards are partially driven by market forces and therefore less dependent on institutional frameworks.
- Flexible mechanism for compliance: Flexibility for compliance of manufacturers is given on two levels (ICCT 2014). Firstly, only the average performance of the production fleet in each category must meet the standard, rather than every vehicle. Secondly, manufacturers may accumulate credits for over-compliance is some weight categories for use in other under-performing categories.
- Education and popularisation: The Japanese government has declared its intention to stimulate the production and consumption of next-generation vehicles through awareness and education campaigns for end-users and manufacturers (Automobile Evaluation Standard Subcommittee 2011).

Complementary policies and incentives: Although Japan's fuel efficiency targets are mandatory, penalties to manufacturers for non-compliance are minimal. However, penalties are effectively transposed onto the customers purchasing non-compliant vehicles through tax incentives at the point of vehicle purchase and registration for lighter vehicles and those with smaller engines (UNEP 2010), and a comparably high tax rate on fuel. In addition, a green-sticker labelling policy ensures easily accessible information for consumers (ICCT 2014).

### 4.2.4 China – Corporate Average Fuel Consumption (CAFC)

China's light duty vehicle stock remained modest in 2008, compared to the U.S., the EU and Japan; China had only 29 cars per 1,000 people, and just 12% as many passengers cars as the U.S. in 2008 (UNEP 2010). However, the significance of China's light duty vehicle fleet emissions is expected to soar; conservative estimates predict that annual sales may reach approximately 50 million units by 2020, which is comparable to total global vehicle sales in 2009 (UNEP 2010). At such a rate of growth, China is expected to have more registered highway vehicles in 2035 than any other country, and the sector might emit 1.9-3.2 $GtCO_2$ per year by this time (UNEP 2010), equivalent to approximately 6-9% of total global emissions across all sectors in 2010 (World Bank 2013).

Fuel economy standards for light duty vehicles in China were introduced in 2004, with the first phase beginning in 2005. Until 2012, vehicles were given specific standards according to their weight category, and every single vehicle produced between 2005 and 2012 was required to meet the standard for its specific category. From 2012, in order to give manufacturers more flexibility whilst at the same time guaranteeing a specific final result for the fleet average, the Corporate Average Fuel Consumption (CAFC) standards were introduced, which combined individual category standards with an average fleet standard to be achieved by manufacturers.

The new CAFC standards should result in the fuel economy levels indicated in Table 13.

**Table 14: Average standards and achieved performances of light duty passenger vehicles in China**

| | Actual performance | | CAFC Standard | |
|---|---|---|---|---|
| Year | 2002 | 2008 | 2015 (set 2012) | 2020 (under review) |
| Fuel economy (km/L) | 11.1 | 12.4 | 14.5 | 20 |

Data relates to the average standard and performance across all weight categories for light duty passenger vehicles. Source: TransportPolicy.net, 2013.

As Table 13 indicates, progress for the first decade after the introduction of the original standards in 2002 was slow. Manufacturers generally met the standards for all vehicle types, but the lack of a corporate average standard incentivised the production of heavier cars with less stringent standards. The CAFC standard facilitates much greater ambition, as demonstrated by the proposed average annual fuel economy improvement of 6.7% between 2015 and 2020.

Flexibility schemes for manufacturers are included in the new mechanism. Electric cars with a range of over 50km may be counted five times, and cars with a fuel economy of over 35km/l may be counted three times towards the corporate average, in order to incentivise the production of these vehicles. Furthermore, manufacturers can accumulate credits for exceeding CAFE standards for use in a subsequent year. Credits have a three year validity.

Despite the relative stringency of these standards, there are concerns that the forecast growth in the scale of China's vehicle fleet will far outweigh the improvements (UNEP 2010). A further barrier is the relatively low fuel tax rate, which decreases the potential incentive for fuel efficiency savings for the consumer. However, China has a number of supporting policies in place, or being piloted, to provide incentives for manufacturers and consumers:

- City-led initiatives for curtailing GHG emissions from transport (e.g. Shanghai and Beijing both have a significant fleet of public transport vehicles and taxis running on alternative fuels).
- A subsidy scheme is in place in some pilot cities to offer approximately $500 USD to consumers for purchases of cars that exceed the fuel economy standards by at least 20%, and up to $7,000 USD for some plug-in hybrid cars (UNEP 2010). The government will invest in the development of recharge facilities throughout the pilot cities.
- Taxes for manufacturers and purchasers have been revised to incentivise the purchase of vehicles with smaller engines. For example, in 2006 the tax rate on vehicles with 1-1.5 litre engines was reduced to 3%, whilst the tax rate for vehicles with engines larger than 4 litres was increased to 20% (UNEP 2010).
- A fuel economy labelling programme is mandatory, and must be displayed in the car at all times.

### 4.2.5 Quantitative assessment

#### 4.2.5.1 Methodological considerations

##### 4.2.5.1.1 Country-level analysis

To quantify the effect of meeting the light-duty vehicle standards, our approach follows these steps:

1. The quantification is based on reference projections for vehicle activity and emissions in the period 2010 – 2020, taken from national studies or other literature sources. These reference emissions projections are used for the reference pathway.
   a) Where data are not available for each separate year (e.g. data are reported in 5-year increments), data for the remaining years are interpolated.
2. Based on these projections the reference fleet's average emission intensity ($gCO_2$/km) are calculated for each year.

3. A frozen technology pathway, which reflects the effect of changes in vehicle activity, is determined using the following steps:
   i. Vehicle activity is taken from the reference projections.
   ii. Fleet average emission intensity is kept at a constant level from the specified base year (i.e. the most recent year for which historical data are available).
   iii. Emissions projections are calculated from the vehicle activity and fleet average emission intensity.
4. The policy pathway, in which the adopted car standards are met, is determined using the following steps:
   i. Vehicle activity is taken from the reference projections.
   ii. The old vehicle stock (i.e. the cars already in the vehicle stock in the base year) is decreased by a constant value each year (in terms of vehicle kilometres driven).
   iii. The emissions of the remaining old vehicle stock are calculated with the fleet average emission intensity from the base year and the vehicle kilometres driven in a given year.
   iv. The difference with total emissions as projected in the reference scenario are attributed to cars built in that year and used to calculate the reference emission intensities of new cars.
   v. In the policy scenario these new car emission intensities are replaced by the emission intensities assumed by the vehicle standards. These new cars stay in the car stock for a specified life time.
   vi. The steps above are repeated for each year until 2020.

The steps indicated here require to take assumptions on different aspects:

1. In case projections are not available for each year, our method assumes a linear development of both emissions and vehicle activity.
2. Vehicle activity is assumed to be the same in all scenarios (i.e. car standards do not influence vehicles kilometres driven).
3. The decrease of the existing car stock is estimated based on assumptions regarding the average car lifetime. The average car lifetime is assumed to be 15 years in all regions.
4. Regarding the new vehicle emission intensities assumed by the vehicle standards, the following assumptions are made in our approach:
   i. Before the first target year, new car emission intensity is assumed to be similar to reference new car emission intensity.
   ii. Between two target years a linear improvement of emission intensity is assumed.
   iii. After the last specified target year, emission intensity is assumed to stay at a constant level.
5. In cases where fuel efficiency targets are adopted (in contrast to emission intensity targets), the target is first converted to an emission intensity target. This is done based on standard emission factors (IPPC, 2006) for gasoline and diesel and assumptions regarding the shares of gasoline and diesel vehicles. Other types of vehicles (e.g. electric) and fuels (e.g. biofuels, LNG) are not taken into account in our analysis. This approach is taken because the shares of

vehicles other than gasoline and diesel vehicles are small in the countries where we had to convert the targets.

#### 4.2.5.1.2 Regional and global upscaling

Multiple approaches can be taken to upscale the results of the country-level analysis to first a regional and, consecutively, a global level. Two approaches were taken into consideration:

- Approach 1. Fleet average emission intensity approach: This approach takes the reference vehicle activity projections for all regions as the basis for the analysis. The 2020 policy scenario emissions are calculated by applying the 2020 fleet average emission intensity from the country-level analysis to the vehicle activity in the appropriate regions. This approach reflects the regional differences in the vehicle activity trends.
- Approach 2. Emission trend approach: In this approach the 2010-2020 emissions trends in the selected countries are applied to the 2010 emissions of the other regions. This method better reflects the different starting points of the different countries.

As the vehicle standard polices are targeted at emission intensity level and not at vehicle activity level, we selected the first approach[22]. With the second method not only the trend in new vehicle emission intensity would be applied to the other regions, the trends in vehicle activity would also be applied to the different regions. Table 14 indicates which countries are used as basis for regional upscaling. In case the emissions in the reference pathway for a region or country grouping are lower than the emissions in the policies pathway, the reference pathway emissions are applied.

**Table 15: Approach for upscaling quantitative analysis of vehicle standards**

| Best practice | Region upscaled to | Reason (to be updated) |
|---|---|---|
| EU | Non-EU Europe<br>Russia<br>Australia<br>Middle East | The EU has the most comprehensive and ambitious policy package which might reasonably be adopted by other industrialised countries. |
| China | India<br>South Korea<br>Africa<br>Asia-Pacific-40 | Second-hand imports from Asia represent the majority of the vehicle fleet in Africa. China is selected for upscaling since it is a non-Annex I country and since Japan's standard is considered too ambitious for unindustrialised countries. |
| US (& Mexico) | Canada<br>Mexico<br>Brazil<br>Latin-America | The current U.S. standards may reasonably be upscaled to the Latin American region, since Mexico has already enacted a virtual copy of the U.S. CAFE standards (with a 1% goal reduction (ICCT and Dieselnet 2014)) and the Latin American vehicle fleet is largely based on U.S. imports. Since the U.S standards are also the least ambitious studied here, they may be realistic for application across the region despite the economic differences. |
| Japan | n.a. | n.a. |

[22] However, the emission trend approach was also calculated. Although this approach leads to different results on a regional level, the aggregated global result is very similar to the fleet average emission approach.

#### 4.2.5.2 Results of quantitative assessment

Light-duty vehicle standard policies in the United States, the European Union, China and Japan are quantified. The input data for the quantification are shown in Table 15.

**Table 16: Input data for quantification of vehicle standards**

| Country/Region | Source for reference emissions and vehicle activity projections | Interpolation of data needed | Analysis base year (i.e. most recent available historic data) | Emission intensity target | Fuel efficiency target | Shares of gasoline and diesel vehicles |
|---|---|---|---|---|---|---|
| **US** | EIA Annual Energy Outlook (EIA, 2014) | No | 2012 | 2016: 250 g $CO_2$ /mile<br>2020: 163 g $CO_2$ /mile<br>(ICCT, 2011) | | - |
| **EU** | ICCT Global Transportation Roadmap Model (ICCT, 2012) | Yes | 2010 | 2015: 130 g $CO_2$ / km<br>2021: 95 g $CO_2$ / km<br>(EC, 2013) | | - |
| **China** | ICCT Global Transportation Roadmap Model (ICCT, 2012) | Yes | 2010 | | 2015: 14.5 km/l<br>2020: 20 km/l<br>(ICCT and Dieselnet, 2014a) | Gasoline:97%<br>Diesel: 3%<br>(Estimation based on ICCT, 2012) |
| **Japan** | ICCT Global Transportation Roadmap Model (ICCT, 2012) | Yes | 2010 | | 2015: 17 km/l<br>2020: 20.3 km/l<br>(ICCT and Dieselnet, 2014b) | Gasoline:92%<br>Diesel: 8%<br>(Estimation based on ICCT, 2012) |

Figure 11 and Table 16 summarise the results of the quantification. From Figure 11 it can be seen that in all regions the vehicle activity is projected to increase until 2020 (e.g. the 2020 Frozen technology emission exceed the 2010 emissions for all countries and regions). In all cases meeting the adopted vehicle standards will lead to an emission reduction compared to the reference pathway. However, in the case of China the LDV emission trend remains upward even with the standards in place. This is due to the strong projected increase in vehicle activity in China. The emission intensity improvement cannot compensate for the strong increase in vehicle activity. The policies in the European Union are the most ambitious and the resulting fleet average emissions in 2020 are projected to be the lowest of the four countries/regions analysed (see Table 16). Although the policies in the United States result in decreasing emission trend of 2% per year, 2020 emission intensity is projected to be significantly higher compared to the other countries/regions.

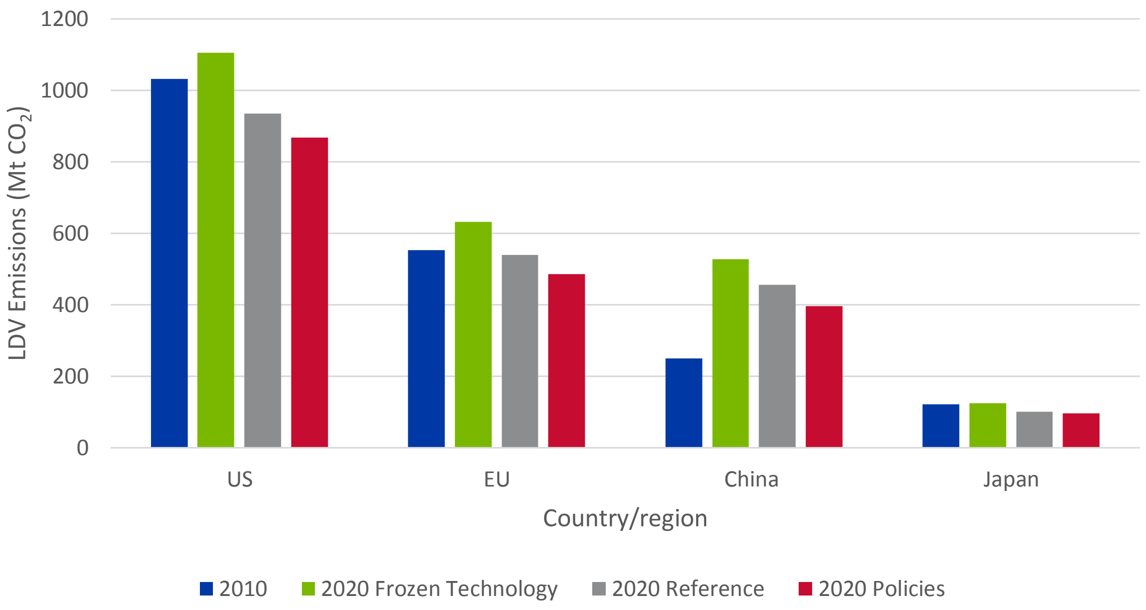



**Figure 11: Results of country-level quantification for LDV vehicle standards**

**Table 17: Results of country-level quantification for LDV vehicle standards**

| | US | EU | China | Japan |
|---|---|---|---|---|
| Base year | 2012 | 2010 | 2010 | 2010 |
| Base year emissions ($GtCO_2$) | 1.0 | 0.5 | 0.2 | 0.1 |
| 2020 emissions policies scenario ($GtCO_2$) | 0.9 | 0.5 | 0.4 | 0.1 |
| 2020 reduction below reference scenario ($GtCO_2$) | 0.07 | 0.05 | 0.06 | 0.00 |
| 2020 reduction below frozen technology scenario ($GtCO_2$) | 0.24 | 0.15 | 0.13 | 0.03 |
| With policies emission trend (% /a) | -2.0 | -1.3 | 4.7 | -2.3 |
| 2020 with policies fleet average emission intensity ($gCO_2$/km) | 189 | 148 | 168 | 155 |

2020 vehicle activity projections from the ICCT Global Transportation Roadmap Model (ICCT, 2012) are used as a basis for the global upscaling of the quantification results. The 2020 fleet average emissions presented in Table 16 are applied to these vehicle activity data according to the outlined approach. The results are shown in Figure 12. The Frozen technology pathway is based on 2020 fleet average emissions and 2020 vehicle activity for each specific region from ICCT (2012). The reference scenario is based on the projections from ICCT (2012). Our upscaling approach suggest that global light-duty vehicle emissions in 2020 will be at the same level as 2010 emissions if the polices adopted in the four countries/regions analysed will be adopted on a global level. Although global emissions are thus not expected to reduce due to these policies, a stabilization of global LDV emissions could be reached. This represents a reduction of 0.8 $GtCO_2$/a below the frozen technology pathway and a reduction of 0.4 $GtCO_2$/a below the reference pathway. If all countries would achieve the same fleet average emission as Europe, the most ambitious regions, this reduction could be 1.0 $GtCO_2$/a below the frozen technology pathway and 0.6 $GtCO_2$/a below the reference pathway.

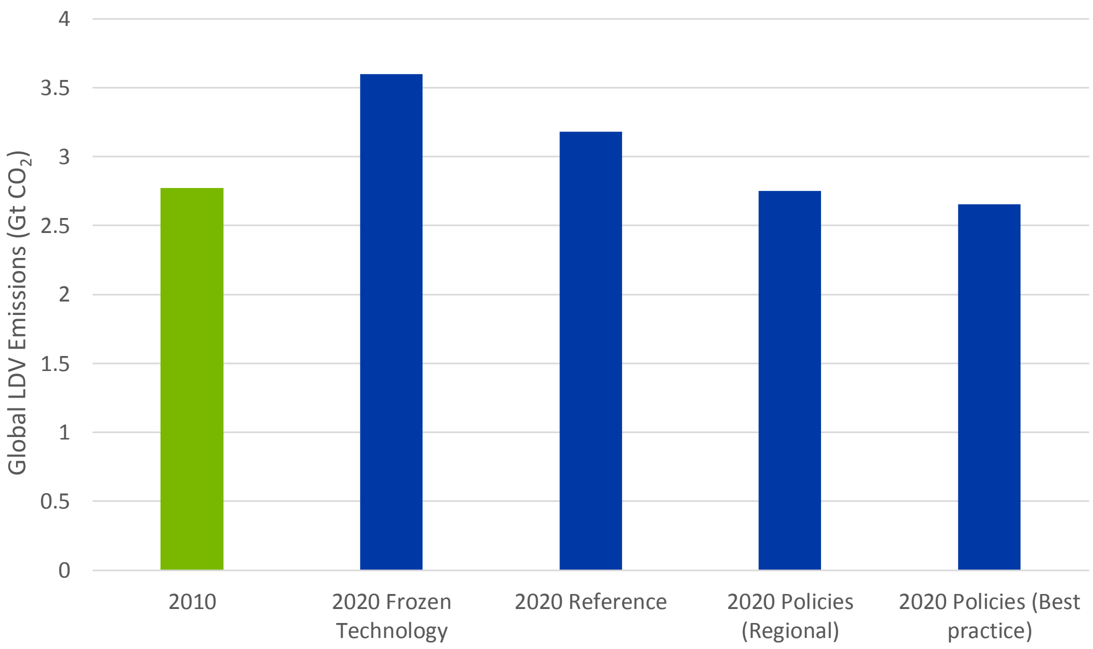



**Figure 12: Global upscaling result for vehicle standards**

This policy potential is about quarter of the technical mitigation potential of 1.7 – 2.5 $GtCO_2e/a$ in 2020 for the entire transportation sector according to UNEP (2013). No technical potential mitigation estimates for LDVs separately could be found for 2020. However, this policy potential for 2020 compares well with the mitigation potential due to energy efficiency options for light-duty vehicles of 0.7 – 0.8 $GtCO_2e/a$ in 2030 at costs below 100 US$ / $tCO_2$ reported by Ribeiro et al. (2007). McKinsey & Company (2009) estimate the technical mitigation potential for LDVs in 2030 to be 1.4 – 1.7 $GtCO_2e/a$.

### 4.2.6 International discussions in related forums

Discussions in the international forums related to transport emissions appear to be leaning towards a focus on a consideration of the transport sector in the wider context of cities and urban planning. The vast majority of journeys (over 85%) for both light duty and heavy duty vehicles are made within cities or between cities with a journey distance of less than 150km (Harrison et al., 2014); this highlights the important role of urban planning and traffic flow management in reducing vehicle stoppages and associated fuel consumption. In this vein, significant emphasis was placed on transport in the ADP Work Stream 2's pre-COP19 workshops for sustainable cities, in which discussions leaned towards the concept of subnational policy making, at city or provincial level, for transport emissions and its supporting incentives. The Partnership on Sustainable Low Carbon Transport (SLoCAT) (REF) argues that transport is so dependent on the local subnational context that Transport Day and Cities Day should be combined at future COP meetings.

SLoCAT also proposes that transport emission targets should be incorporated into the Sustainable Development Goals to be formulated in 2015; this qualitative analysis has shown that light duty vehicle standards may have significant co-benefits for developing and industrialised countries, and related fields such as urban planning and transportation infrastructure also hold key potential for poverty reduction and improved quality of life.

In addition to national efforts, there are several global initiatives seeking to transform the high rate of greenhouse gas emissions from road-based transport:

- IRU 30 by 30 resolution: voluntary commitment of the road transport industry to reduce emissions by 30% by 2030 through various means
- Global Fuel Economy Initiative (GFEI): partnership of six organisations that promotes research and knowledge on fuel economy and vehicle emissions.
- Partnership for Clean Fuels and Vehicles: global Initiative to promote cleaner fuels and vehicles in developing and transition economies; platform for exchange in developed and developing countries.
- International Council on Clean Transportation ICCT: independent not-for-profit; unbiased research and technical analysis for environmental regulators.
- Partnership on Sustainable Low Carbon Transport: SLoCaT promotes the integration on sustainable transport in global policies on sustainable development and climate change.

### 4.2.7 Summary and recommendations for light duty vehicle standards

#### 4.2.7.1 Summary and comparison of case studies

Table 17 and Figure 13 present a summary of the of the light duty vehicle policies in four best-practice case studies: EU, Japan, China and the US.

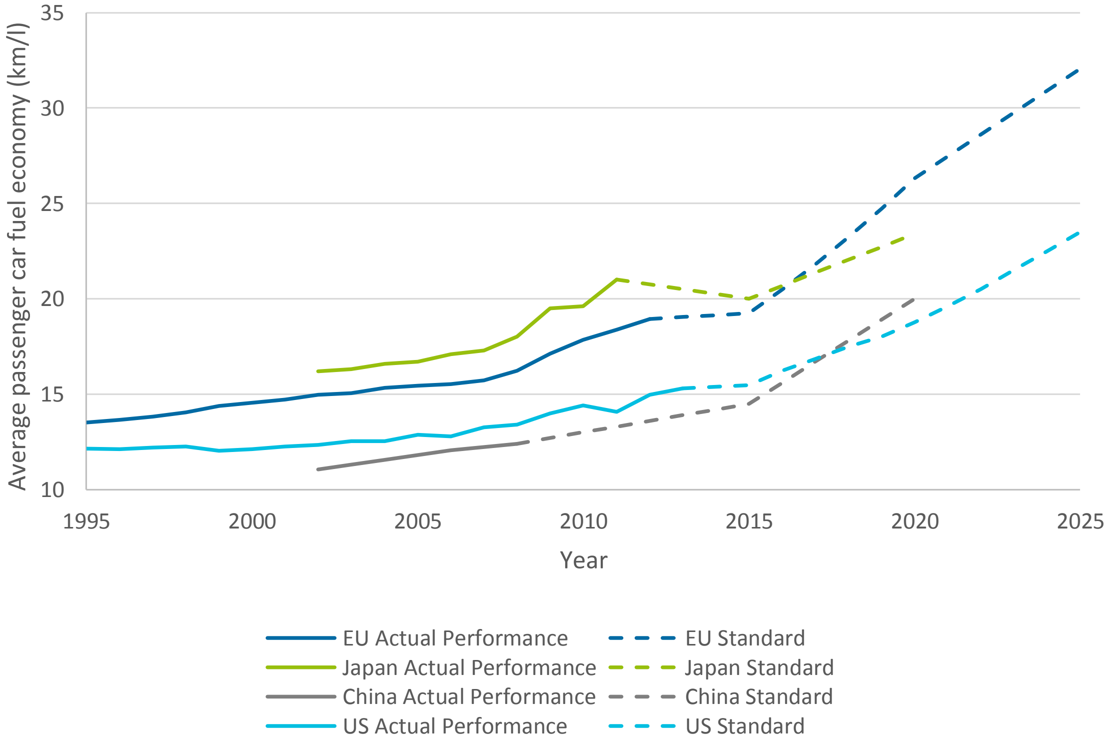
**Table 18: Summary and comparison of vehicle standards in the EU, Japan, China and the US**

| | **EU** | **Japan** | **China** | **US** |
|---|---|---|---|---|
| **Major policy** | Regulation 443/2009/EC | Top Runner Fuel Efficiency Standards for Light Duty Vehicles | Corporate Average Fuel Consumption (CAFC) | Corporate Average Fuel Economy (CAFE) and GHG standards |
| **Type** | Emissions standard | Fuel economy standard | Fuel economy standard | Joint emissions (EPA) and fuel economy (NHTSA) standard |
| **Standard (2020)** (average new fleet passenger vehicles) | 26.3 km/l<br>32.0-36.8 km/l by 2025 (subject to review) | 20.3 km/l | 20 km/l (subject to review) | 18.8 km/l<br>23.5 km/l by 2025 (subject to review) |
| **Ann. improvement (2015-2020)** | 6.47% | 3.86% (Actual annual improvement between 2010 and 2020 is 1.21%; 2015 standard exceeded in 2010) | 6.65% | 3.96% |
| **Key features** | Flexible compliance mechanisms within and between manufacturers' fleets; stringent penalties; super-credits for | Flexible compliance mechanisms; generation of industry competition to reach fuel efficiency. | Flexible compliance mechanisms between manufacturing years; super-credits for innovative technologies. | Combines fuel economy with emissions standards; standards set according to vehicle size, not weight; flexible compliance mechanisms |

| | EU | Japan | China | US |
|---|---|---|---|---|
| | innovative technologies. | | | between manufacturing years. |
| **Complementary polices** | High taxes on fuels; import restrictions for non-compliant vehicles; buy-back schemes; mandatory labelling; R&D. | Fuel tax and tax incentives for light vehicles (for end-users). | Tax incentives; city-led initiatives; subsidies in pilot cities; mandatory labelling. | Gas guzzler tax for very inefficient vehicles; buy-back scheme; priority lanes/parking for fuel economical vehicles; labelling schemes. |
| **Barriers** | - | Low penalties for manufacturers for non-compliance. | Major forecast growth in the fleet size; low fuel taxes. | Low penalties for non-compliance, regularly paid; little incentives for individual end-users; political strength of industry and stakeholders; low fuel taxes. |
| **Co-benefits** | Consumer cost savings; oil consumption/imports reduced; improved air quality; improved respiratory health; improved sales for the vehicle industry; employment opportunities in the vehicle industry. | | | |

Source: Summary of information contained in section 4.2.

**Figure 13: Comparison of achieved light duty vehicle fuel economy and proposed standards for EU, US, China and Japan, MY 1995-2025**




Source: Summary representation of information contained in section 4.2.(see individual data for sources)

To compare the ambition between these cases directly, Figure 13 shows clearly that the EU is forecast to become the global leader in vehicle fuel economy standards, with its policies highly ambitious in both the level of its achievement and in the annual rate of improvement. Japan has historically produced the lightest and most fuel economical vehicle fleet in the world, but considering its significant achievement to date, its standards for 2015 and 2020 are lacking in ambition; the 2015 standards were already met by 2010, and compliance with the 2020 standards would require an annual improvement of just 1.21% up until this date, significantly lower than EU and China's projected improvement rates of around 6.5% per year. However, Japan has a range of policies to support fuel economy and it remains to be seen whether performance continues to improve at a margin comfortably above the standards. Meanwhile, China is set to adopt the world's third most stringent standards if the 2020 target is approved this year, whilst the U.S. will diverge from the leaders who they continue to trail by a considerable margin.

#### 4.2.7.2 Barriers and mitigating policy features

From analysis of the four case studies, the outstanding factor that acts as a facilitator or barrier is the existence of significant incentives for both consumers and manufacturers. Looking at the weakest case presented here, the U.S., penalties for manufacturers' non-compliance are so low that they are regularly paid, and fuel taxes remain critically below a level that might significantly shift consumer demand. In contrast, European Union members states have among the highest fuel taxes in the world, and the penalties for manufacturer compliance are approximately ten times higher than the U.S. Insights from China and Japan suggest that incentives for consumers might hold even more importance than the stringency of enforcement for manufacturers; in Japan, for example, the minimal compliance penalties are offset by great consumer demand for light and fuel efficient vehicles due to the fuel taxes and the range of tax incentives for the purchase of lighter vehicles.

A considerable barrier that may prevent the tightening of incentives and the scaling up of ambition in the U.S. is the political strength of the industry and associated stakeholders. In, this aspect, Japan's system has the potential to mitigate institutional bottlenecks due to the nature of its top-runner approach, which bases the standards on the best industry practices and therefore promotes competition through natural market forces within the industry. However, the actual contribution of the top-runner programme to Japan's performance is debateable given the length of the compliance periods, and the subsequent ease with which they are met.

Looking to specific policies and supporting mechanisms, all four of these best-practice case have implemented flexible mechanisms in one form or another; the EU version is particularly noteworthy for the generation of a market for fuel efficiency between manufacturers, due to the ability of manufacturers to meet standards by pooling their fleets with other manufacturers. All countries also have implemented mandatory fuel economy labelling at the point of purchase; this is a key instrument to overcome barriers associated with awareness, but the overall impact is dependent on consumer incentives to prefer fuel efficient vehicles in the first place.

#### 4.2.7.3 Co-benefits and motivation

Some quantified co-benefits have been included within the individual country case studies. A more general overview of potential co-benefits is given here:

- **Consumer cost savings:** Reduced expenditure at the pump are clear co-benefits for consumers, and a significant motivation for improving fuel economy in most countries. This degree of relevance for these co-benefits (and consequently its potential to drive ambition) is dependent on policies in place to reward economical behaviour. Creating policy conditions that maximise the relevance of these co-benefits will in turn directly drive market innovation and public pressure for the ambition of fuel economy standards.

- **Reduced oil imports:** All of the countries featured in the case studies here are critically dependant on oil imports for transportation, creating a position of potential economic insecurity. Global price hikes or supply failures due to unforeseen circumstances can have devastating consequences for economies around the world. Policies to improve vehicle fuel economy may have a considerable impact on reducing oil imports and increasing energy security.
- **Air quality improvements:** Standards aimed at emissions and standards aimed at fuel economy may reduce local air pollution, with further positive effects for respiratory health. Of the countries reviewed here, this is particularly pertinent to China where urban air pollution poses a major health concern. This was the major motivation for progressive policy reform in Beijing ahead of the 2008 Olympic Games (UNEP 2010).
- **Technological innovation:** Continued improvements in fuel economy and the use of alternative fuels required research and development that will be transferable to other sectors.

Shindell et al. (2011) find that applying the EU vehicle emission standards to developing countries worldwide would, in 2030, prevent 120,00 to 280,000 premature climate related deaths, save USD $600 billion to $2,400 billion in health costs, and save USD $1.1 billion to $4.3 billion in ozone related agricultural yield losses.

#### 4.2.7.4 Future outlook

Figure 13 suggests that the short term outlook for legislation of light duty vehicle fuel efficiency is generally positive; the rate of improvement between 2010 and 2025 is forecast to be significantly higher than during previous decades. This is a reflection of factors that are likely to increase motivation and capability also into the medium and long term:

- Governments will find fuel subsidies increasingly difficult to finance, both in view of increasing oil prices and pressure from international and (some) domestic forums to adopt economic policies that reflect environmental costs. This will increase motivation from two angles, as governments will want to reduce their oil imports and consumers who no longer benefit from the same rate of fuel subsidies will realise the economic gain of behavioural change.
- The increasing availability of more efficient and alternative technologies will improve the capabilities of countries to adopt more ambitious standards. Availability, understanding and technical capacity for biofuels is continuously improving its somewhat contentious potential; the IEA estimate that biofuels could provide up to 27% of transport fuel by 2050, offsetting approximately 2.1 $GtCO_2$ (OECD and IEA 2011). Furthermore, advanced technologies such as integrated start generators and heat recovery are making their way into a number of new vehicles, whilst use of advanced lightweight material may reasonably increase fuel economy by up to 20% (UNEP 2010).
- International pressure for enhanced action on climate change mitigation is increasing for all countries, and the transport sector remains a significant and relatively unexploited source of potential for sizeable emission reductions with great domestic co-benefits.

Given the forecast increase in activity within this thematic area worldwide over the coming decades, it is of vital importance that the above factors combine to motivate concerted and rapid progression. Within the next two decades, China will move from a position of having a light duty vehicle fleet just 10% the size of the U.S.'s, to a position of consuming more vehicles each year than total global production in 2009 (UNEP 2010). Similar patterns of mass car ownership are likely to unravel in other emerging economies, making the global vehicle fleet several scales larger than it is currently. Given the profound impact that this may have on worldwide GHG emissions, the development of low carbon options at an early stage is crucial; investments by developed countries in transferable low-carbon transport technologies now, may enable emerging economies to reasonably assume a greater share of mitigation responsibility later.

#### 4.2.7.5 Policy impacts and mitigation potential

Emission standards for cars have a significant effect on the future growth of emissions in the analysed countries (United States, the European Union, China and Japan). For the developed countries the standards stop the growth in emissions and lead to an absolute reduction. The Emission growth is slowed down for China. If all countries were to implement the best practice policies of peers in their region, an additional 0.4 to 0.6 $GtCO_2e$/a below reference could be reduced in 2020. It could stop the growth in global emissions altogether.

## 4.3 Methane from fossil fuel production

### 4.3.1 Qualitative assessment

There are five main sources for fugitive emissions in oil and gas production[23]:

- Fugitive equipment leaks
- Process venting
- Evaporation losses
- Disposal of waste gas streams (e.g. by venting and flaring[24])
- Accidents and equipment failures (e.g. well blowouts, pipeline breaks, tanker accidents, tank explosions, gas migration to the surface around the outside of wells, surface-casing vent blows)

Further, three broad categories are differentiated:

- Oil and gas production
- Crude oil transportation and refining
- Natural gas processing, transportation and distribution

The following analysis of policies for reduction of emissions from oil and gas production focuses on the reduction of venting and flaring of waste gas streams.

[23] IPCC: Fugitive Emissions from Oil and natural gas activities, in: IPCC: Good Practice Guidance and Uncertainty Management in national Greenhouse Gas Inventories)

[24] Venting refers to the release of natural gas that is not processed for sale or use because of technical or economic reasons; Flaring refers to the burning of natural gas in the field as a means of disposal (Nurakhmet: Gas flaring and venting what can Kazakhstan learn from the Norwegian experience/ Handbook Petroleum Industry: Words and Phrases; Glossary of Canadian Association of Petroleum Producers (www.capp.ca)

#### 4.3.1.1 Norway – the Petroleum Act and the Pollution Control Act

Crude oil production in Norway started in the 1979th. Today, Norway is among the 15 top producing countries of crude oil in the world (IEA 2013[25]). While oil production started to decrease since 2000, gas production keeps increasing and accounted for close to 50% of overall petroleum production on the Norwegian continental shelf in 2012[26].

Since the beginning of oil production in Norway, the government put policies in place to avoid wasting valuable energy[27], in particular natural gas associated with the oil production. Oil production is supervised by the Norwegian Petroleum Directorate (NPD) and the Norwegian Pollution Control Authority (SFT). Two particular laws regulate the handling of associated gas in petroleum production. In the Pollution Control Act[28], emission of gas or other substances into the air are prohibited in general. That applies for the venting of associated gas as well as the flaring of associated gas except for safety reasons. Under the Petroleum Act[29] each dwell is allowed a limited amount of gas flaring as required for safety reasons. The amount of flared gas is determined on a quarterly basis in case of regular operations, on a monthly basis for exploration of new fields. The amounts of gas venting and flaring need to be reported on an annual basis.

In addition, production licenses are provided under the Petroleum Act on a case-by-case assessment. The Petroleum Act requires a plan for development and operation of an oil or gas field (PDO) by the company applying for a production license. The PDO also needs to include an environmental impact assessment. To obtain a production license for a dwell, the company needs to take steps to utilize the associated gas. Mainly, three options are available for the associated gas development: (i) Electricity production via gas-fired turbine generators, (ii) gas conservation and (iii) re-injection into the dwell for improved oil-recovery. In the beginning of oil production in Norway, the production licenses had a limited duration of six month only, hence a regular review of production conditions took place. Today, licenses are valid for a number of years (starting with 4-6 years for exploration and 10-30 years for exploitation).

In 1990, the Norwegian Parliament in addition introduced a $CO_2$ tax for offshore petroleum activities[30] (). For all gas burnt or discharged to the air, a tax of 0.96 Norwegian krones per cubic meter needs to be paid (NPD).

The strict regulation of venting and flaring resulted in a significant reduction of gas venting and flaring. Venting only accounted for 0.5Mt $CO_2$e in 2011 (see Figure 15). Flaring rates in Norway are between 0.3% and 0.4% of the total oil and gas production on the Norwegian shelf, compared with a global average of 1.1%. As Figure 14 shows, while oil and gas production significantly increased between 1980 and 2000, gas flaring not only remained relatively stable, but also declined in a number of years. Today, only about 10% of $CO_2$ emissions from petroleum activities in Norway are from Flaring (Facts 2014), the major part (80%) coming from combustion activities providing the necessary electricity.

---

25 IEA 2013: Oil Information 2013

26 www.environment.no/topics/marine-areas/oil-and-gas-activities/

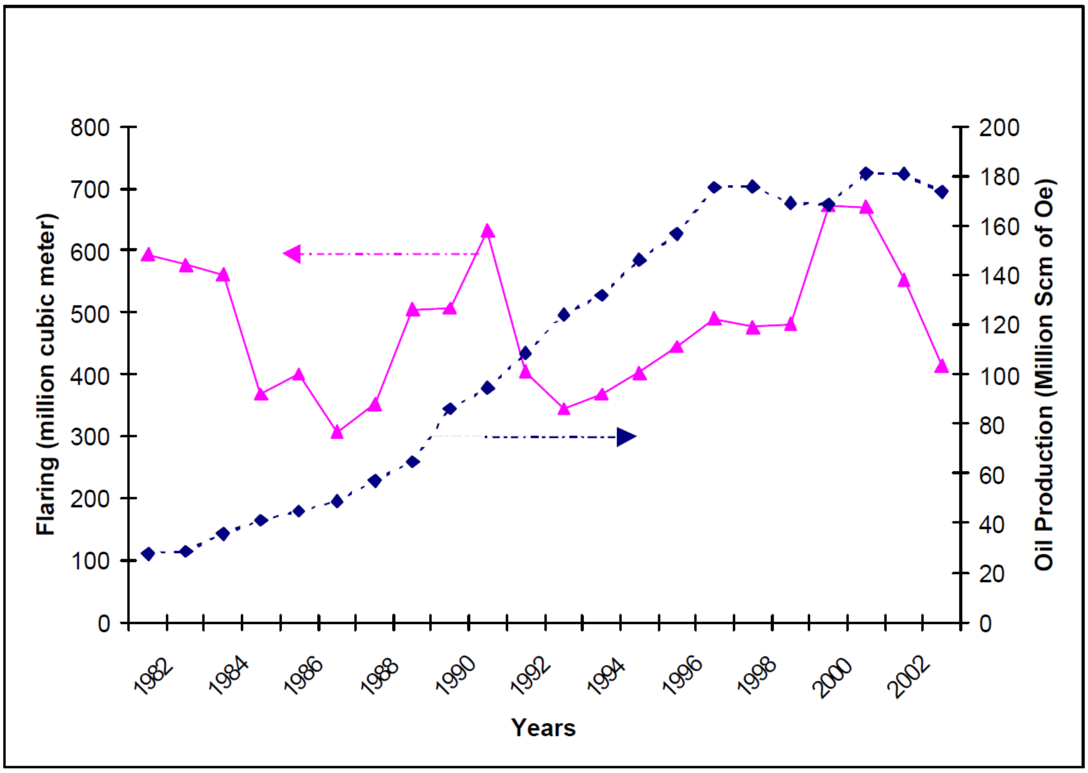
27 The Norwegian Parliament produced „10 oil commandments“ that are significant for the direction of Norwegian petroleum policy. The fifth commandment requires "Flaring of exploitable gas on the NCS must not be accepted except during brief periods of testing" (http://www.npd.no/en/Publications/Norwegian-Continental-Shelf/No2-2010/10-commanding-achievements/).

28 Act of 13 March 1981 No 6 Concerning Protection Against Pollution and Concerning Waste

29 Act 29 November 1996 No. 72 relating to petroleum activities

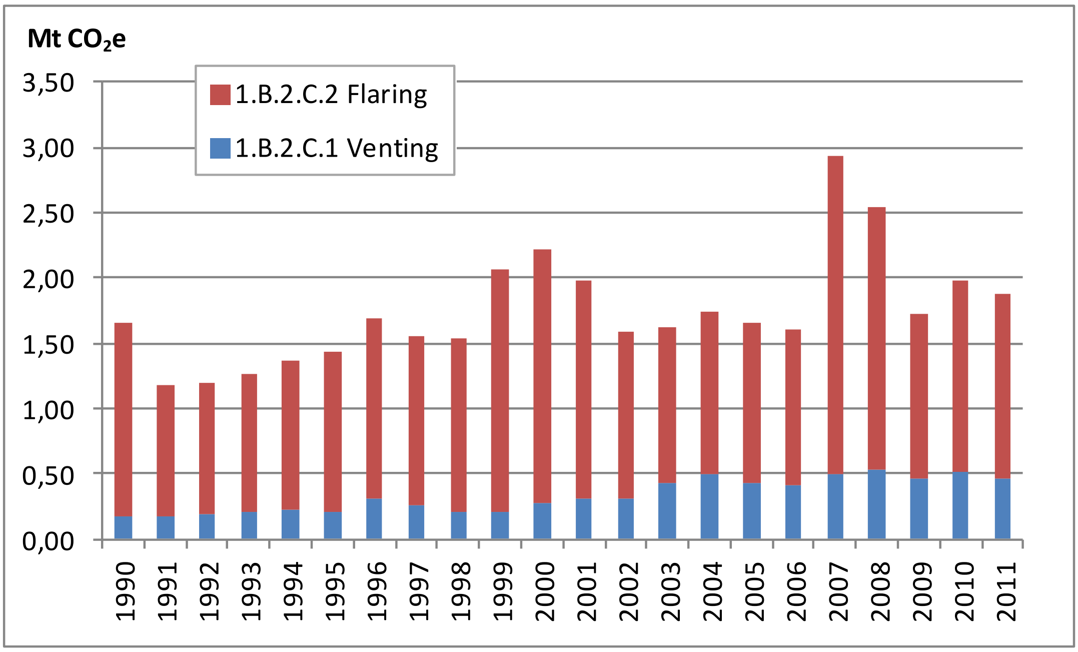
30 Act 21 December 1990 no 72 relating to tax on discharge of CO2 in the petroleum activities on the continental shelf

**Figure 14: Oil production and flaring of associated gas in Norway between 1980 and 2002**




Source: World Bank

**Figure 15: Emissions from venting and flaring in Norway**




Source: UNFCCC data interface

As utilization of associated gas in petroleum production was required from the beginning in Norway, starting point for the implementation of such a policy was quite different compared to countries that want to introduce the same policy subsequently. In particular:

- Companies and other stakeholders were involved in finding an appropriate regulatory approach from the beginning[31].
- As the application for production licenses requires all companies to provide a plan on the utilization of the associated gas, no retrofitting was needed. Also, the requirements lead to investment in infrastructure for the transport of gas which allows further processing and selling of the associated gas. Today, gas makes up about 50% of total petroleum production in Norway.
- Measuring and reporting is an important part of a successful policy to reduce venting and flaring. In Norway, clear rules for reporting apply, a flaring and venting register is kept and regular audits define the correctness and accurateness of the data provided.[32]

A number of co-benefits occurred from the restrictive regulation on associated gas:

- Re-injection of associated gas results in improved oil recovery from a number of dwells.
- Utilization of associated gas for selling and transport via a pipeline system opened up a new market for Norway.

Norway launched two initiatives to promote its flaring policies:

- Oil for development was launched in 2005 by the Norwegian government. It focuses on long-term capacity building and institutional cooperation with relevant governmental agencies within the areas of resource management, revenue management and environmental management.
- The World Bank's Global Gas Flaring Reduction Partnership was launched in 2002. It supports the efforts of oil producing countries and companies to increase the use of associated gas and reduce flaring and venting. It provides a standard framework for governments and companies to take collaborative actions and reduce barriers to associated gas utilization. Major partners include Russia, Kazakhstan, Algeria, Angola as well as major oil producing companies.

#### 4.3.1.2 Russia – License requirements and the law "on environmental protection"

Russia is the second largest producer of crude oil and natural gas[33]. At the same time, Russia is one of the top flaring countries,[34] contributing about 25% to overall flaring in 2012. Only about 76% of the associated gas is utilized[35].

---

31 See Comparison of Associated Gas flaring regulations: Alberta & Norway http://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDUQFjAA&url=http%3A%2F%2Fsiteresources.worldbank.org%2FEXTGGFR%2FResources%2F578068-1258067586081%2FAlberta_Norway_regulations_comparison.pdf&ei=CPeGU4uDEqLT7Aak_oHgDA&usg=AFQjCNFQoEW_CRjSH7LODfVW_2bYaaneSA&bvm=bv.67720277,d.ZGU&cad=rja

32 Nurakhmet: Gas flaring and venting: what can Kazakhstan learn from the Norwegian experience?. http://www.dundee.ac.uk/cepmlp/gateway/?news=28103

33 IEA 2013: Oil Information 2013; IEA 2013: Natural Gas Information 2013

34 Carbon Limits 2013: Associated Petroleum Gas Flaring Study for Russia, Kazakhstan, Turkmenistan and Azerbaijan. Final Report. http://www.ebrd.com/downloads/sector/sei/ap-gas-flaring-study-final-report.pdf

35 Reuters 2012: Russia oil firms face heavy fines for gas flaring. http://www.reuters.com/article/2012/06/16/us-russia-oil-flaring-idUSBRE85F0DN20120616

In 2012, Russia introduced and strengthened regulations that require companies to reduce flaring and stop wasting associated gas. License requirements in two large regions (Khanty-Mansiysk and Yamalo-Nenets) foresee associated gas utilization percentages. Otherwise the license for oil production at the subsoil can be withdrawn.

In addition to the license requirements, the national law "on environmental protection" regulates payments for pollutants associated with flaring and venting of associated gas. Three groups can be differentiated associated with differing payment rates: "within established emission limits", "within temporarily agreed emission limits" and "above-limit emissions". In case emissions exceed a threshold of 5% of the produced associated gas, government decree No. 1148 of 8 November 2012 stipulates a multiplier of 25 (until 2014 a multiplier of 12). If no acceptable measuring equipment is present at the well, a multiplier of 120 applies. No multipliers are applied if the threshold of 5% is not exceeded, if total annual production does not exceed 5 million cubic meters or if the associated gas contains less than 50% non-hydrocarbon components.

To incentives investments in utilization equipment, payments for gas pipelines, compressor stations, separation units, facilities for electricity and heat production or for re-injection of gas into the well can be subtracted from the fines under decree No. 1148. For efficiency, companies can aggregate production across all fields to reach the utilization rate of 95%. If, however, the target is not met, fines are calculated per field.

Further regulations incentivising the utilization of associated gas include:

- Additional economic incentives were provided in 2008 when the pricing of associated gas was liberalized increasing companies bargaining power with the associated gas processing, Gaszprom-owned facilities.
- Associated gas is given priority access to free capacities in the gas transportation pipelines.
- Reduced mineral extraction tax rates apply for associated gas that is re-injected into the well for improved oil recovery.
- An amendment to the law "On electricity" from 2010 gives priority access to the national electricity grid for electricity from utilized associated gas and its derivatives.

Estimations of the World Bank indicate that the economic losses related to gas flaring in Russia are more than $5bn per year, part of which can be recovered if the amount of gas flaring is reduced. Yet, a number of barriers exist[36]:

- A large number of wells with low pressure and low gas volumes and their remoteness from each other and from infrastructure systems for gas transportation require funding investments. Further, local demand close to the wells is very limited.
- Gas impurities require further processing and cleaning before it can be sold.
- Re-injection of associated gas, though often used to improve oil production, can also result in damaging of oil production in a well depending on the geological circumstances.
- In addition to the technical and infra-structure barriers, a further major barrier is the limited enforcement of the rules and regulations described above and the limited economic incentives from the fines that are applied. A recent report on the status of gas flaring in Russia states that so far no case is known in which a company actually lost its production license even though non-compliance with the utilization of associated gas regulations is common. Further, fines do not present the necessary economic incentive to invest in gas

[36] Word Bank 2013: Igniting solutions to gas flaring in Russia. http://www.worldbank.org/en/news/feature/2013/11/12/igniting-solutions-to-gas-flaring-in-russia

utilization equipment.[37] As long as oil production does not become less important for the Russian economy, chances are that political protection of the industry will remain high and continue to hinder introduction and enforcement of effective rules and regulations against gas flaring.[38]

- Comparisons of Russian statistics reveal that different estimation methods for the amount of gas flaring are used[39].

Since 2004, one of the major oil and gas producing districts in Russia, the Khanty-Mansiysk Autonomous Okrug-Yugra is a member of the global gas flaring initiative of the world bank. In Okrug-Yugra, about 86% of the associated gas is utilized as a result of a number of associated gas utilization projects for power generation, municipal heating and improved oil recovery between 2007 and 2010. They increased the utilization rate by almost 8%. However, the reductions in Khanty-Mansiysk have been offset by new flares in other regions[40]. Russia itself is not a member of the World Bank initiative.

### 4.3.2 Quantitative assessment of policies

#### 4.3.2.1 Methodological considerations

Although methane emissions occur at different stages of fossil fuel production, our quantification of policies focusses on flaring of associated petroleum gas (APG) associated with oil production only.

##### 4.3.2.1.1 Country-level analysis

Our approach for quantifying the effect of policies to reduce associated natural gas flaring consists of the following steps:

1. Historical data for the amount of APG flared data are taken from the National Oceanic and Atmospheric Administration (NOAA, 2011). This dataset is based on satellite data and contains the most consistent national and global estimates of gas flaring volumes from 1994 until 2010 (Ismail & Umukoro, 2012).
2. Historic crude oil production is taken from IEA Energy Balances (2013).
3. APG production in 1994 – 2010 is estimated based on:
   i. Where possible, APG flared and estimates of the share of AGP production flared found in literature.
   ii. For the years where no estimates for literature are available, the APG production is estimated based on the relationship between crude oil production and APG produced. This relationship is estimated based on the results of step 2 and 3i.
4. The share of AGP flared is calculated based on the APG produced and AGP flared values.
5. AGP produced in 2020 is estimated based on the 2010 value and regional growth projections for oil production taken from BP (2013).

[37] Carbon Limits 2013

[38] WWF Russia 2009: Russian Associated Gas Utilization: Problems and Prospects. A. Knizhnikov and N. Poussenkova.

[39] Carbon Limits 2013

[40] Carbon Limits 2013

6. The amounts of APG flared in 2020 in the different pathways are calculated.
   i. Frozen technology pathway: the share of AGP flared is kept constant at the 2010 value.
   ii. Reference pathway: The trend of the share in APG flared in recent years (2006-2010) is continued until 2020.
   iii. Policies pathway: The target set for APG flaring is met in 2020.
7. The greenhouse gas emissions related to this amount of flaring are calculated by multiplying with the emission factor 2.7 $MtCO_2e$ / BCM flared (estimated based on Farina, 2010).

The steps indicated here require to take assumptions on different aspects:

1. The main assumption underlying this approach is that crude oil production can be used to estimate APG production. This assumption is made because available statistics do not differentiate between associated and non-associated natural gas production. Although APG production is related to oil production, the proportion of associated gas to oil can vary strongly between oil fields (Ismail & Umukoro, 2012). However, for Russia, for example, we found a strong correlation between APG flared and crude oil production.
2. The greenhouse gas emissions from flaring natural gas are estimated on the global figures for APG flared and the associated emissions from Farina (2010). It is thus assumed that emissions per amount of APG flared are constant worldwide. Due to the different compositions and local characteristics of APG flaring, this emission factor will in practice not be constant.

#### 4.3.2.1.2 Regional and global upscaling

The mitigation potential of flaring reduction policies is only quantified for Russia. It was chosen not to upscale the results of this case study to the global level. Instead it is only upscaled to the top-5 APG flaring countries (Russia, Nigeria, Iran, Iraq, and Algeria). This approach was chosen because the flaring circumstances differ strongly between countries. In developed countries, APG utilization is between 97% and 99% (Ismail & Umukoro, 2012). Scaling up the Russian target of 95% utilization (Svensson, 2012; Farina, 2010) is thus not feasible. Furthermore, in non-oil and gas producing countries reducing flaring will have only an insignificant effect on emissions. Therefore, it was chosen to only upscale the results to the top-5 flaring countries, in which utilization rates are relatively low. These top-5 countries cover 57% of the global APG flaring (NOAA, 2011).

The approach taken for the upscaling consists of the following steps:

1. Historical data for the amount of APG flared data are taken from NOAA (2011).
2. Historic crude oil production is taken from IEA Energy Balances (2013).
3. The ratio of APG flared over crude oil production is calculated.
4. Crude oil production in 2020 is estimated based on the 2010 value and regional growth projections for oil production taken from BP (2013).
5. The amounts of APG flared in 2020 in the different pathways are calculated.

   i. Frozen technology pathway: the ratio of AGP flared over crude oil production is kept constant at the 2010 value.
   ii. Reference pathway: The trend of the ratio of AGP flared over crude oil production in recent years (2006 – 2010) is continued until 2020.

iii. Policies pathway: The 2020 ratio of AGP flared over crude oil production from the Policies pathway for Russia is applied to the 2020 crude oil production.

6. The greenhouse gas emissions related to this amount of flaring are calculated by multiplying with the emission factor 2.7 Mt$CO_2$e / BCM flared (estimated based on Farina, 2010).

#### 4.3.2.2 Results of quantitative assessment

The reduction of flaring from associated petroleum gas (APG) is quantified for Russia only. Russia has set a target of 95% utilization of APG in 2014 (Svensson, 2012; Farina, 2010). In the absence of a target beyond 2014, the same target is applied for 2020. Based on PFC Energy (2007), the APG flaring rate in the period 1994 – 2005 is taken to be on average 45%. As described in the methodology, the amount of APG production for other years is estimated based on crude oil production and literature value for the share of APG flared. As can be seen in Figure 16 the amount of APG flared and crude oil production are strongly correlated in the period 1994 – 2005. After 2005, the amount of APG flared decreased compared to oil production. This decoupling coincides with the increasing awareness for the gas flaring issue in Russia (Farina, 2010). Based on this decoupling from 2006 onwards, the flaring trend from 2006 – 2010 is taken as the basis for the reference scenario.

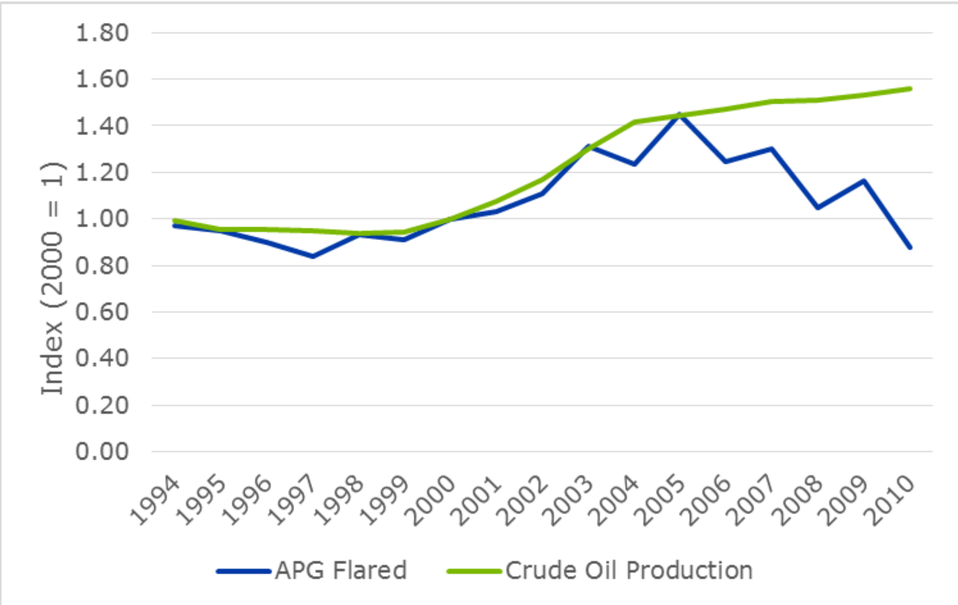



**Figure 16: Index of APG flared and crude oil production for Russia (1994 - 2010)**

Figure 17 and Table 18 show the results of the quantification for Russia. Due to the projected decrease in oil production in the region (BP, 2014) the emissions in the 2020 frozen technology pathway are below the 2010 level. A continuation of the recent trend of decreasing APG flaring would lead to a decrease in flaring emissions of 63% below the 2010 level. Achieving the 95% utilization target would lead to decrease in flaring of 81% below the 2010 level. According to our calculations, this is reduction of 17 Mt$CO_2$e below the reference pathway and 71 $CO_2$e below the frozen technology pathway. However, one has to keep in mind that there is a high uncertainty concerning the amount of APG flared. Russians statistics report values much lower than the NOAA (2013) satellite data. According to Russian statistics the amount of flared APG was in the range of

11-17 BCM in the period 2003 – 2010 (CL, 2013), whereas NOAA reports values in the range of 35-58 BCM in the same period.

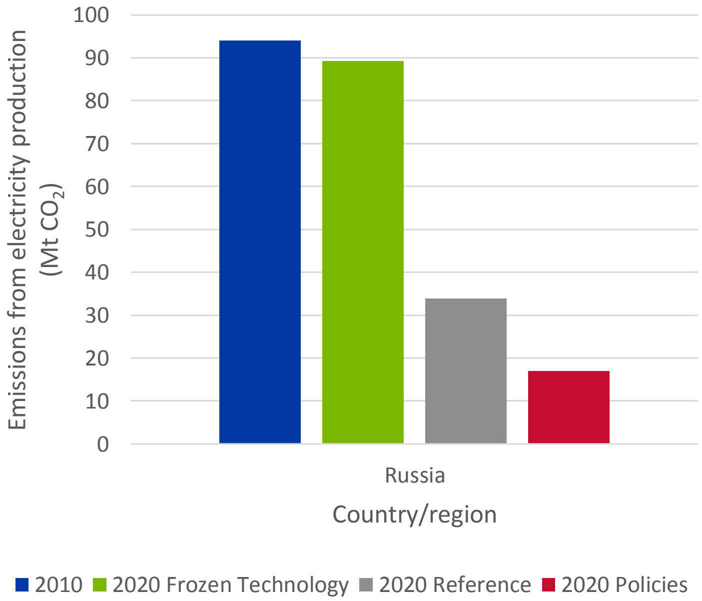



**Figure 17: Results country-level quantification of flaring reduction policies**

**Table 19: Results country-level quantification of flaring reduction policies**

| | Russia (2010) | Russia (2020 with policy) |
|---|---|---|
| APG flaring rate | 26% | 5% |
| Flaring emissions $MtCO_2e$ | 94 | 17 |
| BCM APG flared per mtoe crude oil production | 7E-5 | 1E-5 |

Figure 18 shows the result of upscaling the approach for Russia to the top-5 flaring countries (Russia, Nigeria, Iran, Iraq and Algeria). Emissions in the frozen technology pathway are at the same level as the 2010 emissions, due to the comparable projected oil production. The reference pathway, in which the 2006-2010 trend continues, represents a reduction of 34% of emissions from the 2010 level. The policy potential pathway, in which the amount of APG flared per amount of crude oil production is set at Russian policy target level, represents a reduction of 82% below the 2010 level. This is an estimated reduction of about 100 $MtCO_2e/a$ below the reference pathway in 2020. Since this upscaling only covers the top-5 flaring countries, the global policies potential will exceed this 100 Mt $CO_2e/a$. Considering that the top-5 flaring countries cover 57% of the flaring and that flaring rates in some countries are already below the 5% target, the global policy potential will be below 200 $MtCO_2e/a$.

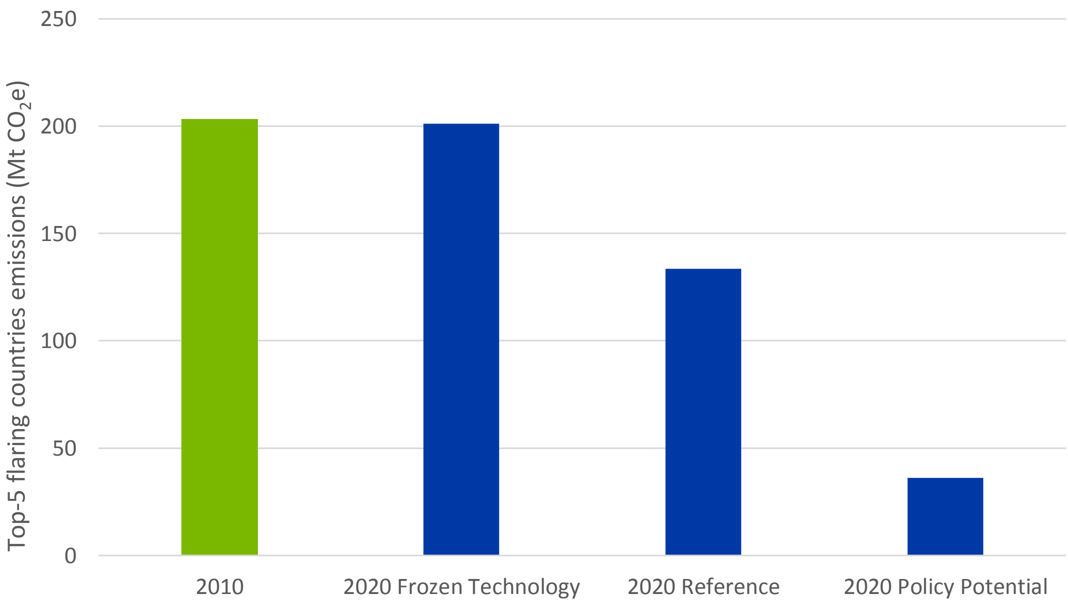



**Figure 18: Upscaling to top-5 flaring countries (only emissions from Russia, Nigeria, Iran, Iraq and Algeria are shown)**

McKinsey & Company (2009) estimate the abatement potential from flaring reduction to be 70 $MtCO_2e$/a in 2030 compared to their reference scenario which includes a 72% reduction of flaring below the 2005 level. This estimate compares reasonably well with our estimate, taking into account that our reference scenario for the top-5 flaring countries represents a 52% reduction of flaring below the 2005 level in 2020.

### 4.3.3 International discussions in related forums

Progress on policy related to short-lived climate forcers (SLFCs) is promoted by its large potential for health improvements; in addition to the climate change mitigation potential, successful mitigation activities could prevent 24 million annual deaths from air pollution, and approximately 32 million tonnes of annual crop losses (Harrison et al., 2014).

Three key international cooperative initiatives focus on methane emissions from fossil fuel energy production:

- The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) is a UNEP awareness raising initiative, seeking to enhance understanding and capacity to overcome barriers for this thematic area,
- The Global Methane Initiative (GMI) builds on the existing success of the Methane to Markets Partnership to promote the recovery and use of methane as a clean energy resource, for both the public and private sectors.
- The Global Gas Flaring Reduction Initiative (GGFRI) of the World Bank promotes private-public partnerships and best practice guidelines for the reduction of flaring.

Importantly, technologies and knowledge for mitigation in this area are at a mature stage, and most countries are considered to be in a state of high-readiness to implement such measures. Countries participating in the CCAC have found development in this area to be a highly efficient means of enhancing domestic development and raising ambition for climate change mitigation. Given the high potential for mitigation and development in this area, a concerted effort currently exists to mainstream consideration of SLFCs in the work of global and regional development banks. In 2012, the World Bank was commissioned by the G8 to investigate ways in which it can better integrate SLFCs in its existing and future project portfolios.

### 4.3.4 Summary and recommendations for methane from fossil fuel production

#### 4.3.4.1 Summary and comparison of case studies

The main features of the two case studies of Norway and Russia are provided in Table 21.

**Table 20: Summary and comparison of methane policy in Norway and Russia**

| | Norway | Russia |
|---|---|---|
| **Major policy** | Petroleum Act and Pollution Control Act | License requirements and law on environmental protection |
| **Type** | License requirements; permit system | Permit system; license requirements |
| **Key features** | Production license requires plan on the utilization of associated gas; Permit system for gas flaring | Limit requirements on gas flaring for production license; payments for gas flaring |
| **Complementary polices** | $CO_2$ tax for offshore petroleum activities applying to gas venting and flaring | Priority use of access transportation capacities for associated gas; liberalization of associated gas pricing; priority feed-in of electricity produced from associated gas into the national grid |
| **Barriers** | High infrastructure costs; Measuring and reporting | High infrastructure costs; Measuring and reporting; effective enforcement of policies |
| **Co-benefits** | Utilization of associated gas e.g. for improved oil recovery, electricity production, heating or export | |

A comparison of the two case studies shows that very similar policies are in place in Russia and Norway. In both cases, license requirements exist and a permit system and fines/ payment system is in place. A major difference in the license requirements is the fact that in Norway companies were facing the requirements from the very beginning, while in Russia the law was only adopted a few years back. Hence, while in Norway companies are required to present a plan for the utilization of associated gas to obtain a production license, the newly introduced Russian law allows for the revocation of the license. However, so far Russian regulators lacked the political will to enforce these license requirements.

#### 4.3.4.2 Barriers and mitigating policy features

In both case studies, distance of production sites to areas where the associated gas could be used presented one of the major barriers. As a result, high investments in one or the other kind of technology are necessary to utilize the associated gas instead of flaring it. While in Norway, a strict requirement for the utilization of associated gas required companies to deal with those investments, in Russia an effective enforcement of a similar policy is missing. So far, non-compliance does not result in a loss of production licence in Russia and fines do not present the necessary incentive to invest in associated gas utilization technology. The two cases show clearly that the lack of political will is a major barrier in Russia.

#### 4.3.4.3 Co-benefits and motivation

The associated gas presents a valuable resource with three major application possibilities: (i) re-injection into the well for improved oil recovery, (ii) local use for heat or electricity generation or (iii) processing and resale/ export. In all cases, an economic value

#### 4.3.4.4 Future outlook

The case study of Norway suggests that strict regulations can result in very low levels of gas flaring in the long run. With the Global Gas Flaring Reduction Initiative of the World Bank, Norway tries to help other oil producing countries and companies to utilize the associated gas instead of just burning it. In the long run, higher gas prices could help to increase the economic incentives for the utilization of associated gas.

#### 4.3.4.5 Policy impact and mitigation potential

The policy to reduce APG flaring to 5% in the analysed country Russia, can lead to a significant decrease in flaring emissions. If the target is met, 2020 emissions in this area decrease by over 80% from the 2010 level according to our calculations. If the top-5 APG flaring countries adopt similar policies an emission reduction of about 100 $MtCO_2e/a$ below the reference could be achieved in 2020. Global implementation of similar policies could result in an even bigger emission reduction.

## 4.4 Appliances

### 4.4.1 Japan: Top Runner programme

In 1998, the Top Runner Programme was adopted in a revision of the Energy Conservation Law, which introduced an efficiency standard programme requiring manufacturers to meet certain levels of efficiency for appliances based on the best performance of current technologies (Hamamoto, 2011). The Kyoto Protocol agreement in 1997 was a driving factor behind the introduction of the Top Runner Programme – with the policy aiming to lower GHG emissions in the residential sector via an increase in the energy efficiency of end-use products in order to contribute to the fulfilment of Japan's Kyoto Protocol target (6 % GHG reduction by 2008-2012 below 1990 levels). The scope of the Top Runner Programme is based on three criteria (Osamu, 2012):

- Products involving large domestic shipments;
- Products that consume a substantial amount of energy in the use phase;
- Products with considerable room to improve energy efficiency.

At the beginning of the Top Runner Programme, nine products were set energy efficiency targets (room air conditioners, fluorescent lighting, television sets, copying machines, computers, magnetic disk units, video cassette recorders, refrigerators, passenger vehicles and freight vehicles).[41] A multi-stakeholder, consultive process decides upon the setting of standard levels and target years for the appliances selected,[42] which are regularly revised, and based upon the 'top runners' (the most energy efficient product on the market during the standard setting process) whilst also taking into account technological potential for energy efficiency improvements.[43] Importantly, the standards are also differentiated based on certain parameters (size, weight, and technology type) and producers are provided flexibility by only having to comply with a weighted average energy efficiency standard for the products that they sold in the target year. This means that the producer does not necessarily have to achieve every product target, however on average they must meet the energy efficiency standard. This flexibility allows producers to sell a wide range of products to meet consumer demand, whilst guiding the overall market to higher energy efficiency standards (Osamu, 2012).

The Ministry of Economy, Trade and Industry (METI) requires producers to submit a report in the target year that includes information on their sales and the energy efficiency of their products, which is the basis for an evaluation on their compliance with the Top Runner Programme. The main sanction for non-compliance with the policy follows the 'name and shame' approach whereby the recommendation from METI for a producer to improve their energy efficiency performance is publically announced if the producer subsequently fails to comply and is then ordered to meet the standard. Although there is no publically available documentation on rates of compliance, no producer has so far been announced as non-compliant. The successful compliance of producers may be due to the limited number of domestic producers in the Japanese appliance market and the fact that culturally criticism from the government acts as a serious penalty (Osamu, 2012). The

[41] The number of products included within the policy has been gradually expanded over time through a process of regular reviews and by 2009 energy efficiency standards and target years were set for 21 products.

[42] 'Energy efficiency standards are discussed and determined by the Ministry of Economy, Trade and Industry (METI) and its advisory committees comprising representatives from academia, industry, consumer groups, local governments and mass media' (Osamu, 2012)

[43] For example, 'the Top Runner Standards for room air conditioners (smaller than 4 kW) for 2010 were set for a 3-4 % improvement over the Top Runner products in 2005, because this level of technological improvement was assessed as feasible by stakeholders' discussions in the Air Conditioner Evaluation Standard Subcommittee' (Osamu, 2012).

implementation of the Top Runner Programme has therefore been very successful with all of the targets shown in Table 19 either being meet or exceeded.

**Table 21: Energy efficiency improvement of major products with Top Runner Standards**

| Product | Estimated improvement with Top Runner Standards * | Result |
|---|---|---|
| Room air conditioners | 66.1% increase in COP (FY 1997 vs 2004 freezing year) | 67.8% |
| Refrigerators | 30.5% decrease in kWh/year (FY 1998 vs FY 2004) | 55.2% |
| TV receivers | 16.4% decrease in kWh/year (FY 1997 vs FY 2003) | 25.7% |
| Computers | 83.0% decrease in kWh/year (FY 1997 vs FY 2003) | 99.1% |
| Fluorescent lights | 16.6% increase in lm/W (FY 1997 vs FY 2005) | 78.0% |
| Vending machines | 33.9% decrease in kWh/year (FY 2000 vs FY 2005) | 37.3% |
| Gasoline passenger vehicles | 22.8% increase in km/L (FY 1995 vs FY 2010) | 22.8% (FY 1995 vs FY 2005) |

Source: Osamu (2012)

Note: * Estimated improvement of weighted average energy efficiency of all categories within each product group

The contribution of the policy to energy efficiency improvements is not always easy to attribute with other factors also potentially responsible (i.e. market demand for efficient products with low energy cost driving improvements or autonomous technological improvement). Nevertheless, the impact of the policy on the energy efficiency of certain products is clearly noticeable. For example, the adoption of standards for room air conditioners altered the technological trajectory away from the 'challenge of increasing heating capacity (to expand the market for heating) to one of improving energy efficiency' (Osamu, 2012). The increase in energy efficiency rates following the introduction of the standard in 1999 was significant and resulted in the 2004 target being exceeded (Figure 19).

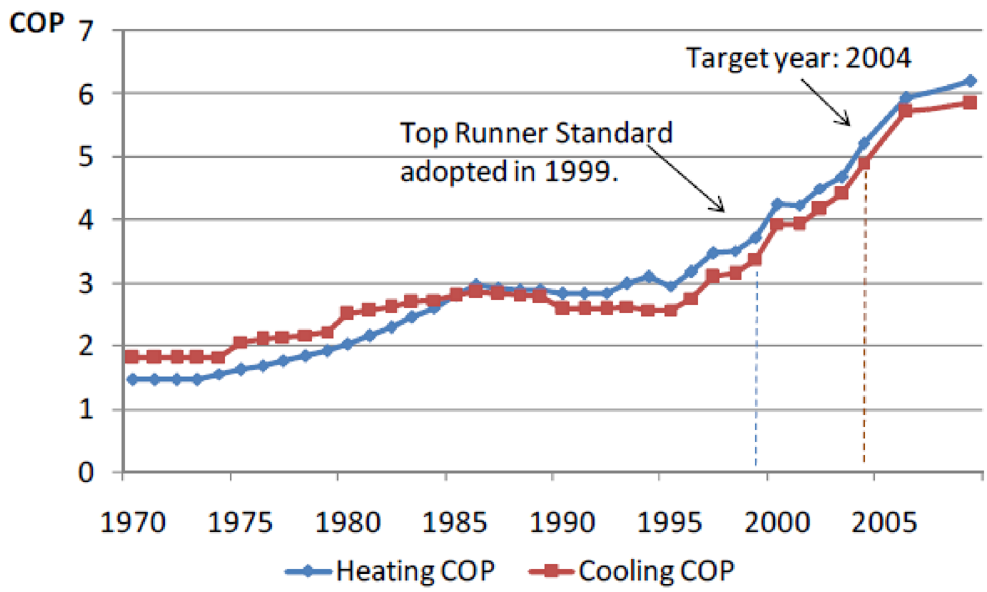



**Figure 19: Long term trend of the energy efficiency of room air conditioners in Japan**

Source: Osamu (2012)

Although the Top Runner Programme has experienced success in encouraging energy efficiency improvements, issues have arisen during the implementation of the policy:

- The consumer prices of products that belong to the listed categories could potentially be affected by the Top Runner Programme.
- Difficulties in determining the rate of technological improvement when target setting has proved challenging for certain products (Osamu, 2012). For example, the target for fluorescent lighting was established just above the Top Runner products on the market due to very conservative estimates for the potential for further energy efficiency improvement. However, in reality unforeseen technological improvements meant that the target was easily achieved and demonstrates the practical problem of target setting and emphasises the need for regular revision of standards and the need for flexibility in the approach.

It is evident that the Top Runner Programme in Japan has successfully encouraged the improved energy performance of a range of appliances through the introduction of efficiency standards that have been continually revised over time in consultation with a variety of stakeholders. The co-benefits of the policy include financial savings from lower energy consumption, which also has considerable benefits with regards to both energy security and lowering GHG emissions. It is important to acknowledge that a necessary pre-condition for the success of the policy was the market structure, which was dominated by a few domestic producers[44] that were willing to accept strict standards (Osamu, 2012). Furthermore, the technological potential for energy efficiency improvement existed – however with the cost effective potential for efficiency of certain appliances becoming exhausted (air conditioner technologies). Decisions over future target setting and the addition of new appliances will be important to ensure the continued success of the policy.[45]

[44] Theoretically the Top Runner standards may constitute improper trade restrictions and therefore could have been met with resistance from influential non-Japanese producers. However, given that the imported products make up marginal shares of regulated markets the possibility of conflict was considerably reduced (Nordqvist, 2006).

[45] Japan’s Agency for Natural Resources and Energy announced on October 22, 2013 that two additional devices (i.e. electric motors and LED lamps) will be added to the list of products included in the Top Runner Programme (refer to http://www.japanfs.org/en/news/archives/news_id034695.html).

### 4.4.2 South Korea: Energy Efficiency Label and Standard Programme

Korea is the 10th largest energy consuming nation in the world and is particularly vulnerable to fluctuations in energy prices as the country imports 96 % of its energy needs from overseas (KEMCO, 2011). The need for greater energy security is therefore an important motivating factor in actively pursuing energy efficiency policies. Furthermore, given the increasing pressure on South Korea to become an Annex I country and to accept binding GHG reductions under the Kyoto Protocol – the impact of mandatory GHG reduction targets would be very negative without changing the energy intensive structure of their economy. In an effort to improve the energy efficiency standards of appliances, South Korea operates three major energy efficiency policies (KEMCO, 2011):

- An energy-labelling programme;
- A high-efficiency equipment certification programme; and
- An energy stand-by programme

In 1992 the Energy Efficiency Label and Standard Programme was introduced, which required all energy-consuming products to have energy efficiency labels – with products graded from 1 (high efficiency) to 5 (low efficiency) and the production of products below the lowest energy efficiency standard is forbidden. The policy is mandatory and all manufacturers are required to comply with the Energy Efficiency Label and Standard Programme. The products included within the policy include household appliances, lighting equipment and passenger vehicles.

In 1996, the High-efficiency Appliance Certification Programme was set up to acknowledge products exceeding certain standards in energy efficiency with the issuance of a special certificate and covers a range of products including pumps, boilers and LED lighting equipment.

The e-Standby programme was established in 1999 to improve energy efficiency via the promotion of power saving appliances. Products that comply with the standby power reduction standards set by the government are recognised by the awarding of an Energy Boy label. In contrast, standby warning labels are applied to the remaining products on the market that fall below the government's standby power reduction standards. Household appliances and office equipment is included within the scope of the policy.

According to the IEA (2008) energy efficiency in the appliances sector of South Korea is now considered to be amongst the best in the world. The introduction of mandatory energy efficiency labels and standards has certainly encouraged positive developments in the energy performance of both refrigerator and air conditioner appliances. For example, energy consumption from refrigerators has declined by 59 % between 1996 and 2010. During the same time period, the energy efficiency ratio of air conditioners has increased by 20 % (KEMCO, 2011). Furthermore, the increased MEP standards introduced for 40W fluorescent lighting in 2004 (i.e. increasing from 60 to 80 lm/ W) transformed the market accelerating the switch towards 32W fluorescent lamps (Figure 20).

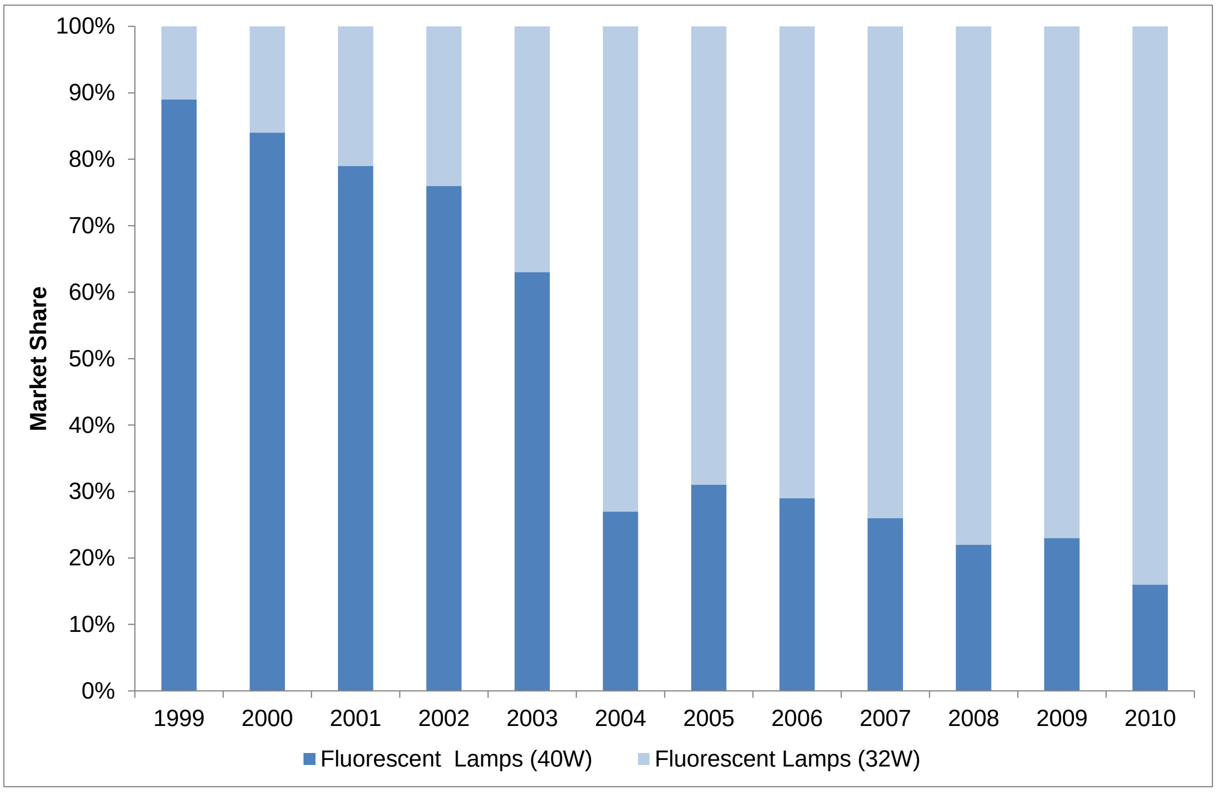



**Figure 20: Transformation of the fluorescent lamp market between 1999 and 2008**

Source: KEMCO (2011)

Voluntary schemes such as the high-efficiency equipment certification programme has encouraged consumers to purchase more energy efficient lighting with sales in the number of high-efficiency certified LED guide lights increasing rapidly from 40,000 in 2008 to 470,000 in 2010 (KEMCO, 2011). [46] This has been further complimented by the South Korean government establishing the LED Deployment 18/30 Plan, which sets the objective to replace 30 % of all lamps with LED lighting by 2020 (IEA, 2012). The energy stand-by programme has also promoted the purchase of the 19 energy saving products covered by the scheme, with the market share of these high standby power reduction products increasing from 60% in 2008 to 98.6% in 2010 (KEMCO, 2011). [47]

The policy measures introduced by the South Korean government have been effective in removing some of the barriers to energy efficiency improvements in appliances (i.e. lack of information). However, the IEA (2012) suggests that improvements in the energy performance of television products are still necessary. Indeed, TVs were the only exception to mandatory indication of energy efficiency grade (1 to 5) among the main energy consuming appliances in households (i.e. refrigerators, air conditioners, washing machines and TVs) – mainly due to the fact that the country is a world leader in the export of TV products (KEMCO, 2011). In order to address this problem, from July 2012 mandatory standards and energy efficiency labelling will also be applied to TVs and it is expected that this will lead to rapid dissemination of LED TVs (which are more energy efficient that alternative products on the market).

[46] The rapid dissemination of the LED technology is also due to additional complementary policies such as tax exemptions and subsidies (KEMCO, 2011).

[47] Although it is important to acknowledge that the market share of these 19 products designated as the standby warning label target products was only 1.4% (KEMCO, 2011).

In conclusion, it is evident that the energy efficiency policies that have been implemented by the South Korean government have been successful in improving the energy efficiency of various appliances over the last 20 years. In particular, the mandatory energy efficiency standards have driven energy efficiency improvements and it is expected that the recent inclusion of TV products in the programme will address a lack of coverage in the scheme and help to promote further improvements in energy efficiency. The additional co-benefits associated with improved energy efficiency in appliances (i.e. financial savings, energy security) further underlines the importance of energy efficiency in a country that is currently very dependent on energy imports. It is also envisaged that improved information via labelling will continue to allow consumers to be aware of the financial benefits of energy efficiency appliances.

### 4.4.3 Quantitative assessment

#### 4.4.3.1 Methodological considerations

##### 4.4.3.1.1 Country-level analysis

To quantify the effect of standards for electrical appliances, our approach follows these steps:

1. Historic data (2000 – 2011) for the electricity consumption of the residential and commercial and public services sectors are taken from IEA Energy Balances (2013a).
2. Based on data on the historic energy efficiency gains from external sources (Odyssee-Mure, 2014), the electricity use without these energy efficiency gains in the period 2000 – 2011 is calculated from the actual electricity consumption in this period. This electricity consumed without efficiency gains is assumed to be the activity level of appliances use.
3. The activity level in 2020 is calculated by applying the average annual growth rate of the activity level in the period 2000 – 2011 to the period 2012 – 2020.
4. The ratio of electricity use over activity level (we call this the 'efficiency factor') is calculated for the period 2000 – 2011.
5. The 2020 electricity use in the different pathways is calculated:
   i. Frozen technology pathway: the 2011 efficiency factor is applied to the projected 2020 activity level (calculated in step 3). We chose to use the 2011 value, because this is the most recent historical year for which data are available. Another possibility could have been to use the year before policy implementation, to distil the factor without policy influence, however that would alter historic emissions for the frozen technology trend. For comparability with the other scenarios, we did not further consider this possibility.
   ii. Reference pathway: The regional annual growth rate of electricity demand of the buildings sector48 from the World Energy Outlook Current Policies Scenario (IEA, 2012) is applied to the 2011 electricity consumption. This approach does not make use of the activity level calculated in step 3.
   iii. Policies pathway: The average trend in the efficiency factor from the year of policy implementation to 2011 is applied to the period 2012 – 2020. If the policy was already

[48] The definition of the buildings sector in the WEO (IEA, 2012) is "The buildings sector includes energy used in residential, commercial and institutional buildings, and non-specified other. Building energy use includes space heating and cooling, water heating, lighting, appliances and cooking equipment".

implemented before 2000, 2000 is used as the starting year for the extrapolation. The resulting 2020 energy intensity is applied to the projected 2020 activity level.

6. The country or region specific emission factor of electricity for 2011 (IEA, 2013b) is applied to the calculated electricity consumption to calculate the emissions in each pathway.

There are some major assumptions underlying this approach. In the ideal case the standards for appliances could be analysed on the detail level of separate appliances (e.g. in way similar to the approach for car standards). However, appliance standards cover a large number of individual appliances. The data needed to do an analysis for separate appliances (e.g. electricity consumption per appliance and country/region, usage data per appliance and country/region) are not available. Therefore, we applied an aggregated approach to this topic area. The following assumptions are made in the approach outlined above:

The appliances and lighting policies in place are assumed to have led to a decrease in electricity consumption already. Continuation of the policies until 2020 is assumed to result in continuing energy intensity decrease. A stronger improvement in energy intensity is not included in the analysis, although it is possible that the downward trend will speed up in the future due to the policies in place or autonomous efficiency improvement. However, based on available data it is not possible to predict how this trend will develop over time.

The electricity use consumption of the residential and commercial and public services sectors are used as a proxy for the electricity use of appliances covered by the standard. This assumption was made because no electricity use data on the level of individual appliances are available. However, as standards cover a wide range of appliances, the vast majority of electricity use in these sectors is expected to be covered by standards. The existence of measures for the efficiency of building envelopes, which reduce electricity consumption for electric heating and cooling, is not considered further.

The electricity use without energy efficiency gains in the period (2000 – 2011) is used as a proxy for the change in activity level of use of appliances.

The country or region specific emission factor of electricity is taken to be constant. Changes in the electricity mix are thus not taken into account in this analysis. A frozen share of energy carriers in the electricity generation means that development in the energy supply sector needs to be analysed separately. The analysis here thus isolates the impact of electric appliances standards.

#### 4.4.3.1.2 Regional and global upscaling

For the upscaling of the appliances and lighting topic area, the trend in activity level and efficiency factor from the best-practice country are applied to the regional electricity use data for the residential and commercial sector for the region upscaled to. The appliances and lighting policies are only upscaled to the OECD region. The reason for this is that the data needed to perform the country-level analysis are only available for the EU. We did not scale up the EU result to the entire world, because the approach included upscaling the activity level trend as well as the energy intensity trend. The activity level trend of appliances use is expected to differ significantly between developed and developing countries. Thus upscaling to the entire world is not feasible for this topic area.

#### 4.4.3.2 Results of quantitative assessment

Policies for energy efficient electrical appliances are only quantified for the EU. The reason for this is the lack of availability of data for energy efficiency gains in households for other countries or regions. For the EU, we use Odyssee-Mure (2014) data on the energy efficiency gains in households for determination of the historic energy efficiency trend (see Figure 21). The Ecodesign Directive was first adopted by the European Council and Parliament (EC, 2005), the efficiency factor trend extrapolation is based on the 2005 – 2011 trend. Although the Ecodesign Directive was extended in 2009 to include all energy related products (EC, 2012), no significant improvement in the energy efficiency gains was observed since 2009 (see Figure 21). Therefore, to include a longer time series, the 2005-2011 trend was taken as the basis of the analysis.

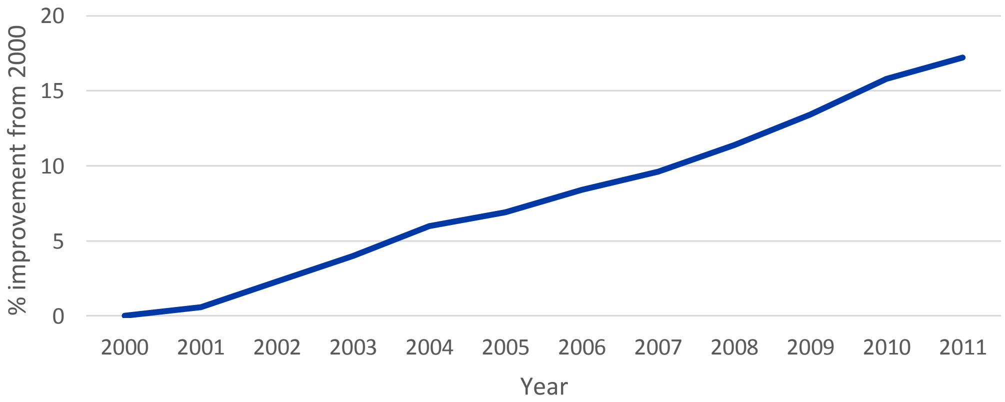



**Figure 21: Energy efficiency gains in households in the EU since 2000 (based on Odyssee-Mure, 2014)**

Figure 22 and Table 21 summarise the results of the quantification. The efficiency factor trend in the period 2005 – 2011 is a decrease of 1.9% year. Applying this improvement rate to the projected activity increase of 3.5% per year leads to an increase of emissions from the 2010 level. However, emissions in the policies pathway are a 120 MtCO2 below the frozen technology pathway. As the WEO Current Policies Scenario (IEA, 2012b) includes the Ecodesign Directive, it is as expected that the reference and policies pathways are comparable.

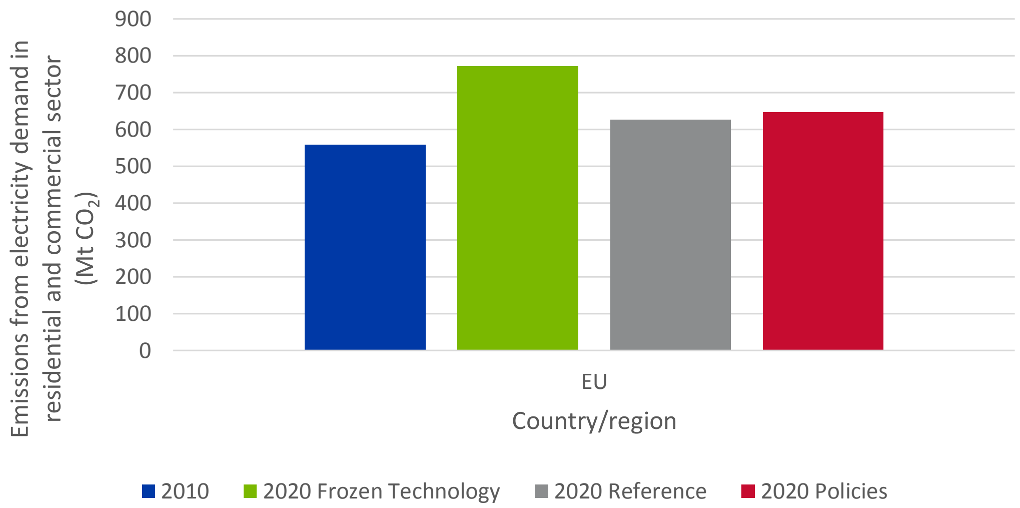



**Figure 22: Results of country-level quantification for appliances policies**

**Table 22: Results of country-level quantification for RES-E support policies**

| | EU |
|---|---|
| 2010 emissions ($GtCO_2$) | 0.6 |
| 2020 emissions policies pathway ($GtCO_2$) | 0.6 |
| 2020 reduction below reference pathway ($GtCO_2$) | 0.0 |
| 2020 reduction below frozen technology pathway ($GtCO_2$) | 0.1 |
| With policies emission trend (% /a) | 1.0 |
| With policies emission intensity trend (% /a) | -1.9 |

The results of upscaling these numbers to the OECD region are shown in Figure 23. They are very similar to the results of the regional-level analysis for the EU. The trend 2011-2020 in activity level and energy intensity determined for the EU, is applied to the 2011 OECD electricity consumption in the residential and commercial sector. This approach results in a slight increase in emissions from the 2010 level in the policy potential pathway. The policy potential pathway is estimated to be comparable to the reference pathway. This indicates that the electricity consumption growth as projected in the WEO Current Policies Scenario for OECD is comparable to the electricity growth based on applying EU policy trends. This can be explained by two factors. Firstly, due to the international nature of the appliance market, policies in the EU are affecting the energy intensity of appliances in other regions as well. Second, some other OECD countries have also already adopted energy efficient appliances policies (e.g. Top-runner programme in Japan).

This analysis only covers the OECD. The OECD represented 64% of global residential and commercial electricity use in 2011 (IEA, 2103a). As the electricity demand growth rates projected for the non-OECD countries are higher than the growth rate for OECD countries (IEA, 2012), this share is expected to decrease in the coming years. There is thus considerable potential for reducing electricity consumption in the non-OECD countries due to energy efficient appliances policies. However, there is a need for additional data on usage and electricity consumption of appliances to be able to quantify this potential.

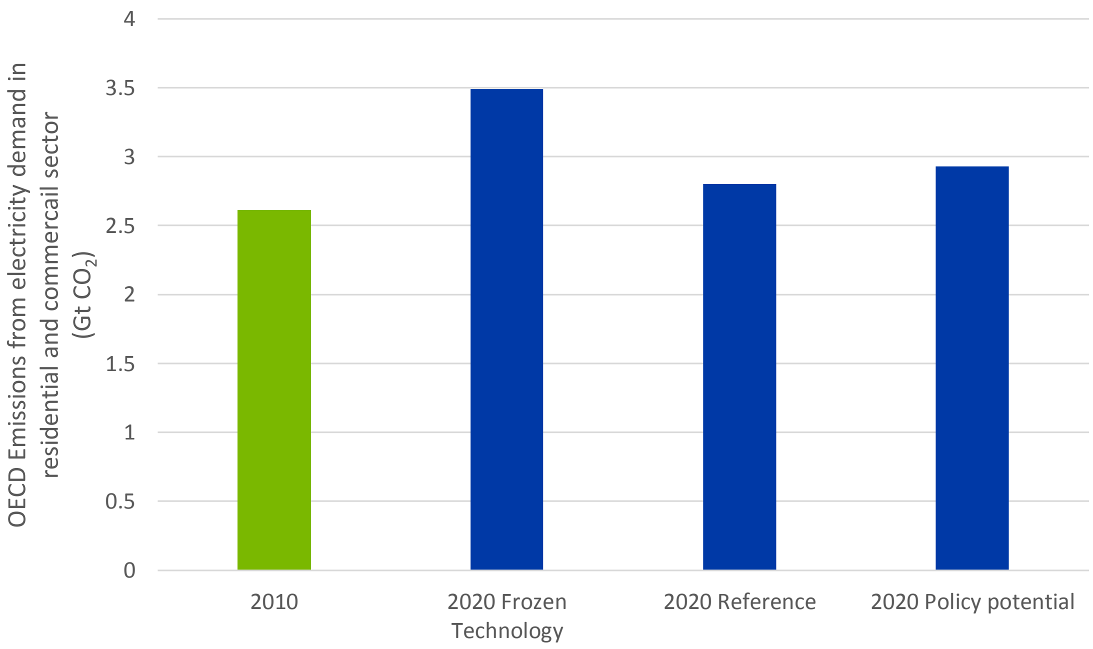



**Figure 23: Upscaling to OECD for appliances and lighting policies**

Our results indicate that the energy efficient appliances policies currently in place will not lead to emission reduction below the reference pathway in 2020. This is, however, the result of the chosen reference pathway. The policies are in place for a long time already and are included in the reference pathway. That the policy pathway is equal to the reference scenario, does not mean that the policies will have no effect. Further it is necessary to note that the already implemented policies will need further support to achieve full compliance to reach the reference level. It is however, beyond the scope of this study to determine what the emissions would have been without the policies adopted.

It has to be kept in mind that there are a number of major assumptions underlying this analysis. As the historic efficiency factor trend is used to predict the impact of the policies, this approach does not take into account a possible speeding up of the energy efficiency gains due to the policies. The policy potential presented here could thus be an overestimation of the remaining emissions. Also 2020 emissions are in practice expected to be below the values shown here, due to the increasing share of renewables in the electricity mix. This effect is not taken into account in this analysis to isolate the effect of policies targeted at energy efficient appliances.

Other studies have estimated the impact of the Ecodesign Directive in 2020. The implementation of the first 13 measures is expected to result in an annual saving of 366 TWh[49] in the EU by 2020 (EC, 2012). Applying the 2011 average EU emission factor of 352 g $CO_2$ / kWh (IEA, 2013b) used in this analysis to this figure, translates into an emission reduction of around 130 Mt $CO_2$ by 2020. Irrek et al. (2010) estimated the 2020 emission savings below the 2.5 $GtCO_2e$[50] business-as-usual to be between 211 and 265 $MtCO_2e$ in the EU, if effective Ecodesign measures are in place. The

[49] No baseline value is presented in this document.

[50] This baseline value is much higher than the values in our analysis. This can be explained by: 1) The analysis by Irrek et al. (2010) covers not only $CO_2$ but also other greenhouse gases. 2) Our study only includes electricity use, whereas the analysis by Irrek et al. (2010) covers other energy carriers as well. 3) Our analysis covers only electricity use in the residential and commercial sector, whereas the analysis by Irrek et al. (2010) covers other sectors as well.

global abatement potential of appliances and lightning is estimated to be 1.2 $GtCO_2e/a$[51] by 2030 by McKinsey & Company (2009).

### 4.4.4 International discussions in related forums

Standards and labelling schemes are becoming increasing popular in countries around the world, due to both the significant mitigation potential and the potential for net savings in the medium to long term. Furthermore, the positive effects of the most ambitious domestic policies are somewhat diffused worldwide due to the global nature of the electric appliances market.

The development of the international dialogue on energy efficiency of electrical appliances is promoted by two key initiatives in particular: The Collaborative Labelling & Appliance Standards Program (CLASP) is an international organisation providing technical and policy support for governments looking to introduce energy efficiency measures. The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative seeks to measure the potential for energy efficient appliance and to provide accurate information to public and private sector stakeholders in order to transform the global market for extra-high efficiency appliances.

Discussions currently continue on a potential new cooperative initiative through CLASP and SEAD, along with en.lighten, which would require signatory countries to commit to an increase in the rate of the process of phasing out inefficient technologies. An agreement with a group of core countries might be reached in 2014 (Harrison et al., 2014), with the intention that these core countries and organisations might provide support for the participation of other countries that face more difficult barriers.

CLASP notes that policy might be focused on three particular appliances in order to maximise the potential of energy savings, given the barriers faced by emerging and developing economies: ownership of air conditioning, hot water heaters and fridges is increasing at phenomenal rate, and the potential for energy savings and GHG emission reductions is very high when this suppressed demand is taken into consideration.

### 4.4.5 Summary and recommendations for appliances

#### 4.4.5.1 Summary and comparison of case studies

An overview of the energy efficiency policies implemented in Japan and South Korea is provided below in Table 23.

**Table 23: Summary of qualitative assessment for appliances**

| | Japan | South Korea |
|---|---|---|
| Major policy | Top Runner Programme | Energy Efficiency Label and Standard Programme |
| Type | Minimum Energy Performance Standards / Labelling | Minimum Energy Performance Standards / Labelling |
| EE target | Range of appliance specific targets set | Minimum standards for appliances covered by the mandatory scheme |
| Key features | Efficiency standard programme requiring | All energy-consuming products have energy efficiency labels – with |

[51] No baseline value for appliances and lighting separate from the building sector as a whole is available in this study.

| | | |
|---|---|---|
| | manufacturers to meet certain levels of efficiency for appliances based on the best performance of current technologies | products graded from 1 (high efficiency) to 5 (low efficiency) and the production of products below the lowest energy efficiency standard is forbidden. |
| Complementary policies | Tax incentives for energy efficient appliances | LED Deployment 18/30 Plan<br>Tax incentives for energy efficient appliances |
| Barriers | The payback period of the capital cost of an energy efficient appliance is sometimes too long. Social behaviour difficult to change. | |
| Co-benefits | Financial savings from lower energy consumption – enhancing energy security. | |

An international comparison of the energy efficiency performance of appliances of different countries is unfortunately not possible due to the lack of data available that is directly comparable. However, assessments undertaken by the IEA indicate that both Japan and South Korea should be considered as examples of best practice in promoting energy efficiency in appliances.

#### 4.4.5.2 Barriers and mitigating policy features

The case studies primarily focus on addressing both the quality of products through the introduction of mandatory standards and improving the information available to consumers through labelling in order to promote the benefits of energy efficient appliances. The introduction of mandatory standards for energy efficiency in Japan has undoubtedly been very effective with the quality of the appliances within the scope of the policy improving considerably over time. However, given that the standards in the Top Runner Programme are set according to the most energy efficient product on the market – standards are often set with little consideration of the impacts on consumer costs (i.e. no requirements for a life cycle analysis or another type of cost analysis) (Osamu, 2012). If consumer costs rise too high as a consequence of the policy it will undermine its' objective as the financial viability of investing in energy efficient appliances will become difficult to justify. It is also evident, that in contrast to Japan (mainly domestic market for appliances) the price competitiveness of exports in South Korea may have been a factor leading to the initial exemption of TVs in the mandatory standards and energy efficiency labelling programme.

#### 4.4.5.3 Co-benefits and motivation

It is evident from the case studies that the co-benefits associated with increasing energy efficiency rates in appliances have been used to further justify the introduction of mandatory standards and labelling schemes in both Japan and South Korea. Improvements in energy efficiency are considered an important mitigation option to allow both countries to deliver future commitments to reduce their GHG emissions under the UNFCCC. However, the enhanced energy security that arises from increased energy efficiency is clearly a key objective influencing government decision making. It is also expected that enhanced energy security through improved energy efficiency will financially benefit consumers through the use of appliances that consume less energy. For example, KEMCO (2011) estimate that as a consequence of the total standby power declining between 2003 and 2011 this was equivalent to an annual financial saving of $ US 136 million KRW in 2011. However this co-benefit ultimately depends on designing a policy that prevents price increases in appliances and on behavioural changes associated with the rebound effect.

#### 4.4.5.4 Policy impact and mitigation potential

Policies for appliances and lighting in the EU are expected to result in an energy intensity improvement of 2% per year until 2020. With increasing activity levels, this is not expected to lead to a reduction from the 2010 emission level. If all countries in the OECD level adopt the same policies, this is not expected to result in an emission reduction below the reference pathway.

## 5 List of References

American Energy Independence, 2013. American Fuels. http://www.americanenergyindependence.com/fuels.aspx.

Brannigan, C., Gibson, G., Hill, N., Dittrich, M., Schroten, A., van Essen, H., van Grinsven, A., 2012. EU Transport GHG: Routes to 2020 II. Final Report Appendix 1: Development of a better understanding of the scale of co-benefits associated with transport sector GHG reduction policies. http://www.eutransportghg2050.eu/cms/assets/Uploads/Reports/EU-Transport-GHG-2050-II-Task-1-FINAL-12Jul12.pdf.

C2ES, undated. Federal vehicle standards. http://www.c2es.org/federal/executive/vehicle-standards.

EIA, 2013. Frequently asked questions. How much petroleum does the United States import and from where? http://www.eia.gov/tools/faqs/faq.cfm?id=727&t=6 (4 August, 2014).

EPA, 2012a. EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. http://www.epa.gov/otaq/climate/documents/420f12051.pdf.

EPA, 2012b. Inventory of U.S. greenhouse gas emissions and sinks: 1990 – 2010. http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Main-Text.pdf.

EPA, 2012c. Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. http://www.epa.gov/otaq/climate/documents/420r12016.pdf.

European Union, 2013. EU Energy in Figures. Statistical Pocketbook 2013. http://ec.europa.eu/energy/publications/doc/2013_pocketbook.pdf.

ICCT, 2014. Global Passenger Vehicle Standards: Info and Tools. http://theicct.org/info-tools/global-passenger-vehicle-standards.

ICCT, Dieselnet, 2014. TransportPolicy website: US: Light-duty: Fuel Economy and GHG. http://transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG (4 September, 2014).

IEA, 2013. Key world energy statistics 2012. http://www.iea.org/publications/freepublications/publication/kwes.pdf (25 November, 2013).

JATO, 2009. FIAT leads the volume brands on $CO_2$ emissions for 2nd year running. http://www.jato.com/PressReleases/Geneva%202009%20C02%20Brands%20Release%20-%20REVISED%20-%20FINAL.pdf.

NHTSA, 2014. CAFE - Fuel Economy. http://www.nhtsa.gov/fuel-economy (2014).

OECD, IEA, 2011. Technology Roadmap. Biofuels for Transport. http://www.iea.org/publications/freepublications/publication/biofuels_roadmap.pdf (4 September, 2014).

Shindell, D., Faluvegi, G., Walsh, M., Anenberg, S., van Dingenen, R., Muller, N., Austin, J., Koch, D., Milly, G., 2011. Climate, health, agricultural and economic impacts of tighetr vehicle-emission standards. Nature Climate Change, 1, 59–66. http://www.nature.com/nclimate/journal/v1/n1/abs/nclimate1066.html.

UNEP, 2010. Global Fuel Economy Initiative. http://www.unep.org/transport/gfei/autotool/case_studies/northamerica/cs_us_0.asp (4 September, 2014).

United States Government Accountability Office, 2007. Vehicle Fuel Economy. Reforming Fuel Economy Standards Could Help Reduce Oil Consumption by Cars and Light Trucks, and Other Options Could Complement These Standards. http://www.gao.gov/new.items/d07921.pdf.

World Bank, 2013. World development indicators 2013. World Bank, Washington, D.C.

Höhne, Niklas; Hare, Bill; Vieweg, Marion; Braun, Nadine (2011): Climate Action Tracker Australia. Assessment of Australias policies impacting its greenhouse gas emissions profile. Unter Mitarbeit von Markus Hagemann, Hanna Fekete und Hanna Grözinger. Hg. v. Cindy Baxter. Ecofys and Climate Anayltics. Germany. Online verfügbar unter http://www.ecofys.com/files/files/cat_country%20report_australia_2011.pdf, zuletzt aktualisiert am 28.11.2011, zuletzt geprüft am 02.03.2012.

JRC/PBL (2012): Edgar Version 4.2 FT2010. Joint Research Centre of the European Commission/PBL Netherlands Environmental Assessment Agency. Online verfügbar unter http://edgar.jrc.ec.europa.eu/index.php, zuletzt geprüft am 30.01.2013.

Höhne et al. 2011. Climate Action Tracker- Country Assessment Methodology. http://climateactiontracker.org/assets/publications/publications/WP1_MethodologyCountryAssessment_website_2011.pdf

IEA. 2007. Energy Policies of IEA Countries: Germany 2007 Review

BMU. 2013. Renewable Energy Sources in Figures, National and International Development

Futon. 2012. The German Feed-in Tariff: Recent Policy Changes. DB Research

BMU. 2009. Electricity from Renewable Energy Sources: What does it cost?

Schuman. 2010. Improving China's Existing Renewable Energy Legal Framework: Lessons from the International and Domestic Experience. NRDC White Paper

Brown. 2012. U.S. Renewable Electricity: How Does the Production Tax Credit (PTC) Impact Wind Markets?

EPA. 2013. "Department of Treasury. http://www.epa.gov/lmop/publications-tools/funding-guide/federal-resources/treasury.html

U.S. Department of Energy. 2013. 2012 Wind Technologies Market Report.

KPMG. 2013. The American Taxpayer Relief Act of 2012. http://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/taxnewsflash/Documents/taxpayer-relief-act-booklet-jan-3-2013-v2.pdf

Deloitte. 2013. Swerving from the cliff – Tax provisions in the American taxpayer Relief Act of 2012. https://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Tax/us_tax_swerving_from_the_cliff_010213.pdf

Schueneman, Tom. 2014. “Senate Finance Committee Approve Bill to Extend Renewable Energy Production Tax Credit”. http://theenergycollective.com/globalwarmingisreal/366596/senate-finance-committee-approve-bill-extend-renewable-energy-production-

KPMG. 2014. Tax provisions in Administration’s FY 2015 Budget Proposals. http://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/taxnewsflash/Documents/fy-2015-budget-booklet.pdf

Ofgem. 2014. Renewables Obligation – Annual Report 2012-13

Woodman and Mitchell. 2011. Learning from experience? The development of the Renewables Obligation in England and Wales 2002-2010. Energy Policy.

National Renewable Energy Action Plan for the United Kingdom

Huhne, Chris. 2014. The Guardian. “The Conservatives’ onshore wind sums are all at sea”. http://www.theguardian.com/commentisfree/2014/apr/06/conservative-onshore-wind-green-energy-renewables

Mason, Rowena. 2014. The Guardian. “Tories plan new attack on windframs”. http://www.theguardian.com/politics/2014/apr/01/tories-plan-attack-windfarms

Harrison et al. 2014. Enhancing Ambition Through International Cooperative Initiatives. http://www.ecofys.com/en/publication/enhancing-ambition-through-international-cooperative-initiatives/

BMU.2012. Renewable Energies: Driving Germany’s Energiewende

Directive 2009/EC/28

The Economist. 2013. The East is grey.http://www.economist.com/news/briefing/21583245-china-worlds-worst-polluter-largest-investor-green-energy-its-rise-will-have

UBA. 2013. Renewable Energy Sources in Figures, National and International Development

Hamamoto. 2011. Energy efficiency regulation and R&D activity: A study of the Top Runner Program in Japan.” Low Carbon Economy 2:91-98.

Osamu, K.. 2012. The Role of Standards: The Japanese Top Runner Program for End-Use Efficiency. Historical Case Studies of Energy Technology Innovation in: Chapter 24, The Global Energy Assessment. Grubler A., Aguayo, F., Gallagher, K.S., Hekkert, M., Jiang, K., Mytelka, L., Neij, L., Nemet, G. & C. Wilson. Cambridge University Press: Cambridge, UK.

KEMCO. 2011. Korea’s Energy Standards & Labelling – Market Transformation

IEA. 2012. The Energy Policies of IEA Countries – The Republic of Korea 2012 Review

# 6 Appendix

## 6.1 Countries selected for the screening analysis

**Table 24: List of countries that are selected for the screening analysis**

| Country | Emission in 2010 in $MtCO_2e$ JRC/PBL 2012. (Source | Rationale for inclusion |
|---|---|---|
| China | 11,182 | Top30 emitter |
| United States | 6,715 | Top30 emitter |
| EU | 5,023 | Top30 emitter |
| India | 2,692 | Top30 emitter |
| Russian Federation | 2,510 | Top30 emitter |
| Indonesia | 1,946 | Top30 emitter |
| Brazil | 1,621 | Top30 emitter |
| Japan | 1,379 | Top30 emitter |
| Germany | 979 | Top30 emitter |
| Canada | 728 | Top30 emitter |
| Mexico | 661 | Top30 emitter |
| Korea, Republic of | 647 | Top30 emitter |
| Australia | 629 | Top30 emitter |
| United Kingdom | 620 | Top30 emitter |
| France | 538 | Top30 emitter |
| South Africa | 422 | Top30 emitter |
| Turkey | 420 | Top30 emitter |
| Thailand | 413 | Top30 emitter |
| Ukraine | 397 | Top30 emitter |
| Malaysia | 330 | Top30 emitter |
| Kazakhstan | 318 | Top30 emitter |
| Argentina | 315 | Top30 emitter |
| Venezuela | 310 | Top30 emitter |
| Viet Nam | 306 | Top30 emitter |
| Colombia | 187 | Top30 emitter |
| Philippines | 159 | Top30 emitter |
| Belarus | 150 | Top30 emitter |
| Ethiopia | 109 | Ambitious goal for carbon neutral growth by 2025. |
| Chile | 107 | Low emission development plans |
| New Zealand | 80 | Ambitious policies on deforestation and agriculture |

| Country | Emission in 2010 in $MtCO_2e$ JRC/PBL 2012. (Source | Rationale for inclusion |
|---|---|---|
| Norway | 67 | Comprehensive climate policies |
| Denmark | 66 | Comprehensive climate policies |
| Switzerland | 57 | Developed an interesting $CO_2$ levy |
| Costa Rica | 11 | Ambitious goal to become climate-neutral by 2021 |
| Maldives | 1 | Ambitious goal to become climate-neutral by 2020 |

## 6.2 Appendix I – Indicators for selection of countries and thematic areas

**Table 25: Structure of indicators by policy area and sector**

| | 1.Changing activity[52] | 2.Energy Efficiency | 3.Renewable Energy | 4.Low Carbon | 5.Other / Non Energy |
|---|---|---|---|---|---|
| **1. Electricity** | | | | | |
| **2. Industry** | | | | | |
| **3. Buildings** | | | | | |
| **4. Transport** | | | | | |
| **5. AFOLU[53]** | | | | | |

Source: Own illustration adapted from Climate Action Tracker methodology (ref). Greyed out boxes are non-applicable combinations.

The indicators cover policy incentives which have a direct or indirect impact on emission reduction in a country.

The **sector** defines the scope of the emission source that the policy is addressing:

- Electricity: Incentives and barriers relating to central electricity and heat production.
- Industry: Incentives and barriers relating to all industry sectors, including refineries, and the waste sector.
- Buildings: Incentives and barriers relating to energy consumed in residential, commercial and public buildings, including energy use, fuel and electricity
- Transport: Incentives and barriers relating to energy used in all modes of transport.
- Agriculture, Forestry and Other Land Use (AFOLU): Incentives and barriers relating to non-energy emissions from agriculture, forestry and other land use, which includes all land-based activities, e.g. non-$CO_2$ emissions from agriculture and $CO_2$ emissions from all forestry activities. The sector is further divided into the agriculture sector and land use, land use change and forestry (LULUCF) activities.

A **policy area** is a logical cluster of incentives and barriers. The following areas have been defined:

[52] Changing activity refers to transformations from one set of polluting activities to less polluting activities.

[53] Agriculture, Forestry and Other Land Use (AFOLU)

- **Changing activity**: Incentives and barriers that indirectly reduce emission by changing behaviour or by introducing new technolgy concepts.
- **Energy efficiency**: Incentives and measures to reduce energy consumption whilst maintaining activity.
- **Renewable energy**: Support for renewable energy sources across all relevant sectors.
- **Low carbon**: Policy support for direct $CO_2$ reduction. For the sectors involving energy use, policies may aim to influence the carbon intensity of the fuel mix except renewables, i.e. the shares of different emissions intensive fossil fuels, carbon capture and storage and nuclear power.
- **Non-energy**: Incentives and barriers relating to all emissions and removals from sources not directly linked to energy, especially emissions from processes in industry and from the land use sector. This category also includes all emissions from other gases, while the other areas mainly cover $CO_2$ emissions (except activity for AFOLU).

The specific indicators evaluated in each sector and policy area are given in Table 26.

**Table 26: Data collection guideline for indicators**

| Sector | Sub-sector |
|---|---|
| **All sectors** | 0. Cross-cutting |
| | Is there a stringent framework for sustainable biomass import? |
| **Electricity** | 1 Electricity (heat) production |
| | 1.1 Cross-cutting |
| | Are there overarching incentives in place that apply to the entire electricity sector? |
| | a.) Emissions trading |
| | b.) $CO_2$ and/or Energy taxes |
| | 1.2 Energy efficiency |
| | Incentives |
| | Are incentives to increase efficiency of fossil fuel power plants in place? |
| | a.) Direct subsidies |
| | b.) Performance standard or closure of inefficient plants |
| | c.) White certificates |
| | d.) Other |
| | Is there support to increase the share of CHP? |
| | Are policies in place to reduce distribution losses? |
| | Barriers |
| | Are there any subsidies applicable in the electricity sector, e.g. coal penny ? |
| | 1.3 Renewables |
| | Incentives |
| | Is there effective support for RES-E? |
| | a.) Feed-in Tariffs/ premiums |

| Sector | Sub-sector |
|---|---|
| | b.) Portfolio standards (RPS)/ RE Quota |
| | c.) Tender |
| | d.) Green Certificates |
| | e.) Tax exemptions |
| | f.) Other |
| | Does this support differentiates/ incentivises the diffusion of different technologies? |
| | Barriers |
| | Is the administrative environment a major barrier to implementation? |
| | Is preferential grid access and congestion management for renewable electricity in place? |
| | Is an investment & implementation strategy for RE oriented grid structures in place |
| | 1.4 Low carbon |
| | Incentives |
| | Are policies in place that influence fuel choice and lead to a fuel switch? |
| | a.) Direct subsidies |
| | b.) Tax exemptions |
| | c.) Emission performance standards |
| | d.) Other |
| | Are incentives for biomass CCS in place? |
| | Are incentives for coal or natural gas CCS in place? |
| | Is there active support for nuclear energy? |
| **Industry** | 2 Industry |
| | 2.1 Cross-cutting |
| | Are there overarching incentives in place that apply to the entire industry sector? |
| | a.) Emissions trading |
| | b.) $CO_2$ and/or Energy taxes |
| | 2.2 Changing activity |
| | Are there policies in place that support the redesign of products to be less material intensive, long lasting, or recyclable? |
| | 2.3 Energy efficiency |
| | Incentives |
| | Are there schemes that lead to improvements over the baseline situation (additional) in energy efficiency in industry? |
| | a.) Direct subsidies |
| | b.) Tax exemptions |

| Sector | Sub-sector |
|---|---|
| | c.) Voluntary agreements |
| | d.) White certificates |
| | e.) Other |
| | Do policies that support the demonstration of breakthrough technologies exist (R&D support)? |
| | Barriers |
| | Are there subsidies, tax exemptions for energy intensive industry for conventional fuel supply and consumption (direct and indirect) in place? |
| | 2.4 Renewables |
| | Incentives |
| | Are policies in place that effectively lead to increasing the use of renewable energy in industry? |
| | a.) Direct subsidies |
| | b.) Tax exemptions |
| | c.) Green certificates |
| | d.) Renewable energy quota |
| | e.) Mandatory energy audits |
| | f.) Other |
| | Barriers |
| | Are subsidies, tax exemptions for energy intensive industry for conventional fuel supply and consumption (direct and indirect) that hinder the uptake of energy efficient technologies or renewables? |
| | 2.5 Low carbon |
| | Are there incentives for coal / gas CCS development in industry? |
| | Are there incentives for biomass and process emission CCS development in industry? |
| | 2.6 Non-energy |
| | Are there policies to reduce $N_2O$ emissions in industry? |
| | Are there incentives to reduce fugitive CH4 emissions from oil and gas production? |
| | Are there incentives to decrease in landfill gas emissions, by either less landfilling or CH4 capture in place? |
| | Are there policies to reduce F-gas emissions? |
| **Buildings** | 3 Buildings |
| | 3.1 Cross-cutting |
| | Are there overarching incentives in place that apply to the entire buildings sector? |
| | a.) Emissions trading |
| | b.) $CO_2$ and/or Energy taxes |
| | 3.2 Changing activity |

| Sector | Sub-sector |
|---|---|
| | Is there an urbanisation policy in place that leads to energy efficient development? |
| | 3.3 Energy efficiency |
| | Incentives (electricity) |
| | Are there incentive (regulation, support and information) for use of efficient appliances, including air conditioning? |
| | a.) White certificates |
| | b.) Product performance standards |
| | c.) Direct subsidies |
| | d.) Information campaigns |
| | e.) Tax exemptions |
| | f.) Other |
| | Barriers (electricity) |
| | Are there subsidies, tax exemptions for electricity use in buildings (direct and indirect)? |
| | Incentives (fuels) |
| | Are there (ambitious) efficiency standards for new buildings for all types of buildings in place? |
| | a.) Binding buildings performance standards |
| | b.) Direct subsidies |
| | c.) Credit schemes (e.g. KfW) |
| | d.) Information campaigns |
| | e.) Tax exemptions |
| | f.) Other |
| | Are there sufficient incentives for high retrofit rates for all types of existing buildings (for complete retrofit, i.e. full building envelope & upgrade supply system)? |
| | a.) Binding buildings performance standards for retrofitting |
| | b.) Direct subsidies |
| | c.) Credit schemes (e.g. KfW) |
| | d.) Information campaigns |
| | e.) Tax exemptions |
| | f.) Other |
| | Are there policies for efficiency improvement for other than heating fuel uses (i.e. cooking, hot water use)? |
| | Barriers (fuels) |
| | Are there detrimental subsidies, tax exemptions for fuel use in buildings (direct and indirect) in place? |
| | If it exists, are there solutions to the landlord tenant problem in place? These could include regulation that allows costs for retrofitting of buildings to be included in the rent or be covered in contracting? |

| Sector | Sub-sector |
| --- | --- |
| | Are standards for new buildings properly implemented and enforced? |
| | 3.4 Renewables |
| | Incentives |
| | Are there policy instruments for use of sustainable renewable heating/cooling in new buildings and existing buildings in place for all types of buildings? |
| | a.) Tax exemptions |
| | b.) Binding buildings performance standards or obligations to use RE |
| | c.) Direct subsidies |
| | d.) Credit schemes (e.g. KfW) |
| | e.) Information campaigns |
| | f.) $CO_2$/ energy taxes |
| | g.) Other |
| | Are there policies supporting cooking and hot water supply with sustainable renewable fuels in place? |
| | 3.5 Low carbon |
| | Is there support for switching from oil/ coal to gas as heating/ cooking/ hot water use fuel in place? |
| **Transport** | 4 Transport |
| | 4.1 Cross-cutting |
| | Are there overarching incentives in place that apply to the entire transport sector? |
| | a.) Emissions trading |
| | b.) $CO_2$ and/or Energy taxes |
| | 4.2 Changing activity |
| | Incentives |
| | Are there strategies to avoid traffic and to move to non-motorised transport in place? |
| | Are there strategies for modal shift to low carbon transport modes (public transport, freight rail, freight ships) in place? |
| | Barriers |
| | Is there a fiscal or other incentives which promote higher fuel use in transport (buy more cars, bigger cars or drive/fly more) in place? |
| | 4.3 Energy efficiency |
| | Is there an incentive to reduce light vehicle emissions (e.g. cars) per kilometre? |
| | a.) Vehicle fuel-economy or emission standards |
| | b.) Direct subsidies |
| | c.) Tax exemptions |
| | d.) Other |
| | Is there an incentive to reduce heavy vehicle emissions per kilometre? |

| Sector | Sub-sector |
|---|---|
| | a.) Vehicle fuel-economy or emission standards |
| | b.) Direct subsidies |
| | c.) Tax exemptions |
| | d.) Other |
| | Are there energy or $CO_2$ taxes in place that could incentivise reduction of fuel use in the transport? |
| | 4.4 Renewables |
| | Are there incentives in place to increase renewable energy sources in transport (biofuels)? |
| | a.) RE quota |
| | b.) Tax reliefs |
| | c.) Direct subsidies |
| | d.) Other |
| | 4.5 Low carbon |
| | Support for fuel switch from oil to natural gas or other low carbon technologies? |
| | Are there incentives for electric mobility? |
| **AFOLU** | 5 AFOLU |
| | 5.1 Changing activity |
| | Incentives |
| | Are there activities to promote sustainable consumption practices in place? |
| | Does a consistent land use strategy exists (including a strategy for forest management planning), minimizing emissions from land use change (under the given national circumstances), promoting stabilization or increase of forest, wetland and protected areas that is supported by policy tools to secure its implementation? Please specify in the comment field |
| | Barriers |
| | 5.2 Non-energy |
| | Incentives |
| | Are there incentives to support emission reduction in agriculture for Livestock, $CH_4$ and $N_2O$ emissions in place? |
| | Are incentives in agriculture for cropland and organic/peaty soils, all non-$CO_2$ emissions (including rice production) in place? |
| | Are there incentives to reduce emissions from grassland in place? |
| | Are there incentives to reducing deforestation, forest management, afforestation in place? |

## 6.3 Appendix II

Table 27 shows a list of databases and reports used in the determination of national policies.

### Table 27: List of data sources consolidated for the analysis

| Database/report | Link | Country coverage | Thematic coverage |
|---|---|---|---|
| IEA policies and measures database | http://www.iea.org/policiesandmeasures/ | IEA member countries | Climate change policies<br>Energy efficiency polices<br>Renewable energy policies |
| Reegle | http://www.reegle.info/ | Global | Clean energy |
| Global buildings performance network | http://www.gbpn.org/databases-tools | Global | Buildings |
| Transportpolicy.net | http://transportpolicy.net/index.php?title=Main_Page | European Union, United States, California, China, Japan, India, Brazil, Mexico | Transport |
| Institute for industrial productivity | http://www.iepd.iipnetwork.org/ | 14 countries | Industrial energy efficiency |
| Energy standards information system | http://www.apec-esis.org/ | Australia, Brunei Darussalam, California, Canada, Chile<br>China (PRC), Chinese Taipei (Taiwan), Hong Kong, Indonesia, Japan, Korea (ROK), Malaysia, Mexico,<br>New Zealand, Papua New Guinea, Peru, Philippines,<br>Russia, Singapore, Thailand,<br>United States, Vietnam | Appliance standards |
| Interactive ETS map of the International Carbon Action Partnership | http://icapcarbonaction.com/index.php?option=com_wrapper&view=wrapper&Itemid=147 | Global | National and regional emission trading systems |
| Globe climate legislation study | http://www.globeinternational.org/images/climate-study/3rd_GLOBE_Report.pdf | Global | National climate legislation |
| Global Climate Change Policy Tracker | http://www.dbcca.com/dbcca/EN/investment-research/investment_research_2412.jsp | Global | National energy and climate targets |
| EU Climate Policy Tracker | http://www.climatepolicytracker.eu/ | 27 EU member states | All energy and climate policy |
| REN 21 global status report | http://www.ren21.net/RenewablePolicy/GSRPolicyTable.aspx | Global | Renewable energy |