The Emissions Gap Report 2012

A UNEP Synthesis Report

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Chapter 4

Bridging the Emissions Gap

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4.1 Introduction

The analyses in Chapters 2 and 3 of this report concluded that the emissions gap in 2020 will likely be between 8 and 13 $GtCO_2e$. The chapters also estimated the difference between BaU emissions in 2020 and the emissions level consistent with a "likely" chance of staying within the 2°C target to be 14 $GtCO_2e$. This chapter explores the potential for bridging this gap using a sector policy approach.

Firstly, the chapter provides a summary and update of the estimated emission reduction potential by sector from the Bridging the Emissions Gap Report (UNEP, 2011). Secondly, it examines a number of sector-specific policies that have already been adopted by national or local governments in several countries and regions around the world, and that have been successful in reducing greenhouse gas emissions.

Without pretence of being comprehensive in either the choice of sectors or policy instruments, the focus of the second part of the chapter is on best practices in three sectors: buildings, transport and forests. Together, the emission reduction potential of these three sectors makes up roughly 40% of the total emission reduction potential estimated in the Bridging the Emissions Gap Report (UNEP, 2011).

Besides the relative importance of these sectors in terms of their contribution to greenhouse gas emissions, they also offer examples of how ambitious policy instruments that lead to significant emission reductions can foster innovation and economic growth, bolster national energy security, improve public health and address other key developmental priorities.

A key objective of the review of best practice policies is to demonstrate how they can be scaled up (both in ambition and geographical reach) in different countries and regions with due consideration to national differences and circumstances. Therefore, the chapter focuses not only on efficiency and equity issues, but also on political and economic factors that are the basis for successful policy design, implementation and enforcement. Regulatory issues of governance and legal and institutional settings are also discussed. Other policy instruments which could help achieve emission reductions in the power, industry, agriculture and waste sectors will be analysed in subsequent UNEP Emissions Gap Reports.

4.2 Emission reduction potentials by sector in 2020 – summary and update

4.2.1 Greenhouse gas emission reduction potentials based on sector studies

One approach to estimating the total emission reduction potential is to review detailed studies of the reduction potential by sector up to a certain marginal cost level. Adding up the sector estimates gives an indication of the total potential. Adopting this approach, the Bridging the Emissions Gap Report (UNEP, 2011) estimated the total emission reduction potential in 2020, at a marginal cost of about 50 – 100 US$/$tCO_2e$ to be in the range of 17 ± 3 $GtCO_2e$. A summary of the findings is provided in Table 4.1. As can be seen in the table, the uncertainty in the estimated emissions reduction potential for each sector is high. Hence, the value of the estimated emission reduction potential ranges from 10 to 23 $GtCO_2e$. However, if it is assumed that not all uncertainties are at their high end at the same time, then a more reasonable estimate of the emissions reduction potential would be 17 ± 3 $GtCO_2e$[30].

The mid-range of 17 $GtCO_2e$ confirms that the total emission reduction potential is sufficient to close the emissions gap between projected emissions based on country pledges and the emissions level consistent with a “likely” chance of staying below the 2°C target. The value also exceeds the estimated difference between projected BaU emissions in 2020 and the emissions level consistent with a “likely” chance of staying below the 2°C target (that is 14 $GtCO_2e$), noting that the low range of emissions reduction potential just equals this difference.

reported in the Bridging the Emissions Gap Report (UNEP, 2011) and summarised in Table 4.1.

The Global Transportation Energy and Climate Roadmap (ICCT, in press) estimates the emission reduction potential for the transport sector, including aviation and marine, in 2020 to be around 2 $GtCO_2e$. For buildings, the scenario analysis of best practice policies for low energy and carbon buildings (Ürge-Vorsatz et al., 2012) confirms the significant emission reduction potential of the building sector. For 2020, the study estimates an emission reduction potential of approximately 2.1 $GtCO_2e$ globally. Both estimates are well within the uncertainty ranges of the emission reduction potential of the transport and building sectors reported here.

Table 4.1 Sectoral greenhouse gas emission reduction potentials in 2020 compared to BaU, at marginal costs below 50 to 100 US$/$tCO_2e$, either explicitly or implicitly

Sector	Emission reduction potential in 2020 ($GtCO_2e$)
Power sector	2.2 – 3.9
Industry	1.5 – 4.6
Transport*	1.7 – 2.5
Buildings	1.4 – 2.9
Forestry	1.3 – 4.2
Agriculture	1.1 – 4.3
Waste	around 0.8
Total (Full range)	10 – 23
Total	17 ± 3 (Assuming not all uncertainties at their high end simultaneously**)
Source: UNEP Bridging the Emissions Gap Report (UNEP, 2011)	

* including shipping and aviation
** see footnote 30

4.2.2 An update on sectoral emission reduction potentials

Since the release of the Bridging the Emissions Gap Report (UNEP, 2011), a number of studies have been published that provide new scenarios of relevance to bottom-up, sectoral assessments of energy-related greenhouse gas emission reductions. The studies include the three scenarios of the Global Energy Assessment (Johansson et al., 2012); an update of the Energy Technology Perspectives of the International Energy Agency (IEA, 2012); an update of the Energy Revolution scenarios prepared for Greenpeace, Global Wind Energy Council (GWEC) and European Renewable Energy Council (EREC) (Teske, 2012); a scenario based analysis prepared by the Global Buildings Performance Network and the Central European University (Ürge-Vorsatz et al., 2012b); and the Global Transportation Energy and Climate Roadmap, updating the Roadmap model (ICCT, in press). All of these studies have a long-term focus, leading up to 2050, and provide snapshots of mitigation opportunities in different scenarios.

As a first conclusion, the findings of these studies are consistent with the range of emission reduction potentials

Focusing on “current developments” rather than scenarios, the latest Energy Technology Perspectives report (IEA, 2012) highlights good progress over the past year for renewable power generation; moderate progress for industrial energy efficiency, vehicle fuel economy and the transition to electric vehicles; and disappointing results for power plant efficiency, nuclear power, carbon capture and storage, buildings and transportation biofuels. These developments may have an impact on the potential that can be realized in 2020.

A very positive development in recent years is the significant reduction in the cost of photovoltaic (PV) power generation. At the start of 2012, prices of photovoltaic modules were down 50% compared to a year earlier, and 76% below the level in the summer of 2008 (McCrone et al., 2012). Levelized Energy Costs[31] of generating electricity from photovoltaic systems are now in the range of 100 – 260 US$/MWh (McCrone et al., 2012). These developments have led some authors to adjust their 2020 estimates for installed solar PV capacity upwards (Krewit et al., 2010; Breyer, 2011; Teske, 2012). An increase of the installed photovoltaic solar capacity by as much as 500 GW will lead to an increase in

30 It is unlikely that all or several sectors will be simultaneously at the high ends of their uncertainty range. Therefore, assuming that the uncertainties are independent between sectors (which may hold under many cases) we can apply an error propagation rule to calculate the range of the sum of the sectors (the square root of the sum of the squares of the range for each sector). This gives a reduced range of ±3 Gt CO_2e compared to the full range of ±7 Gt CO_2e.

31 Levelized Energy Cost (LEC) refers to the price at which electricity must be generated from a specific source to break even over the project lifetime. It takes into consideration all the costs associated with an energy generating system over its lifetime including initial investment, operations and maintenance, cost of fuel, and cost of capital.

avoided emissions of 0.4 $GtCO_2e$. Although this is a very substantial potential contribution by one single technology, it falls within the uncertainty range for the total emission reduction potential indicated in Table 4.1. Together with the generally positive trend in renewable power generation, it is becoming more likely that the higher end of the potential estimated in UNEP (2011) would be achieved for this category.

4.2.3 The emission reduction potential is still significant, but time is running out

In summary, the review of recently published studies generally confirms the emission reduction potentials for 2020, as estimated in the Bridging the Emissions Gap Report (UNEP, 2011) and shown in Table 4.1. However, the mixed progress reported from different sectors (as highlighted in the latest Energy Technology Perspectives report (IEA, 2012); see Section 4.2.2 above) gives rise to concerns about the estimated emission reduction potential in 2020. This is particularly so because an important caveat to estimates of emission reduction potential is that they can only be realized if strong, long-term and sector-specific policies are in place at the global and national levels (UNEP, 2011).

Even if the potential remains the same, there is basically one year less to achieve this reduction, implying steeper and more costly actions will be required to potentially bridge the emissions gap by 2020. At the same time, any new investments in buildings, transportation systems, factories, and other infrastructure would fix energy use patterns for decades. Therefore, lack of action now will lead to a "lock in" of high energy use and emissions for a long period of time. Without ambitious policies, these investments may also lead to other consequences, including harmful pollution and increased energy demand which could result in higher energy prices. However, the rapid implementation of sound policies can steer those investments towards low-carbon technologies and sustainable growth.

4.3 Best practice policies

This section illustrates how a number of sector-specific policies that have already been successfully implemented in several countries and regions around the world have the potential, if scaled up both in ambition and geographical reach, to contribute to bridging the emissions gap.

4.3.1 Best practice policies in the building sector: building codes

Introduction

Building codes are regulatory instruments that set standards for specific technologies or energy performance levels and can be applied to both new buildings or to retrofits of existing buildings. The building sector contributes around 8% of global greenhouse gas emissions and approximately one third of all energy-related greenhouse gas emissions. In addition to the reduction potential for 2020 listed in Table 4.1, the sector has been recognized as having the largest longer-term, cost-effective greenhouse gas mitigation potential of any industrial sector (IPCC, 2007; Ürge-Vorsatz et al., 2012b).

While there is extensive greenhouse gas mitigation potential in the building sector, buildings are long-lived. A combination of slow turnover and retrofit rates implies that the shorter term potential is significantly below the longer term potential. A recent scenario-based study (Ürge-Vorsatz et al., 2012b) estimates the global emission reduction potential to be approximately 2.1 $GtCO_2e$ by 2020, but up to 9 $GtCO_2e$ by 2050[32]. To illustrate, this implies that by 2050, the building sector could consume 30% less energy compared to 2005, despite a close to 130% projected increase in built floor area over the same period. Figure 4.1 illustrates these scenarios.

"Lock-in" and urgency of action

The long-lived nature of buildings also implies that there is a risk of "locking in" energy inefficiencies resulting in emissions that are substantially higher than necessary. For instance, if policy development and reform continues at current rates (illustrated by the "moderate" scenario in Figure 4.1), it is estimated that emission reductions will be 1.6 $GtCO_2e$ in 2020 and 4.5 $GtCO_2e$ in 2050, in contrast to the 2.1 $GtCO_2e$ in 2020 and 9 $GtCO_2e$ in 2050 estimated to be technically and economically feasible.

The strength and appropriateness of building sector policies in place over the next few years will therefore determine total building emissions for several decades to come – pointing to the advantages of quick action. If the building sector is to reduce emissions sufficiently to contribute to achieving the 2°C target, policy packages containing state of the art building codes may need to become mandatory over the next 10 years in all the major economies such as the USA, India, China and the European Union (Ürge-Vorsatz et al., 2012b).

Policies that work

Building codes are an example of visible success in the field of climate-related policy-making. Few other areas exist where policies have been put in place over the last decade to achieve significant emission reductions, while providing the same or even increased service levels. Leading European countries have used the last 20 to 30 years to develop and increase the stringency of building energy policies. However, China has taken only a decade to develop and implement its first generation codes and under the 12th five year plan is rapidly increasing the stringency of codes and mandating the application of energy efficiency standards to renovation projects. In the USA, two sets of codes are in place, but there is potential for further action (see Box 4.1).

Building codes that set minimum energy performance requirements have proven to be among the most effective policy tools for cost-effective energy savings and greenhouse gas reductions (UNEP, 2008). To be most effective, they should be implemented as a core element of integrated packages of regulatory standards, financial incentives, and voluntary programmes (Ürge-Vorsatz and Koeppel, 2007). In practice, building codes have proven more efficient than

32 These figures refer to all buildings, including residential, public and commercial, and cover heating, cooling and hot water energy use.

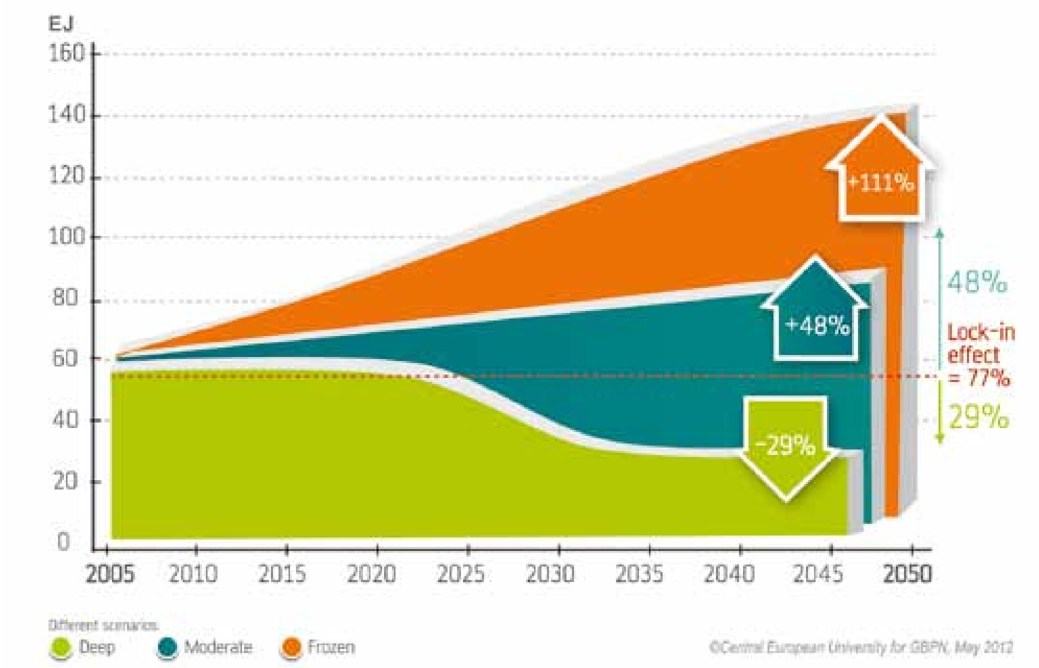


Figure 4.1 Three scenarios of total world thermal energy use in buildings. *Source: Ürge-Vorsatz, D., et al. (2012)*[33]

33 The scenarios are based on the following assumptions:
(a) 'frozen' scenario: A baseline scenario, where energy performance of new and retrofit buildings does not improve as compared to their 2005 levels,
(b) 'medium' scenario: Assuming that the current rate of policy development and reform continues,
(c) 'deep' scenario: State-of-the-art policies adopted as integrated packages.

Box 4.1 Building codes in the EU, USA and China

EU: Reducing the energy required for heating has been a major focus of building energy policies in the European Union, where the existing building stock is large and rates of replacement are relatively low, and where a majority of the population live in cool to moderate climate zones. The EU Energy Performance in Buildings Directive is the key policy framework for driving low energy consumption in new and existing buildings. Introduced in 2002, it creates an integrated basis for the implementation of performance-based, rather than prescriptive building codes and supporting policy strategies. It sets common targets for absolute reductions in energy consumption across the EU member states. In 2010 the Directive was recast with more stringent energy reduction targets, including the requirement for member states to implement "Near Zero Energy" building codes. However, it still faces challenges in implementation and compliance, since there are significant variations among member states (Levine et al, 2012).

USA: Buildings in the USA have the highest energy consumption relative to population compared to other places where codes have evolved over the last decades. The International Energy Conservation Code and the codes of the American Society of Heating, Refrigerating and Air-conditioning Engineers, as well as other variants of these codes, are applied to all major new building types in the USA with varied stringency by different states, creating a patchwork of effectiveness in the code environment. California, the Pacific Northwest, and some Northeast states lead in terms of rapid implementation of national model codes. However, there is a potential to move to more performance-based codes in order to facilitate absolute energy reduction targets, such as "Net Zero Energy" buildings (Levine et al, 2012).

China: As in most emerging countries, new buildings are the priority for emissions reduction in China. China adds about 1.7 billion square meters of new building floor area annually (Bin and Li, 2012) and buildings in China currently account for nearly 20% of total annual primary energy consumption and greenhouse gas emissions. Over the past twenty years China has made great efforts to reduce heat loss in and improve efficiency of space heating in the northern regions, in particular in residential buildings. Three design standards now cover four out of the five climate zones of the country (Levine et al., 2012). China has also recently introduced building energy performance codes for new public and commercial buildings in all climate zones.

market-based instruments[34] in the residential and commercial sectors, due to market imperfections such as owner-tenant and builder-occupant split incentives; inadequate information and associated high transaction costs; risk aversion towards higher first-costs; first-cost psychology barriers; and other factors.

In general, effective policies for reducing greenhouse gas emissions from the building sector set targets for absolute energy performance for new buildings and occasionally for

34 Market-based instruments harness market forces (e.g., prices, taxes, levies, subsidies and other economic variables) to encourage the adoption of good practices.

retrofits[35]. Absolute targets provide a more certain policy environment for market transformation that can help drive demand for more energy efficient buildings (Economist Intelligence Unit, 2012). Policy targets for mandatory energy efficient renovation of existing buildings are under way within the European Union and in different parts of China and the USA. Although state-of-the-art, these targets have yet to become widely implemented in building codes, which implies that even in the most progressive jurisdictions, there is significant potential for scaling up mandatory energy efficient renovation to further reduce emissions (Ürge-Vorsatz et al., 2012b).

With regard to cost-effectiveness, very few studies exist that rigorously evaluate cost-effectiveness on a comparable basis. Available estimates however, show attractive ranges. For example, one study estimates that emission reductions from buildings in the EU region could have an average cost of less than 36.5 US$/t$CO_2$e with a cost range spanning –109 to 49 US$/t$CO_2$e (Kiss et. al., in preparation). Generally, the overall cost-efficiency that can be achieved will be dependent on the design of the building code and how the code is implemented.

Drivers and co-benefits

Building regulations are often not motivated by environmental or energy reasons. Instead, they are advanced to promote safety, save costs, or for other socioeconomic reasons. In addition, well-designed and implemented building codes are associated with major co-benefits (see, Tirado et al., 2011). First of all, the general co-benefits related to improved energy efficiency all prevail, including improved energy security and social welfare, improved outdoor air quality and related health and productivity, and competitiveness gains.

Very high performance buildings also result in significant gains in values of the building infrastructure and ability to rent out properties.

Large retrofit programmes have been assessed to have important net employment benefits, even when employment losses in the energy supply sector are considered. A study of a broadly implemented ambitious retrofit programme in Hungary reported a significant net employment gain (Ürge-Vorsatz et al., 2010). The employment created by ambitious retrofit programmes is mostly localized and not exportable because it requires on-site labour, thus contributing to regional and local development goals.

Lessons and scope for scaling up

While there have been major successes in policies that reduce energy use of buildings around the world, often these measures merely constitute the tip of the iceberg. Scaling up efforts in terms of ambition in energy performance levels, building types covered (new and retrofit), and geographic regions, presents an exceptional opportunity for emission reductions from the building sector that could dwarf any reductions already accomplished or planned up to now.

Compared to code frameworks in the USA, China and India, the EU's Energy Performance in Buildings Directive has had greater success in achieving deep reductions in thermal energy required by buildings (Urge-Vorsatz et al., 2012b). It is therefore tempting to suggest that all regions should follow the EU's lead. However, effective development and implementation of building codes is very site specific and depends on cultural practices. For example, market-based mechanisms are important for steering building improvements where a more liberal ideology is prevailing, as exemplified by building regulations in the USA. However, in Europe there is greater acceptance of government-led programmes supported by voluntary measures (Levine et al., 2012). In China there is a greater acceptance of central government implementation and enforcement of building codes (Bin and Li, 2012), while in India there appears to be a tension between state level implementation and a propensity for self-organization at the local level (Kochar, 2010).

Another lesson for scaling up and for the time frame in which emission reductions can be achieved relates to codes for new buildings. In many developed countries, new building codes aimed at very ambitious performance levels (such as net zero energy), will have limited impact on emission reductions in the next few decades, since new construction is limited[36]. In developed countries, therefore, building codes related to retrofits can make the largest difference in heating and cooling related emissions during the next decades. By contrast, in fast growing and urbanizing developing countries, regulating new construction brings the largest short term emission reduction gains. Building codes for new urban buildings can attain large emission reductions, since 85% of the growth in building energy use up to 2050 will occur in urban areas, 70% of which will be in developing countries (Ürge-Vorsatz et al., 2012a).

This points to an important role of cities as engines for introducing ambitious building codes. Codes introduced at the city level can capture the lion's share of building-related heating and cooling mitigation potential. Cities are also very appropriate units for passing building code regulations because regulations work best when tailored to local climatic and cultural conditions. Besides, cities can often be more proactive and flexible in policy experiments than national governments. This is demonstrated by the proliferation of building-related performance mandates that cities have been adopting worldwide during the past decade primarily for climate reasons.

Enforcement is crucial for the effectiveness of building codes. Unfortunately the track record of building codes so far shows weak enforcement. It will be crucial to improve enforcement in order for building codes to become a key global mitigation strategy.

In conclusion, design and implementation of codes should be guided by cultural and governance characteristics, in addition to population density, variation of climatic zones and the age and typologies of buildings. Often, building

35 Existing buildings are more challenging to address through building codes because codes in this case would only be applied when the building is renovated, and that is not very often. Therefore, most policies have focused on new construction where it is enough to have more stringent performance levels prescribed to components or for the building as a whole.

36 The percentage of new construction also varies among developed countries. For instance, in Europe building lifetimes and retrofit cycles are long; whereas the USA experiences larger new construction rates due to population growth, shorter building lifetimes and retrofit cycles.

Credit: Franck Boston/Shutterstock.com

codes will be associated with co-benefits and in many cases it may be these benefits that drive building code policies, as they may be high priorities of local and national decision-makers. It is clear that there is significant untapped potential to reduce emissions through building codes. This is the case globally, regionally, nationally and locally. The ambition of policies within the next few years will not only determine the emissions reduction potential that can be realised in the building sector in 2020, but will also have major implications in the decades to follow.

4.3.2 Best practice policies in the building sector: appliance standards and labels

Introduction

Energy performance standards and labels for appliances, equipment, and lighting are instruments that offer a large opportunity to improve energy efficiency. Moreover, they lead to substantial reductions in greenhouse gas emissions from households. Households are known to account for a significant percentage of total greenhouse gas emissions in different countries (e.g., Saidur et al., 2007; Milito and Gagnon, 2008; Kenny and Gray, 2009; Kerkhof et al., 2009; Gough et al., 2011). At last count, over 75 countries with more than 80% of the world's population had energy efficiency standards or labelling policies in place (Egan, 2011). If best practice policies are adopted worldwide, standards and labels could result in emission reductions of approximately 0.7 $GtCO_2e$ in 2020.[37]

Energy-efficiency standards are regulations that prescribe the energy performance of manufactured products, sometimes prohibiting the sale of products that are below a minimum level of efficiency. There are three types of energy-efficiency standards:

- ***Prescriptive standards*** require that a particular feature or device be installed in all new products.
- ***Performance standards*** specify minimum efficiencies or maximum energy consumption levels that manufacturers must achieve in products. They specify the energy performance but not the technology or design details of the product.
- ***Class-average standards*** specify the average efficiency of a class of manufactured products, allowing each manufacturer to select the efficiency level for each model, such that the overall average is achieved.

Energy-efficiency labels are affixed to manufactured products to describe the product's energy performance, usually in the form of energy use, efficiency, or energy cost. The labels provide consumers with the necessary information to make informed purchases. There are two basic types of labels:

- ***Endorsement labels*** are essentially "seals of approval" given according to specified criteria.
- ***Comparative labels*** allow consumers to compare performance among similar products using either discrete categories of performance or a continuous scale.

Standards and labelling programmes have the potential to significantly affect energy consumption in the residential, commercial, and industrial sectors in the next several decades, since much of the equipment that will use energy in the buildings sector in 2020 has yet to be installed. Developing robust standards and labelling programmes now can avoid "lock-in" of inefficient equipment and lead to the realization of significant emission reductions. To illustrate, it is estimated that the minimum energy performance standards implemented from January 2010 through April 2011 by member governments of the Super-efficient

37 CO_2 savings estimates are from the Bottom-up Energy Analysis System (BUENAS), a model developed by Lawrence Berkeley National Laboratory (LBNL) and CLASP, and scaled up to a global estimate from the 62% of global final energy demand currently included in the model.

Equipment and Appliance Deployment (SEAD) Initiative[38] will yield savings of approximately 125 $MtCO_2$ in 2020[39], which is as much energy as produced by roughly seventy five 500 MW coal-fired power plants.

Appliance standards and labelling moves fairly quickly compared to other emissions reduction policies. However, there can be significant time lags between the time a government decides to regulate an appliance and actual emission reductions. In the USA for example, the supporting analyses required by law may take approximately two years. Once a new regulation is passed, it will often have a waiting period of about three years before implementation. Once implemented, emission reductions will accrue over the lifetime of the appliance, which may be up to 10-15 years.

Because labels do not eliminate products from the market, they have a lower regulatory burden and require less complicated analysis than standards. Therefore, labels can generally be implemented more quickly than standards, but it is evident that labelling without standards is less effective as a mitigation policy.

Policies that work

Standards and labelling policies are appropriate in most cultures and markets and are increasingly seen as a main tool for governments to address rising energy consumption and emissions in the appliance sector. Employing a combination of standards and labels allows for a larger impact on energy efficiency throughout the energy performance spectrum in each product class. One determining factor for the selection of the most effective standards and labelling combination is the product's current energy efficiency in the market. Other conditions that affect policy choices may include the maturity of the programme, the presence or absence of domestic manufacturing, the level of consumer awareness, and the cost of electricity.

Governments around the world have made extensive use of minimum energy performance standards and labelling programmes to improve the energy efficiency of appliances and equipment, and thereby reducing appliance sector emissions. A recent example of minimum energy performance standards is Australia's phase-out of incandescent lamps over the period from 2007 to 2010, estimated to cut Australia's greenhouse gas emissions by approximately 0.14% (Department of Environment, Water, Heritage and the Arts, 2009). This phase-out approach using minimum energy performance standards is the model being promoted by UNEP's en.lighten initiative[40], a public-private partnership led by UNEP, the Global Environment Facility (GEF) and lighting industry partners aimed at phasing-out inefficient lamps in developing countries.

Variations of the minimum energy performance standards approach include Japan's Top Runner Programme[41] and the European Union's Ecodesign Directive[42]. The Top Runner approach identifies the most energy efficient product on the market in a product category, and uses that efficiency as the class average standard (Top Runner Standard) for all products at the next standard setting period, usually the next 3-7 years. The EU's Ecodesign scheme establishes a framework for setting requirements for relevant environmental characteristics of energy related products. The level of energy efficiency or consumption is set to minimize the life-cycle energy cost to end-users, while also taking into account other environmental impacts. The Top Runner and Ecodesign Directive approaches have led to residential energy savings of 11% in Japan and 16% in the EU (Siderius and Nakagami, 2012).

For labelling programmes, the USA's ENERGY STAR voluntary endorsement label has been successful in increasing market availability and consumer awareness of efficient products, and is also used as a model by other countries. As one of the first successful consumer-oriented labelling programmes, ENERGY STAR gained critical support from manufacturers in its early days, and then increased the stringency of the programme once it became an important and well-known label to consumers.

Standards and labelling have been successful in developing countries as well. For example, Ghana initiated a standards and labelling programme in 2005 with a minimum energy performance standard for room air conditioners, which is expected to save consumers and businesses an average of US$64 million annually in energy bills and reduce emissions by about 2.8 $MtCO_2e$ over 30 years[43].

Drivers and co-benefits

One of the factors that encourage the development of energy efficiency policies is that, from a societal perspective, improving energy efficiency is generally more economically efficient than increasing energy supply.

Similar to the co-benefits of building codes, energy-efficiency standards and labelling policies reduce electricity use, which reduces fuel combustion in electric power plants and the associated impacts from extracting, transporting, and burning such fuels. Such cost-effective reduction in overall fuel combustion not only improves a nation's economic efficiency, but it also benefits nations by lowering consumers' energy bills, making energy services more affordable and improving public and environmental health. In the USA alone, additional efficiency improvements in 14 key product classes could result in US$300 billion cumulative savings to consumers by 2030 (McNeil et al., 2011).

Lessons and scope for scaling up

The success of minimum energy performance standards and product labelling depends on selecting and designing

38 SEAD is an initiative of the Clean Energy Ministerial. Member governments include: Australia, Brazil, Canada, the European Commission, France, Germany, India, Japan, Korea, Mexico, Russia, South Africa, Sweden, the United Arab Emirates, the United Kingdom, and the USA. These economies are responsible for about one half of global energy demand.

39 Energy and CO_2 savings estimates are from the Bottom-up Energy Analysis System (BUENAS), a model developed by Lawrence Berkeley National Laboratory (LBNL) and CLASP. These estimates include the following SEAD member governments: Australia, Canada, EU, Korea, Mexico, and USA. These estimates do not include the following SEAD member governments: Brazil, India, Japan, Russia, South Africa, the United Arab Emirates, and EU members France, Germany, Sweden and the United Kingdom.

40 For further details, see http://www.enlighten-initiative.org/portal/Home/tabid/56373/Default.aspx

41 For further details, see http://www.eccj.or.jp/top_runner/index.html and http://www.climatepolicy.jp/thesis/pdf/09035dp.pdf

42 For further details, see http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/legislation/framework-directive/index_en.htm

43 Energy and CO_2 savings numbers from the Policy Analysis Modelling System (PAMS), a model developed by Lawrence Berkeley National Laboratory (LBNL) and CLASP.

rules and regulations that meet the specific needs of a country and its particular objectives. Additional market-based incentives or informational policy options generally support standards and labelling but do not displace standards and labelling in cost-effectiveness. It is also clear that a combination of standards and labelling is more effective than either instrument alone, and mandatory schemes are generally more effective than voluntary ones. Experience shows that successful standards and labelling policies are usually preceded by rigorous cost-benefit analyses to ensure that they generate economic benefits even in the absence of a carbon price.

Comparability among regulations and test methods for a product is critical for encouraging more stringent policies, as it helps countries understand what efficiency levels are possible based on what other programmes have accomplished. Other factors important to the success of standards and labelling programmes and to their scaling up include (Weil and McMahon, 2005):

- Availability of trained, competent personnel;
- Availability of institutions capable of implementing change in the sector;
- Existence of the political will to support implementing agencies in fulfilling their mandate;
- Existence of product testing capabilities or the ability to establish them;
- Availability or ability to establish the necessary measurement, verification and enforcement infrastructures; and
- Consultations with all stakeholders involved in the manufacture and sale of targeted products to ensure acceptance and encourage manufacturers to adopt the standards.

Finally, policies should be reviewed and revised regularly, possibly every 3-5 years, to increase stringency and drive continued energy savings. For standards, the development of improved and cost-effective energy saving technologies should be encouraged, so as to enable more stringent standards. For labels, especially non-categorical ones, once the market becomes too saturated with highly efficient products, it becomes more difficult for consumers to differentiate among the most efficient products. Hence, it is important to regularly increase the stringency of labels in order for them to remain meaningful to consumers.

Establishing appropriate institutions and processes takes time. The same applies for conducting techno-economic analyses to identify priority products and establish savings potentials, and the testing of methodologies and establishment of verification procedures. In the case of product labelling, additional time and investment in communications and outreach will be required to build up awareness and trust.

4.3.3 Best practice policies in the transport sector

Introduction

The rapid motorisation characterising 20th Century development, while resulting in economic growth and improved quality of life, has produced many adverse consequences such as traffic congestion, air pollution, unsafe roads and social inequalities. At the same time, the transport sector has the highest projected growth rate of greenhouse gas emissions and currently accounts for 13% of global greenhouse gas emissions. As noted in section 4.2, the sector also has significant potential for cutting emissions, estimated at 1.7-2.5 $GtCO_2e$ in 2020, including aviation and marine sources (ICCT, in press). In the past, transportation development focused on improvements for higher-emitting private vehicles. At present there is a move towards more sustainable transport, as indicated by the eight biggest multilateral development banks pledging US$175 billion for sustainable transport over the next decade at the Rio+20 UN Conference on Sustainable Development in June 2012.

Sustainable transport represents a shift in the way transport infrastructure is approached, focusing on moving people rather than vehicles through mass transit, walking and cycling, and inland waterways. Along with this shift, a framework focusing on “Avoid”, “Shift” and “Improve” policies and measures (see below) is increasingly being adopted. A variety of successful policies within these three categories have been in place for decades in countries around the world (Pucher and Buehler, 2010).

Avoid policies – aim and examples

These policies have an overall aim of avoiding or reducing trips, thereby reducing the generation of vehicle-kilometres[44] and subsequently greenhouse gas emissions.

A key focus is to promote comprehensive planning of new communities, or the redevelopment of economically depressed or polluted areas, focusing on mixed-uses with access to mass transit. Integration of land-use policies, transport planning and the development of new urban areas around transit corridors is an example of a comprehensive “avoid” policy package. This can be a central policy option in emerging economies to prevent growth in the use of private vehicles and associated increases in future emissions from the transport sector. Transit-oriented development is one example of such an “avoid” policy, discussed later in this section.

Avoid policies often use a range of instruments that in addition to planning may comprise economic, regulatory and information instruments (Sakamoto et al., 2010). Examples of such instruments include elimination or reduction of fossil fuel subsidies; and pricing mechanisms designed to change behaviour and incentivize people not to use individual vehicles. Other examples are fiscal mechanisms such as emissions-based road use charges for freight vehicles to encourage improved loading and routing and a reduction of empty movements; and, encouraging the use of telecommunication to reduce travel.

“Shift” policies – aim and examples

These policies promote shifts to the lowest greenhouse gas emitting modes of transportation and discourage shifts from walking, cycling, and public transport to private vehicles by improving the quality of public transport. Creating a transport

44 Vehicle-kilometres is a measure of traffic flow. It is a unit of measurement representing the movement of a road motor vehicle over one kilometre (http://glossary.eea.europa.eu/terminology/concept_html?term=vehicle-km)

Bus and bicycles, Malmo, Sweden. Credit: Tupungato/Shutterstock.com

environment that facilitates "shift" requires development of a system of alternatives that has higher utility to users than private vehicles, which among other factors, implies that services must be high-quality and reliable as well as accessible to a large proportion of the population. The system should also allow easy transitions between the different transportation modes through physical, operational and fare integration. Examples include Bus Rapid Transit (BRT) (e.g., Ahmedabad, Bogota, Guangzhou, Johannesburg, Los Angeles, Mexico City and Rio de Janeiro), Bike Share Systems (e.g., Copenhagen, Hangzhou, London, Mexico City and Paris), Rail-based mass transit (e.g., Berlin, Hong Kong and New York), Pedestrian and Cycling network development (e.g., Copenhagen and Guangzhou), Parking Management (e.g., Budapest, San Francisco and Zurich), and Intermodal freight System Management (e.g., Germany). Bus Rapid Transit systems are discussed later in this section.

Similar to "avoid" policies, a number of instruments are available to support "shift" policies and often a combination of such instruments will be appropriate. In addition to the planning, economic, regulatory and information instruments already mentioned above, technology-focused instruments are also available to support "shift" policies (Sakamoto et al., 2010). For example, instruments aimed at increasing vehicle efficiency, through technologies for engine transmission and driveline improvements, hybrid systems, lightweight materials or further development of low carbon and alternative fuels, can be part of "shift" policies (Dalkmann and Brannigan, 2007).

"Improve" policies – aim and examples

These are policies aimed at improving the energy efficiency of vehicles and fuels through the introduction of new vehicle technologies and policies, including vehicle performance standards, voluntary programmes, fiscal mechanisms, low carbon and alternative fuels, financial subsidies for advanced vehicle technologies, fleet scrappage programmes, amongst others. The aim is to ensure that future vehicles and fuels are cleaner, and to encourage efficient vehicles (Dalkmann and Sakamoto, 2012). Best practices for vehicle performance are discussed later in this section.

The Avoid-Shift-Improve framework has been devised to support governments and institutions at all levels to develop better and more comprehensive approaches to transport planning, urban mobility, and commodity flows. The following examples describe best practices, barriers, and opportunities within the Avoid-Shift-Improve framework.

"Avoid" policies that work: transit-oriented development

Transit-oriented development is the practice of mixing residential, commercial and recreational land uses to promote high-density neighbourhoods around public transit stations. One of the earliest and most successful examples of transit oriented development comes from Curitiba in Brazil. In the 1970's the city government actively promoted the organization of the city along high-density transit corridors. It integrated zoning laws and transportation planning into the city's master plan. It also created pedestrian malls, instituted parking policies and developed cost-effective Bus Rapid Transit corridors.

The availability of comprehensive studies of the emission reduction potential of transit-oriented development is limited. However, a study for the USA estimates that applying transit-oriented development best practices could both reduce vehicle-kilometres by 10% from 2005 levels and cut annual greenhouse gas emissions by 145 million tonnes of CO_2e in 2030, the equivalent of some 30 million cars in the USA or 35 large coal power plants (Winkelman et al., 2009). Importantly, the study finds that these reductions are associated with significant economic benefits, yielding net cost savings per tonne of CO_2, when avoided costs for infrastructure, fuel, insurance and projected tax revenues from economic development, are taken into account.

"Shift" policies that work: Bus Rapid Transit

Bus Rapid Transit systems can provide the high-quality service needed to maintain a strong public transport system. In addition to the construction and operational features that can make BRT run smoothly, some of the key elements are frequent, high capacity service, higher operating speeds than conventional buses, separated lanes, distinct stations with level boarding, and fare prepayment and unique branding (Owen et al., 2012).

Since the 1970s, BRT has expanded to more than 100 cities around the world, with the largest increase taking place during the last 10 years. BRT or similar systems are now in place in many cities in Latin America, Asia, North America, and Europe and represent approximately one percent of the global modal split. Despite many institutional and policy challenges, these systems have been adapted to a range of different physical and regulatory environments.

The number of BRT systems has increased because they can reliably move large numbers of people and reduce travel times. Their expansion is also explained by the fact that the capital costs of BRT systems are between one-third and one-tenth of that of rail system costs.

Although BRT systems lead to lower emissions than many other transit options, they are usually constructed for other reasons, for example, to reduce local air pollution, traffic fatality rates, and road congestion (Transmilenio, 2011). There is a lack of studies assessing the emission reductions achieved through BRT, although project level estimates exist. For instance, in Bogota, Colombia, BRT is estimated to have resulted in emission reductions of 1.7 million metric tons CO_2e over seven years[45] (see also Box 4.2).

Barriers to more rapid expansion of BRT include inadequate fare levels and the fact that there is sometimes a preference for rail systems without adequate analysis of alternatives.

Furthermore, overcrowding and deterioration of roadways in some places make BRT less attractive to potential users. Transit agencies can play an important role in maintaining the attractiveness of BRT through service and operation improvements and through communication with the public (Weber et al., 2011). To illustrate, Jaipur City Transportation Service increased their ridership over 100% in one year by improving the fare structure, colour-coding bus routes, and improving operation by conducting adequate analysis of operations and cost data (Jain, 2011). The example of Jaipur city shows that large investments in infrastructure and technology are not always needed to create a "shift".

Lessons and scope for scaling up transit oriented development and bus rapid transit

In light of the attractiveness of combined sound land use policies such as transit oriented development and bus rapid transit, many cities are looking at replicating these "avoid" and "shift" policy practices. They provide significant benefits from a social and private perspective in addition to curbing growth in emissions from transportation. Some of the key principles that could facilitate the scaling up of transit-oriented development and BRT programmes are:

(i) Identifying and assessing the co-benefits, such as road safety, improved air quality, job creation, social equity and health benefits, among others, in order to leverage political support.

(ii) Implementing the highest standard from the onset in order to minimise public discontent and makes future expansion and further investment easier.

(iii) Improving accessibility through the integration of transit with active modes and surrounding land uses in order to attract citizens out of their private vehicles.

(iv) Developing strong institutional support at the national, regional and local level to facilitate and ensure:
- the efficiency of passing legislation and regulations,
- the creation of comprehensive land use development policies, and
- the improvement of infrastructure finance mechanisms.

(v) Engaging industry early-on to identify appropriate technologies, lower costs, streamline procurement procedures, and create a proper finance structure.

Box 4.2 Mexico City Metrobus system

Metrobus in Mexico City is a successful example of "shift", where 10% of BRT riders have shifted from private cars (Investigaciones Sociales Aplicadas, 2007). From its inception in 2005, it has grown to a system with four lines, covering 95 km, and serving 687,000 passengers per day (City of Mexico, 2012). The location of the routes and stations along popular corridors makes the service attractive and easy to access for pedestrians. In addition, formalizing service and reducing mixing in traffic has reduced the number of road fatalities along the corridor.

Annually:
- 169 million passengers are served
- 36.7 million travel hours are saved
- 143,000 tons CO_2 emissions are avoided
- and approximately 23 lives are saved

Note: EMBARQ calculations compared to a baseline without the BRT. Total time saved is based on average time savings per passenger trip. CO_2 emissions avoided are based on the difference between modal split in the two scenarios, distance travelled by buses, and IPCC emission factors.

45 http://cdm.unfccc.int/Projects/DB/DNV-CUK1159192623.07/view

"Improve" policies that work: Vehicle Performance Standards for New Light-duty Vehicles

This section provides an overview of vehicle performance standards for new light-duty vehicles, which establish minimum requirements based on fuel consumption or greenhouse gas emissions per unit of distance travelled. A number of regulatory approaches to reducing light-duty vehicle fuel consumption and greenhouse gas emissions have evolved through the last several decades, relying on different test procedures, formulas, performance-based attributes and baselines. Seven countries including Australia, Canada, China, the European Union, Japan, South Korea, and USA, have established or are in the process of revising light-duty vehicle fuel consumption or greenhouse gas emission standards.

These standards have a proven track record for achieving vehicle efficiency improvements. Approved and proposed vehicle performance standards are expected to reduce fuel consumption and greenhouse gas emissions of the new light-duty fleet in these countries by over 50% by 2025 from 2000 levels (see Figure 4.2) (ClimateWorks Foundation and ICCT, 2012). Because these standards have been implemented at the national level, their effects on total greenhouse gas emission reductions are substantial. Adopted vehicle performance standards for the light-duty fleet are estimated to result in emission reductions of 0.8 $GtCO_2e$ globally in 2020 (ICCT, in press). In the case of the USA, the standards targeting model years 2012–16 are expected to save each car owner about US$3,000 over the life of the vehicle (USA. Environmental Protection Agency and National Highway Traffic Safety Administration, 2010). Vehicle performance standards also stimulate technology innovation by requiring automakers to build more efficient vehicles. Substantial improvements in vehicle efficiency can be realized through engine transmission and driveline improvements, hybrid systems, lightweight materials and better aerodynamics and rolling resistance.

Lessons and scope for scaling up

There are several key principles for successful introduction of vehicle performance standards including:

(i) standards should be technology-neutral[46] so that markets find the most cost-effective solution;

(ii) standards should be made continuously more stringent – by 3 to 6% annually – to encourage on-going innovation and send long-term signals to automakers (ClimateWorks Foundation and ICCT, 2012);

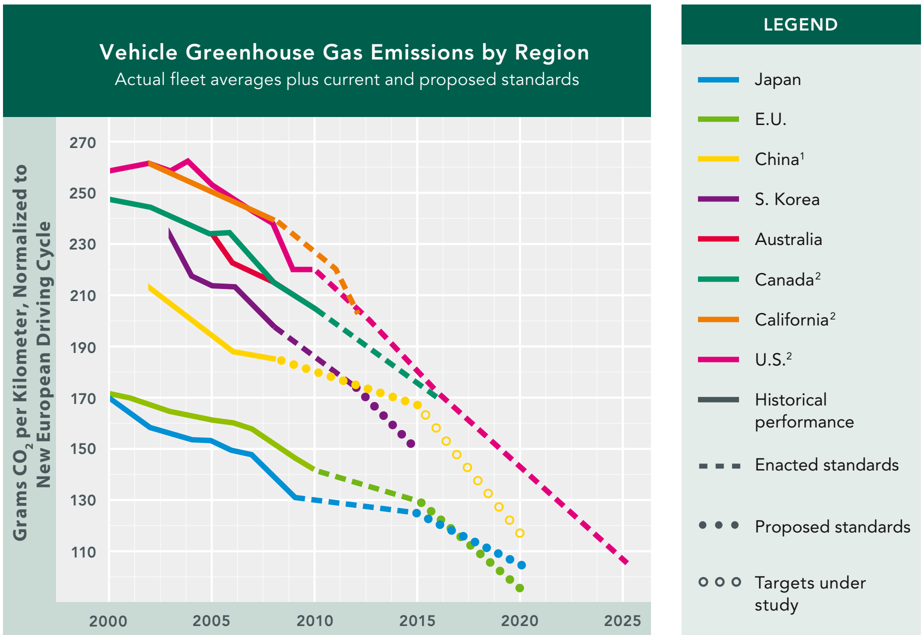
(iii) standards should include all vehicle classes to prevent loopholes;

(iv) standards should not be weight-based, but footprint-based so they no longer discourage the use of light-weight materials;

(v) countries should improve testing procedures and rules so that test vehicle efficiency closely reflects real-world performance; and,

(vi) countries should combine vehicle performance standards with fiscal mechanisms and vehicle scrappage programmes that can help incentivize purchase of the most efficient vehicles and speed up the turnover of the existing fleet.

These international best practices for successful policy design can also be used to strengthen standards in places where they already exist. Designing effective standards requires strong institutional support from the governmental agencies that hold the regulatory authority to approve the standards, as well as extensive technical expertise and knowledge of international results to apply lessons learned from other countries.



Passenger vehicle fuel economy standards have substantially reduced CO_2 emissions.

[1] China's target reflects a gasoline fleet scenario. If other fuel types are included, the target will be lower.

[2] U.S. and Canadian light-duty vehicles include light commercial vehicles.

Figure 4.2 Vehicle GHG emissions by region. *Source: ClimateWorks Foundation and ICCT, 2012.*

46 That is, standards should not advocate a specific technology

4.3.4 Best practice policies to curb deforestation

Introduction

Forests provide major ecosystem services such as watershed protection and biodiversity conservation, as well as livelihoods for around 1.6 billion, mostly poor, people (Chao, 2012). Greenhouse gas emissions from the forestry sector are caused by deforestation and forest degradation. These emissions, which constitute the largest non-energy source of greenhouse gas emissions, are estimated to be 4.4 $GtCO_2e$/yr in 2008, and represent about 11% of global anthropogenic CO_2 emissions (see Chapter 2).

Deforestation is mainly caused by expansion of agricultural frontiers (Angelsen, 2010; Pfaff et al., 2010), while forest degradation can be caused by natural phenomena (e.g., diseases and pests, storms, fire, drought and other climatic stresses) or by anthropogenic factors (e.g., air pollution, fire, economic overexploitation and overgrazing) or by a combination of both natural and anthropogenic factors (EEA, 2011).

Although it has remained under-utilized, "avoided deforestation[47]" is considered a low-cost greenhouse gas emissions reduction option (IPCC, 2007). While the annual rate of tropical deforestation decreased from 160,000 km^2 in the 1990s to 130,000 km^2 in the 2000s (FAO, 2010), it is believed that significantly greater reduction in deforestation is achievable.

The following sections describe policies that are effective at curbing deforestation. Four distinct policy categories are presented:

Establishing protected areas: This involves designating some forest areas as protected areas[48]. This is arguably the most common policy instrument for preserving tropical forests. It is generally effective in preventing deforestation, but is even more effective when the protected areas are close to expanding frontiers (e.g., expanding agricultural frontiers) rather than in remote low-threat areas (Joppa and Pfaff, 2010; Pfaff et al., 2010; Nelson and Chomitz, 2011).

Using command-and-control measures: This involves the enactment and enforcement of environmental regulations and putting in place adequate monitoring structures to ensure compliance (Hargrave and Kis-Katos, in press).

Using economic instruments: This involves the use of economic tools such as taxes, subsidies and payments for ecosystem services for encouraging forest conservation (Angelsen, 2010; Pfaff et al., 2010).

Creating policies affecting drivers and contexts: This involves creating or changing sectoral policies, institutional frameworks and governance structures so as to influence the dynamics of deforestation (Angelsen, 2010; Pfaff et al., 2010).

Successful national strategies for curbing deforestation have typically included a combination of these categories (Chomitz et al., 2007). Brazil and Costa Rica stand out as examples of countries that have successfully sustained anti-deforestation policies with large-scale results. The section below takes a closer look at policies in these countries and how their successful experience may be reproduced elsewhere.

Policies that work

In Brazil, recent deforestation has occurred mostly in the Amazon, so we focus on policies applied there. The Amazon forest is the largest tropical forest on earth, holding a significant share of the world's biodiversity and 66±7 GtC, or 23% of the world's forest carbon[49] (Saatchi et al. 2007; FAO, 2010). Deforestation in the Brazilian Amazon reached its second highest historical level in 2004 (27,772 km^2), and was responsible for the emission of around 1.1 $GtCO_2e$. Since then, deforestation has decreased by three-quarters (6,418 km^2 in 2011) (INPE-EM, 2012). Public policies contributed substantially to this reduction (CEPAL/IPEA/GIZ 2011). One estimate suggests that they were responsible for about one-half of the reduction between 2005 and 2009, or 0.6 $GtCO_2e$. The remainder has been attributed to lower agricultural commodity prices (Assuncao et al., 2012). Compared to the country's official BaU scenario[50], Brazil avoided 2.8 $GtCO_2e$ in emissions from 2006 to 2011 (Brazil. Ministry of Environment of Brazil, 2012).

Costa Rica has gone from very high annual deforestation rates (around 3 to 4% of its forest area/year) during the 1960s and 1970s to close to zero forest loss today (Camino et al., 2000; Sánchez-Azofeifa et al., 2007).[51] Public policies were also important drivers of this change, together with structural economic changes (Camino et al., 2000; Sánchez-Azofeifa et al., 2007; Robalino et al., 2008; Brown and Bird, 2011).

Protected areas: In the last decade, Brazil has increased its Amazon protected areas, indigenous lands and sustainable-use areas by a significant 709,000 km^2 representing 45.6% of the Amazon biome in 2009 (Soares-Filho et al., 2010). Much of the recent expansion of protected areas occurred near especially threatened areas (CEPAL/IPEA/GIZ, 2011). The expansion of protected areas has significantly decreased both Amazon fire incidence and deforestation (Chomitz and Thomas, 2003; Nepstad et al., 2006; Arima et al., 2007; Soares-Filho et al., 2010).

Protected areas in Costa Rica represent 24% of its territory (1.2 million ha) and are used more intensively than in Brazil, especially for ecotourism (Hoffman, 2011)[52]. Tourist numbers increased from 387,000 in 1988 to 2.5 million in 2008, when tourism reached 15% of GDP. Ecotourism alone now brings in more foreign currency than livestock exports did previously (Camino et al. 2000; Brown and Bird, 2011; Christian et al., 2011).

Command-and-control measures: During the 2000s, Brazil invested heavily in modernizing its satellite-based monitoring strategy. Detailed deforestation data has directly supported field-based law enforcement in real time, and

47 Avoided deforestation is the prevention or reduction of deforestation in order to decrease greenhouse gas emissions.

48 A protected area, according to IUCN, is "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008).

49 Considering only carbon stored on above ground live biomass.

50 The official BaU scenario assumes 19,535 km^2 of annual deforestation, which equals the 1995-2006 average.

51 Some disagreement about forest cover changes in Costa Rica remains (Sánchez-Azofeifa et al. 2007)

52 One specific marketing advantage for Costa Rica is its closeness to the American market.

enforcement teams can now reach new deforestation spots a few days after its detection (INPE, 2008). Furthermore, the federal environment police (IBAMA) was modernized and innovative enforcement measures to combat deforestation, such as confiscation of illegally used assets (e.g., cattle, timber and machinery) and area-based trade embargos were adopted. Federal prosecutors also made slaughterhouses and supermarkets liable for offences by suppliers involved in illegal deforestation. Several studies indicate improved law enforcement as a key to reduced deforestation (Barreto and Silva 2010; CEPAL/IPEA/GIZ, 2011; Hargrave and Kis-Katos, in press). After 2007, Brazil's federal government blacklisted high-deforesting municipalities (up to 42 out of 756) and carried out law enforcement raids, embargoes, and other actions. Concentrating on selected targets was not only cost-efficient, but also made local mayors share responsibility for deforestation (CEPAL/IPEA/GIZ, 2011).

In Costa Rica, command-and-control measures were also part of the policy mix, though somewhat less prominently compared to Brazil. A complete ban on forest conversion was adopted already in 1997. Although, enforcement was not always 100% effective, the task was generally easier than in the Amazon, due to smaller forest size, lower agricultural land pressures, and clearer land-tenure arrangements (Camino et al., 2000; Sánchez-Azofeifa et al., 2007).

Economic instruments: In Brazil, economic instruments have so far played a relatively small role. By contrast, Costa Rica is a model for using forest-based economic instruments in the developing world. This has included applying forest conservation and reforestation incentives on private farms (Brown and Bird, 2011). From 1979 to 1990, policies focused on tax breaks for plantations and natural forest conservation (Camino et al., 2000; Brown and Bird, 2011). After 1991, direct subsidies for farm-level forest conservation were introduced, culminating from 1997 onwards in the programme of payments for ecosystem services (PES) (protection of watersheds, carbon stocks, biodiversity, and natural beauty). PES was predominantly financed by a new tax on fossil fuels and by international financing (Camino et al., 2000; Brown and Bird, 2011).

Many argue that economic incentives were central to Costa Rica's conservation success (Sánchez-Azofeifa et al., 2007; Robalino et al., 2008). The effectiveness of PES remains uncertain though, because deforestation was already small when PES policies were introduced (Pagiola, 2008).

Policies targeted at drivers and contexts

Traditionally, Costa Rica subsidized forest conversion for crops and pastures. Falling commodity prices, economic crisis and structural adjustment programmes in the 1980s were key factors for phasing out these incentives and curbing land clearing (Camino et al., 2000; Kleinn et al., 2002; Brown and Bird, 2011). Well-defined land tenure (Brown and Bird, 2011) also lowered pressure for forest conversion. This contrasts with the Amazon, where land appropriation by homesteaders (clearing land to establish or consolidate property rights) was an important driver of deforestation.

Compared to the Amazon's abundant forest, Costa Rica's forests became scarcer earlier, which gradually led to a political commitment to address deforestation and promote sustainable forest management. Costa Rica experienced a typical turning point in its 'forest transition', with rising wages and urban employment pulling workers from farms into cities (see Rudel et al., 2010). Costa Rica's high level of commitment to economic and human development, and sustainable development, were also instrumental.

In Brazil, stagnating commodity prices (soy, beef) from the mid-2000s explain part of the decrease in deforestation (Barreto and Silva, 2010; Soares-Filho et al., 2010; Assuncao et al., 2012). But Brazil also managed to mobilize widespread internal political support for curbing deforestation. Bringing the deforestation agenda into the President's Cabinet created unprecedented political will to coordinate anti-deforestation policies across ministries. Policies were bundled into a single strategy which covered 14 government ministries. This was a major factor in the success story of curbing deforestation (CEPAL/IPEA/GIZ, 2011).

Scope for scaling-up

The previous sections illustrate that policies to curb deforestation typically require cross-sector policy coordination involving multiple stakeholders. Similarly, a policy mix of incentives, disincentives, and appropriate enabling policies may be most appropriate. But which enabling factors are key to replicating and scaling-up successful policies?

First, countries may learn from the Brazilian experience, where the capacity to properly monitor deforestation was a key factor in reducing deforestation. Monitoring can be strengthened without major changes in regulation or political support, and requires mainly financial resources and technology transfer.

Second, to achieve large-scale results, countries need strong political commitment from the core of government. In both Costa Rica and Brazil, this provided the basis for developing and implementing comprehensive strategies across sectors and levels of government.

Third, as stated earlier, protected areas generally have an important impact on conserving forests, but they can be even more effective if they are positioned near deforestation frontiers or areas liable to future threats. Protected areas with sustainable use of natural resources[53] provide an interesting compromise between local livelihoods and environmental interests, and could therefore serve as an option in areas where there is conflicting interest between forest conservation and local livelihoods.

Fourth, in Brazil, a sudden increase in enforcement of existing forestry laws triggered strong reactions from agricultural interests against the laws (Barreto and Araujo, 2012). To avoid a similar situation, countries may have to combine enforcement with new legislation and institutions. Costa Rica's combination of incentives, disincentives and enabling measures is a noteworthy example of an easy-to-accept policy mix.

53 According to IUCN, a "protected area with sustainable use of natural resources" refers to an area designated for the purpose of "conserving ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area" http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/.

Rio Negro in the Amazon River basin, Brazil. Credit: AND Inc/Shutterstock.com

Fifth, well-defined land tenure can provide an incentive for conserving forests. Once stronger institutions and secure property rights to forest lands have been established, economic incentives for conservation in private properties may become nationally applicable, rather than restricted to pilot projects. To maximize effectiveness, PES schemes may target areas where deforestation risks and forest services such as medicinal plants, watershed protection, and lumber are most abundant.

Finally, economy-wide policies can in some cases be one of the underlying causes of deforestation. While some land-clearing incentives, such as global commodity prices, are usually outside a particular government's control, others including taxes, subsidies, credit provision, and regulations, are not. Removing perverse national policy incentives may reduce both government budgets and forest pressures, resulting in a win-win situation.

It is noteworthy that changes in Brazilian and Costa Rican policies pre-dated the adoption of the Reduced Emissions from Deforestation and forest Degradation (REDD+) policies under the UNFCCC. In Costa Rica, the main motivation was to support forest owners producing domestic environmental services (watershed protection and touristic landscape beauty). In Brazil, national and international public opinion exerted political pressure favouring protection of the Amazon, due to co-benefits linked to conservation. A focus on such benefits may thus also render climate change mitigation strategies more politically viable.

Currently, REDD+ seems to provide low-cost opportunities for mitigating emissions (Streck and Parker, 2012) while producing important co-benefits (Strassburg et al., 2012). National anti-deforestation policies and on-the-ground pilot projects are both considered core to REDD+. Most tropical forest-rich countries are already designing their REDD+ strategies, and developed countries have been, in turn, requested to scale up short- and long-term financing. In most cases, REDD+ strategies will need to adopt customized policy mixes to become effective. The cases of Costa Rica and Brazil can help provide some of the ingredients.

4.4 Conclusions

The analysis of studies published in the past year do not change estimates of the total mitigation potential in 2020 of 17 ± 3 $GtCO_2e$ identified in the Bridging the Emissions Gap Report (UNEP, 2011). However, while the emission reduction potential remains significant, time is running out. Delays in action will gradually reduce the 2020 mitigation potential because of emissions "lock-in".

It is also known that emission reduction potential can only be realized if strong, long-term and sector-specific policies are in place at the global and national levels. The good news is that a wide range of policies, successful in cutting greenhouse gas emissions, have already been adopted in various sectors and countries. The second part of this chapter analysed how such ambitious, sector-specific policies can be instrumental in achieving the emission reduction potential.

Although market-based instruments play a crucial role for emission reductions, experience has shown that market imperfections, including information asymmetries and undefined property rights, limit the application of such instruments. Additionally, some of the key decisions that affect emission trajectories for decades and, in some cases, centuries, are not market-based. For this and other reasons, command-and-control instruments such as codes, standards, labels and zoning, together with price-based policy instruments such as taxes or payments for environmental services, should all be part of the considered options, depending on national and local circumstances.

The political feasibility of introducing ambitious regulatory measures such as standards and regulations is higher in some sectors, such as buildings and transportation, which are intrinsically local. The same is true for most of the timber extraction in tropical forests when it is directed to domestic markets. However, the range of benefits associated with the implementation of the policies described in this chapter is so wide (reduction in energy consumption and prices, improved air quality, increased environmental services from forest protection, etc.) that these examples should motivate national and local governments around the world to replicate or expand similar policies.

Clearly, successful scale-up of the policies described in the chapter requires that the instruments be tailored to local economic, financial and social conditions, such as the existing capital stock, weather and urbanization patterns, technical capacity, and economic and demographic trends. Forest policies, for example, must account for the existing variety of ecological and economic aspects of land use. The presence of effective institutions is also crucial to the successful implementation of policies. The availability of appropriate monitoring and enforcement mechanisms are also a key to success.

Creating the right conditions for effective policies can take time even when there is strong political will. Ideally, policy design needs to be strong enough to resist the volatility of electoral cycles.

This chapter can be viewed as an attempt to provide policymakers with an understanding of how certain policies can also be significantly leveraged to help bridge the emissions gap.

Among the key findings of this chapter, three stand out. Firstly, many developed and developing countries have already taken action to implement sector-specific policies that, in addition to reducing carbon emissions, have also proven effective at delivering a wide range of other benefits. These have included, saving money, reducing air pollution, improving public health, strengthening energy security and creating jobs. In fact, in most of the examples presented in this chapter, the case for policy implementation was triggered by national and local interests, rather than climate concerns.

Secondly, while it is encouraging that so many countries are actively pursuing targeted, sector-specific policies with the potential to significantly reduce greenhouse gas emissions, the window for closing the emissions gap is getting narrower as we get closer to 2020. Since today's investments in buildings, transportation systems, factories, and cities will set future energy use patterns for decades, early policy action at the national and local level is essential to avoid emissions "lock in", and prevent energy waste and excessive pollution. Losses, often permanent ones in carbon storage and in biodiversity, can be avoided with effective deforestation policies that create norms and incentives for good land use.

Thirdly, the considerable progress in sector-specific policy implementation has the potential to make the adoption of a coherent climate policy more likely, both at the national and international level. The scaling up of effective policies both in terms of ambition and geographical reach is certainly challenging, but it is also feasible, as the cases analyzed here suggest. If pursued broadly, these successful policies would set the world on a more sustainable climate trajectory.