Information and data on mitigation potentials and ranges of emissions reductions of Annex I parties

Submission of the Climate Action Network International¹ to the AWG
5 September, 2008

The ranges of emissions reductions required
To prevent dangerous anthropogenic climate change, global average temperature increases must be kept as far below 2°C as possible, compared with preindustrial levels: global emissions will need to peak within the next 10 years and decline thereafter. Delaying action further will require much greater rates of emission reductions later to achieve the same stabilization, at significantly higher cost, and may make lower, and therefore safer, stabilization levels impossible to achieve.

The binding QELROs of developed countries must be ambitious: at least at the top end of the 25-40% reduction range (by 2020 from 1990 levels). A large majority of the effort must be made domestically, as a massive shift is required in the unsustainable and inequitable consumption patterns of developed countries and to lay the ground for the much deeper cuts (of at least 80-95%) required by 2050. In addition to domestic efforts, deeper additional emissions reductions must be achieved internationally in support of sustainable development. Strong domestic action is not only possible, but can often be highly advantageous in the co-benefits, for example to human health, that it can bring.

Progress so far

Figure 1: Greenhouse gas emissions of Annex I countries 1990-2005, excluding LULUCF²

Annex I countries have made differentiated progress towards meeting their legally binding Kyoto Protocol emissions reductions obligations. While overall emissions from these

¹ CAN-International welcomes the opportunity to provide inputs to the discussions moving towards a post 2012 agreement. CAN is a coalition of more than 400 environmental and development non-governmental organizations in 85 countries worldwide, committed to limiting human-induced climate change to ecologically sustainable levels.

² UNFCCC factsheet on 1990-2005 emission trends
countries are below 1990 levels, most of that has been achieved by the Economies in Transition (EITs) (highlighted in Table 1. The only non-EITs to reduce emissions beyond their Kyoto targets are Finland, France, Sweden and the UK, and each of these has potential to, and must, reduce substantially further. The worst offenders for not making adequate progress in reducing their emissions are Turkey (by far the worst offender for emissions increases, but without a Kyoto target), Spain (also a notable outlier, despite the generous allowance in the EU target sharing agreement), Austria, Canada, Liechtenstein, Luxembourg, New Zealand and the USA.

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Table 1: The reality gap between what is needed and what has been achieved is the percentage point difference in emissions between the Kyoto target and actual emissions of Annex I countries in 2005. Emissions changes exclude LULUCF. EIT countries are shaded. EU countries’ targets are those agreed under the EU burden sharing agreement. The figure for Turkey is from 2004.
**Achieving deeper cuts**

There is great mitigation potential in each developed country. Many rely heavily on fossil fuels for electricity and transport and there are clear opportunities to replace these fuels with clean, sustainable sources of energy. There is of course also a great need to reduce the demand for energy by improving the efficiency with which it is used and the use of new technologies and, in the medium to long term.

**Renewables and low-emission technologies**

Clean technologies are essential in each country. Each Annex I country has great potential for employing renewable energy, although the potentials for different technologies differ by a country’s natural resource endowment.

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Figure 2: world solar insolation

Figure 2 shows that of the developed countries, Australia, New Zealand (in summer), Japan (in summer), the USA and southern Europe have excellent solar potential, which unvaryingly is not being exploited to its full potential.

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The map created by 3Tier and shown in Figure 3, demonstrates the massive scope for wind energy world wide, with Iceland, the UK, Norway, Australia, New Zealand, Japan, Russia, the US and Canada having areas of exceptional potential. The map provides data on wind at 80 meters high over an area of 15 kilometers for a year.

Figure 4 highlights the potential of the US, Japan, New Zealand, parts of southern Europe, and Iceland to exploit their geothermal potentials, while Figure 5 demonstrates that western

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4 http://news.cnet.com/8301-11128_3-9885177-54.html
5 http://geothermal.marin.org/GEOpresentation/sld015.htm
Europe, Norway, Iceland, Australia, New Zealand, the US and Japan all have exceptional scope to use the energy of the oceans.

In addition, there is significant scope for biomass energy in Russia and Japan, with the USA, Canada, New Zealand, Australia and parts of Europe also having potential to manage their production forests as sources of energy.

Nuclear power is an unsustainable, and therefore completely unacceptable, means to achieve mitigation objectives.

In all high-emitting industrial sectors, there is potential for greater process efficiencies, while using renewable energy will reduce the direct emissions of production. In some, there are hopeful technological breakthroughs, although these are not yet commercial.

For example, aluminum might be able to move beyond its 19th century process to a new inert anode technology that the US government thinks could be commercial by 2010-20156. The US’s Argonne National Laboratory is developing a lower-temperature electrolytic process for aluminum extraction, which does not produce CO₂ and PFCs as by-products and which uses less energy in processing7.

It is the responsibility of each Annex I country to develop their renewables potential to the maximum.

Reducing demand
Energy efficiency has the potential for massive emissions reductions in industrial, electricity, housing, heating and cooling and transport sectors, and others, at low, or even negative net costs. Developed countries must put in place effective policies, covering all relevant sources and sectors, to ensure that they fulfill the mitigation potential in each sector, to do their fair share to avoid dangerous climate change.

Figure 6 shows that some countries are already notably more efficient than others. Russia and Canada have exceptional potential to improve their energy efficiency per unit GDP, and it is imperative that they do so. The US’s 18% energy intensity target will help it to become slightly more efficient than India, and towards as efficient as Japan and the EU – both of which have remaining massive potentials for improving their efficiencies further.

Specifically, each country has the potential to reduce emissions by:

- Setting binding ambitious energy efficiency targets. Voluntary agreements so not deliver, and binding targets can help to spur technological innovation
- Increasing efficiency in the power sector. For G8+5, the reduction potential ranges from 5% to 45%; of the Annex I countries, Russia has the greatest potential\(^9\)
- Implementing the polluter pays principle, and phasing out subsidies for conventional energy sources, while increasing taxation on fossil fuels and other unsustainable energy sources\(^10\).
- Introduce performance standards on new and, crucially, existing buildings. Specific areas include insulation standards, support for efficiency heating and cooling systems for existing buildings stock – new buildings can be designed to have good passive temperature control
- Introduce minimum efficiency standards for household appliances and office equipment.
- Introduce minimum efficiency standards for passenger and freight vehicles

Cooperation on setting standards on specific areas between some or all of the developed countries could help to phase out inefficient technologies from the global market.

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\(^9\) Ecofys 2007 “Making Energy-Efficiency Happen from Potential to Reality”, commissioned by WWF International

\(^10\) Price effects energy use: a report from the US Department of Transportation found that in the past nine months Americans drove 53.2 billion miles less than they did in the same period in 2007. Urban travel dropped by 1.2% and rural travel by 4%. – The Economist, 13 August 2008
While there is great potential to reduce emissions from aviation and shipping in all Annex I countries, through technological efficiencies as well as lifestyle changes, a particularly easy means of reducing emissions in these sectors is to end redundant trade (ie a commodity from country A is traded for that same commodity in country B, with all the attendant transportation emissions). Such trade for the sake of trade is environmentally damaging and real efforts should be made to end this practice.

There is potential to reduce emissions from land use changes, forestry and agriculture. Moving away from a high-input agricultural system towards one less reliant on fertilizers requiring high inputs of fossil fuels and leading to high N₂O emissions would be a step forward. Promoting diets lower in animal products, such as meat and dairy products, would help to reduce methane emissions from ruminants, allow a more rational use of grains and other feedstocks, and also help to combat the obesity crisis in Annex I countries.11

Forestry in Annex I countries also has the potential to reduce emissions, but the accounting methodology must reflect what the atmosphere sees: the current asymmetric accounting system is perverse in its accounting for sinks but not sources. Addressing relevant sources of emissions not currently accounted for, such as those from industrial-scale impacts on peatlands, also have potential to reduce emissions.

The country-specific papers that follow demonstrate considerable potential to mitigate in a manner consistent with the 2° imperative.

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11 http://www.youtube.com/watch?v=Ibd1HbGSFrY: Rajendra Pachauri, Chair of the IPCC, World Environment Day 2008, Wellington NZ, “It would help the global community enormously if we eat consume meat... if you turn to eating less meat, as I say, individuals will be more healthy and so will the planet... We should not assume that established patterns of consumption and production are beyond the pale of actions and options that people should be exercising.”
AUSTRALIA

| % of world total CO₂ emissions (excludes LULUCF) (2004) | 1.18% |
| Rank of world polluters (2004) | 18th |
| % emissions change since 1990 (2004) | +24.6% |
| Tons CO₂ per person (2004) | 17.5 |
| World ranking in per capita emissions (2004) | 9th |
| Total GHG emissions, including LULUCF and bunkers (2005) | 535.6 Mt CO₂-e |
| Total GHG emissions, without LULUCF (2005) | 538.8 Mt CO₂-e |
| Total CO₂ emissions, including LULUCF and bunkers (2005) | 387.1 Mt CO₂ |
| GHG emissions from bunkers (2005) | 9.9 MtCO₂-e |
| GHG emissions from LULUCF (2005) | -3.2 Mt CO₂-e |

Source: CAIT (www.cait.wri.org)

Overview

As shown in figure 7, stationary energy – predominantly electricity generation – accounts for 50% of emissions, while agriculture and transport account for 16% and 14% respectively. LULUCF, fugitive emissions, industrial processes and waste make up 7%, 6%, 5% and 3% of national emissions respectively.

Figure 7: Australia’s GHG emissions (2006)

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12 Department of Climate Change (2008), National Greenhouse Gas Inventory.
While Australia’s total national GHG emissions increased by only 4.2% over period 1990-2006, this does not tell the full story of Australia’s emissions trajectory. The relatively small growth in Australia’s emissions is overwhelmingly a result of a 70% reduction in LULUCF emissions. Emissions also fell slightly in the waste and agricultural sectors. However emissions from stationary energy have risen by more than 47%, largely due to increased coal consumption. Emissions from transport have also grown substantially, rising by more than 27% over the period 1990-2006. The growth in emissions from freight transport has outstripped that of personal transport. The largest growth in transport emissions was recorded for domestic air travel, for which emissions increased by more than 107% over the period 1990-2006. Trends in Australia emissions are illustrated in figure 8, below.

Figure 8: Trends in Australia’s GHG emissions (1990-2006)

According to the Australian Government’s latest projects, Australia will meet its Kyoto Protocol target (108% above 1990 levels). By 2020 emissions are projected to increase to 20% above 1990 levels unless further action is taken. It is important to note that this is a “with measures” projection, which assumes that current abatement measures continue to be implemented. The government’s business as usual scenario projects that emissions will increase to 47% above 1990 levels by 2020 (see figure 9)

Figure 9: Projections of Australia’s emissions to 2020

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13 Department of Climate Change (2008), National Greenhouse Gas Inventory.
When the contribution of LULUCF is excluded, Australia’s emissions grew by 25.6 per cent over 1990 to 2005. This is the sixth highest rate of growth among Annex I countries and significantly higher than emission growth in the United States (16.3 per cent in 2005 over 1990 levels)\textsuperscript{15}. Given these figures, it is reasonable to conclude that Australia has so far taken little serious action to stabilize its GHG emissions.

**Australia’s Overall Mitigation Potential**

Australia is a major GHG emitter relative to its size. To date, Australia has taken very little serious action to reduce its emissions despite being a relatively rich country and having ample opportunity across multiple sectors to reduce emissions. Australia has low penetration of renewable energy, inefficient fossil fuel power stations and has done little to pursue energy efficiency improvements. As a result, Australia has substantial opportunities to achieve significant and rapid emission reductions in the future.

In summary, Australia’s mitigation potential is high and it is well placed to adopt a steep reduction target, consistent with the global aim of avoiding a 2°C global mean temperature increase.

A recent report by the international consultancy firm McKinsey & Company investigated the level of greenhouse emission reductions ('carbon abatement') that are technically feasible at the very minimum across all sources of greenhouse gas emissions in Australia. The report costed this abatement for 2020 and 2030\textsuperscript{16} and found that emission reductions of 30% below 1990 levels by 2020 and of 60% by 2030 could be achieved without major technological breakthroughs, lifestyle changes or investment in public transport. It also found that the average annual gross cost per household would be $290 per year by 2020, compared with an expected increase in average household income of $20,000 over the same period. Australia’s GDP would continue to grow with a slight reduction, from the current growth rate of 3.00% (assuming no costs from climate change impacts) to 2.98% per year\textsuperscript{17}.

This same consultancy also carried out a parallel global study. They concluded that Australia has larger abatement opportunities to 2030 than the global average. With a hypothetical carbon price of $65 per tonne CO2-e, Australia could reduce emissions by 60% below 1990 levels by 2030, compared with the global average reduction opportunity of 20%. Additionally, a large share of emission reduction opportunities represent net savings to the economy\textsuperscript{18}.

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\textsuperscript{14} Department of Climate Change (2008), *Tracking the Kyoto Target: Australia’s Greenhouse Emissions Trends: 1990 to 2008-2012 and 2020.*

\textsuperscript{15} UNFCCC 2007b, p.1


\textsuperscript{17} Downey et al. (2008) *op cit.*

\textsuperscript{18} Downey et al. (2008) *op cit.* p.9.
Table 3 summarises several key indicators of Australia’s emissions profile. Australia is a relatively wealthy and well-resourced Annex I country, with a GDP of US$561 billion in 2004\(^\text{19}\). In that year, Australia’s GDP per capita was US$28,112, higher than that of the European Community (US$23,244) and considerably higher than that of the average Annex I country (US$19,528)\(^\text{20}\). Australians enjoy a very high quality of life and rank second only to Norway on the Human Development Index at 0.96\(^\text{21}\).

Australia is also a relatively high emitter of greenhouse gases, emitting 529 million tonnes of CO\(_2\) equivalent (Mt CO\(_2\)e) in 2004\(^\text{22}\). On a per capita basis, Australia’s GHG emissions of 26.5 tonnes CO\(_2\)-e per person are the second highest of the Annex I countries (behind Luxembourg) and more than double that of the group’s average\(^\text{23}\). Australia’s GHG emissions per unit of GDP (PPP) are also much higher than that of the average Annex I country and 6\(^\text{th}\) highest after Russia, Ukraine, Estonia, Belarus and Bulgaria.

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\(^{19}\) UNFCCC 2007a, p.23  
\(^{20}\) UNFCCC 2007a, p.24  
\(^{21}\) UNFCCC 2007a, p.24  
\(^{22}\) UNFCCC 2007a, p.23  
\(^{23}\) UNFCCC 2007a, p.24
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Table 3: Summary of indicators of Australia’s emissions profile

Figure 11: Australia’s emissions per capita and per unit GDP

Australia produces the highest level of GHG emissions (4.7 t CO₂-e/tonne of oil equivalent, TOE) in the production of primary energy of all Annex I countries26. This is largely due to its reliance on coal – in 2003, 42.6% of Australia’s primary energy was produced from coal, the fourth highest for an Annex I country behind the Czech Republic, Poland and Estonia27. Over

24 The reporting countries were Australia, Denmark, Finland, France, Germany, Ireland, Japan, Norway, Sweden, United Kingdom and United States.
26 UNFCCC 2007a, p.24
27 UNFCCC 2007a, p.25
60% of Australia’s emissions were a result of energy production and agriculture, with a relatively low proportion contributed by households.\textsuperscript{28} Australia’s energy industries produced by far the highest level of GHG emissions per kilowatt of electricity produced of any Annex I country (841g CO\textsubscript{2}e/kWh).\textsuperscript{29} At 32.7%, the efficiency of Australia’s fossil fuel power plants is the lowest of all Annex I countries reporting.\textsuperscript{30} This compares with 35.1% efficiency for US plants and 41.5% for the UK.\textsuperscript{31} In 2004, renewable energy accounted for only 8.3% of electricity production in Australia, significantly below the average for Annex I countries (21.3%).\textsuperscript{32} Australia’s GHG emissions per capita for the transport sector in 2004 were much higher than that of the Annex I country average and 4\textsuperscript{th} highest of all the countries reporting.\textsuperscript{33} Australia’s GHG emissions per capita for the land use change and forestry sector were the 4\textsuperscript{th} highest of all the countries reporting. Australia was one of only five countries to have net emissions from this sector; on average, this sector is an emissions sink.\textsuperscript{34} Australia also has the highest level of per capita emissions from waste at almost 1 tonne per person and has a relatively low level of methane recovery.\textsuperscript{35}

When the contribution of LULUCF is excluded, Australia’s emissions grew by 25.6% over 1990 to 2005. This is the sixth highest rate of growth among Annex I countries and significantly higher than emission growth in the United States (16.3% in 2005 over 1990 levels).\textsuperscript{36} Furthermore, Australia has projected that its emissions will increase by 35% over 1990 levels by 2010 which will represent the 5\textsuperscript{th} highest growth rate of the 37 Annex I countries reporting.\textsuperscript{37} Also, Australia’s greenhouse gas emissions are projected to increase by 54% above 1990 levels by 2020.\textsuperscript{38} Given these figures, it is reasonable to conclude that Australia has so far taken little serious action to stabilize its GHG emissions.

\textsuperscript{28} UNFCCC 2007a, p.26
\textsuperscript{29} UNFCCC 2007a, p.27
\textsuperscript{30} UNFCCC 2007a, p.27
\textsuperscript{31} UNFCCC 2007a, p.27
\textsuperscript{32} UNFCCC 2007a, p.27
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\textsuperscript{34} UNFCCC 2007a, p.29
\textsuperscript{35} UNFCCC 2007a, p. 33
\textsuperscript{36} UNFCCC 2007a, p.32
\textsuperscript{37} UNFCCC 2007b, p.1
\textsuperscript{38} UNFCCC 2007a, p17

Figure 12: Australia’s emissions from electricity and the share of renewables in electricity production
The figures in Table 1 suggest that Australia has a higher mitigation potential than other Annex I countries. Australia has higher than average economic performance and standard of living, which provides it with resources to reduce emissions. Australia’s emissions are above average across most sectors, which means there should be many opportunities to achieve reductions across the economy.

Potential for emissions reductions from energy efficiency

Australia has made little attempt to improve energy efficiency to date. A recent study on energy efficiency improvement in Australia found that ‘Australia’s technical energy efficiency improvement between 1990 and 2004 has been around a third the average amongst other IEA-assessed OECD countries’\textsuperscript{39}. It also found that ‘over the period, Australian energy efficiency improved at an average annual rate of 0.3%, while the average in other IEA countries was 0.9% per year’\textsuperscript{40}. Improvements in energy efficiency can make a significant contribution to GHG abatement in Australia. Recent findings are outlined below:

- **Greenpeace**: energy efficiency measures could reduce electricity demand by up to 40% by 2020, saving 105 TWh a year.\textsuperscript{41}
- **McLennan Magasanik Associates (MMA)**: identified significant scope for improvements in energy efficiency. This includes 13-73% improvements in residential energy efficiency, 10-70% improvements in commercial energy efficiency and 6-46% improvements in the manufacturing sector.\textsuperscript{42}
- **Allen Consulting**: energy efficiency could deliver a net economic benefit of around $710 million over the period 2010-2020.\textsuperscript{43}
- **Centre of International Economics**: Capitalizing on the building sector’s potential to lessen the costs of a broad based GHG emissions cut. The building sector as a whole could reduce its share of GHG emissions by 30-35% whilst accommodating growth in the overall number of buildings by 2050.\textsuperscript{44}

![Figure 13: Australia’s potential to increase energy efficiency and its potential to reduce electricity demand.\textsuperscript{45}](image)

\textsuperscript{39} The Climate Institute 2007a

\textsuperscript{40} *ibid*


\textsuperscript{43} Allen Consulting Group (2008), *Potential for Mandatory Energy Efficiency Investment Requirements: Cost benefit analysis of program options*.

\textsuperscript{44} Centre for International Economics (2007), *Capitalizing on the building sector’s potential to lessen the costs of a broad based GHG emissions cut* (www.thecie.com.au).

Greenpeace estimates that energy efficiency measures in the electricity sector could deliver abatement of 10 Mt CO2-e by 2020. Other estimates of abatement have been based on emissions reductions below business as usual. For example, a preliminary analysis prepared for The Climate Institute estimates that energy efficiency could reduce Australia's emissions by approximately 60-107 Mt per year by 2020. Similarly, McKinsey estimates that by 2020 GHG savings of close to 80 Mt CO2-e could be achieved through cost-negative measures, mainly through improved energy efficiency.

**Renewable Energy Potential**

The government has promised to strengthen Australia’s Renewable Energy Target to 20% by 2020. Evidence suggests that renewable energy could play an even bigger role. A recent report by Energy Strategies and Greenpeace International, the 'Energy Revolution Scenario', found a combination of renewable energy and energy efficiency could reduce energy-related emissions by 37% over 15 years, from 370 million tonnes (Mt) in 2005 to 232 Mt in 2020. Increased uptake of renewable energy for electricity could provide 40% of electricity by 2020, increasing to 70% by 2050\(^46\).

![Figure 14: The potential for renewables growth in Australia](image)

**Transport**

In the transport sector, many options are available for Australia such as: fuel efficiency standards; greenhouse standards for fuels; taxes on vehicle purchase, registration and use and on motor fuels; road and parking pricing; investment in attractive public transport facilities and non-motorized forms of transport\(^48\).

Few of the available options have been seriously pursued in Australia, leaving great potential for future emission reductions.

In 2006 emissions from transport accounted for approximately 14% of Australia’s total emissions. Emissions from this source have increased by more than 27% since 1990. The growth of emissions from freight transport has outstripped that of personal travel. While emissions from the transport sector grew by over 27% between 1990 and 2006, emissions

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\(^{47}\) International and Energy Strategies, Amsterdam and Canberra, p.8.


UNFCCC 2007a, p. 36
from freight transport grew by 40% over the same period. Potential abatement of up to 33 Mt CO₂-e pa could realistically be achieved by 2020, through: increased up-take of new technologies and fuels; improved fuel efficiency; use of monetary policies; improvements in urban design; improved public transport; and construction of a fast-rail network.

Emissions from the Land Use Sector
McKinsey identifies avoided deforestation as a “large, immediate and perishable opportunity to reduce GHG emissions” within Australia. Additionally they note there are large opportunities for replanting marginal crop and grazing land, as a relatively cost competitive abatement measure. They report over 100Mt of abatement from this sector by 2020 and over 170Mt by 2030.

Land clearing
Australian Government has estimated that regulation by the Queensland and New South Wales governments will reduce emissions by 20 MtCO₂-e pr/yr. However, land clearing could be reduced even further. Clearing of regrowth vegetation is not covered by these sectors. If the clearing of regrowth was reduced this could reduce emissions by up to 15 MtCO₂-e.

By further reducing land deforestation from clearing and reducing clearing regrowth on top of existing measure Australia could reduce emissions from deforestation by at least 35 MtCO₂-e after 2013.

Native forests logging
This currently counted under managed native forests which is not counted towards Australia’s Kyoto target. Australia did not elect any activities under Article 3.4. The federal government says emissions from logging managed native forests is about 20 MtCO₂-e tonnes a year. However, in the national greenhouse gas inventory these emissions are more than cancelled out by the regrowing forest. If native forest logging were to cease these emissions would cease but the forests would continue to grow according in response to recovery from previous logging. This is likely to be an underestimate of the mitigation potential as the National Carbon Accounting System is likely to be a gross underestimate carbon stores.

Forest plantations
Australian Government has projected a net sequestration by Kyoto Forest Plantations of 21 MtCO₂-e by 2010. This annual level of sequestration is projected to continue to 2020. However, it could be argued that this is business as usual sequestration as the Plantation 2020 Vision program established in 1997 had a goal of increasing plantations to 3 million hectares by 2020.

Agriculture
There are various options to reduce emissions in the Agriculture sector. Analysis prepared for The Climate Institute estimates that total abatement potential is up to approximately 30 Mt

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49 Total Environment Centre. 2008. Freight Transport & Climate Change
50 33Mt CO₂-e reductions per year is 53% of 1990 levels of 62MT CO₂e, and 38% of 2008-2012 average as reported in 2007 Tracking to the Kyoto Target, Department of Climate Change
51 The Climate Institute, Australian Emissions Reduction Model [publication forthcoming].
CO2-e per year by 2020. Australia does not currently account for emissions/sequestration associated with changes to soil carbon. It is estimated that relatively small soil carbon improvements could reduce emissions by an additional 14.5 MtCO2-e per year by 2020. Reducing livestock numbers would also provide opportunities for significant additional abatement.

**Other Sources of Emissions**

**Waste**

Emissions from waste management and disposal constitute a relatively small fraction of Australia’s overall emissions (3% in 2006). It is estimated that action in this sector could reduce emissions by approximately 3.7 t CO2-e per year by 2020.

**Fugitive Emissions**

In 2006 fugitive emissions accounted for approximately 6% of Australia’s total emissions. It is estimated that approximately 9 MtCO2-e per annum could be saved from this sector by 2020. This would involve actions to increase electricity generation from coal-seam methane, use of world’s best practice technology for methane flaring and reducing leakage from gas distribution networks.

**Potential external emissions reductions through REDD, technology and finance**

As a wealthy country with an exceptionally high per capita carbon footprint, despite excellent renewables potential, Australia, like other wealthy nations that have done the most to contribute to the climate change problem have the capacity and the moral duty to contribute to greenhouse gas abatement in developing countries through provision of finance and technology.

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53 ibid
54 ibid
55 ibid
Belarus

<table>
<thead>
<tr>
<th>% of world total CO₂ emissions (excludes LULUCF) (2004)</th>
<th>0.22%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank of world polluters (2004)</td>
<td>49&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>% GHG emissions change since 1990 - 2005 (excludes LULUCF)</td>
<td>-40.6%</td>
</tr>
<tr>
<td>Tons CO₂ per person (2004)</td>
<td>6.7</td>
</tr>
<tr>
<td>World ranking in per capita emissions (2004)</td>
<td>49&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total GHG emissions, including LULUCF and bunkers (2005)</td>
<td>63.0 MtCO₂-e</td>
</tr>
<tr>
<td>Total GHG emissions, without LULUCF (2005)</td>
<td>75.8 MtCO₂-e</td>
</tr>
<tr>
<td>Total CO₂ emissions, including LULUCF and bunkers (2005)</td>
<td>42.6 MtCO₂</td>
</tr>
<tr>
<td>GHG emissions from bunkers (2005)</td>
<td>0.2 MtCO₂-e</td>
</tr>
<tr>
<td>GHG emissions from LULUCF (2005)</td>
<td>-12.8 MtCO₂-e</td>
</tr>
</tbody>
</table>

Source: CAIT (www.cait.wri.org)

**Overview**

Belarus has made good progress with energy efficiency in its economy over last years, however there remains significant room for improvement. Belarus GDP energy intensity is still almost 2 times higher than the world average. Considerable emissions reductions could be achieved through the measures in energy production and industry: 50% and 12% of total GHG emission reduction value, respectively. According to government estimates, additional investments on the level of €10-12 per ton of CO₂-e would allow to reach GHG emission reduction by 53% from 2005 level as early as 2012.

Belarus is a country with high dependence on energy imports and therefore investments in energy efficiency are beneficial to the country for better economics and greater impact on energy security compared to investments in additional electricity generation capacity.

**Analysis of Sources of Emissions and Potential for Emissions Reductions**

The main issue for GHG emissions in Belarus is low energy efficiency in most industrial sectors. According to the IEA, Belarus’s energy intensity levels are more than double the world average.
The results of the government assessment based on a sectoral approach showed that the main part of reduction could be achieved by implementation of emission reduction potential in the field of energy production and industry: about 50% and 12% of the total GHG emissions reduction value respectively. With regard to emission source categories, the highest climate change mitigation potential is associated with the hydrocarbon fuel fired facilities (over 65% of total emissions); then the agricultural enterprises and municipal waste landfills follow (over 20% and 8% respectively)\textsuperscript{57}.

According to the government analysis of the existing measures, instruments and technologies it is possible to determine the minimal target value of net GHG emission reduction in Belarus in 2008-2012 equal to 12 million tons of CO$_2$eq (which is set in the draft of the National Program for Climate Change Mitigation Measures for 2008-2012)\textsuperscript{58}.

Government estimates that additional financial resources and transfer of best available technologies in the framework of the Kyoto mechanisms would give an opportunity to enlarge the range of the mentioned target index to 40 million tons of CO$_2$eq already during the first commitment period\textsuperscript{59}. Such reductions correspond to 53% GHG emission reductions from the current level of emissions already by 2012. From an economic point of view, it will require additional financing on the level of €10-13 per tonne of CO$_2$\textsuperscript{60}.

**Energy sector**

Energy-related GHG emissions in Belarus account for 74.1% of total GHG emissions\textsuperscript{61}.

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\textsuperscript{55} IEA, 2008

\textsuperscript{56} Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, *Information and views on the means to achieve climate change mitigation objectives, including information on the potential environmental, economic and social consequences* and spillover effects, 2008.

\textsuperscript{57} ibid

\textsuperscript{58} ibid

\textsuperscript{59} ibid

\textsuperscript{60} The current average price on the Joint Implementation market in other countries with economies in transition

\textsuperscript{61} National report on GHG cadastre in 2004 of Belarus, http://www.minpriroda.by/ru/site_menu/napravlenia/mejdunsotr/konvencia
The main energy sources used in Belarus now are fossil fuels with a very high share of natural gas: natural gas 71.2%, liquid fuels 21.3%, coal and peat 3% and biomass 4.4% [2]. 99.2% of natural gas and most of oil are imported into the country. This has stimulated the government to change the structure of the fuel consumption towards reduction of natural gas and increasing the share of peat, coal and biomass and introduction the energy efficiency programs and policies.

Figure 14: Changes in the structure of fuel consumption in Belarus, 1990, 2005 and 201562

Between 2001-2005, Belarus implemented the State Program on Energy Efficiency, which aimed to stabilize energy consumption in the country with planned GDP growth on the level of 118-123%. The program could be considered as successfully fulfilled: energy intensity was reduced by 20% from 2000 levels. Although energy consumption did not stabilize and increased by 3.9% from 2000 levels, it can be explained with much higher GPD growth than initially planned in the program63.

In 2006 Belarus government has adopted new program on energy efficiency for 2006 – 2010 with the following aims:
- reduce energy intensity of GDP by 26.1% - 30.4 % by 2010 from the level of 2005;
- reduce greenhouse gases into atmosphere at least by 12 million tons of CO2 e64.

Although the energy efficiency is the central focus of the government, Belarusian industries, and especially state-owned energy companies, lack economic incentives from the government to use energy more efficiently. In Belarus there is no market mechanism to set up tariffs for the energy both for households and industrial consumers. The tariffs do not always reflect the true costs for the energy and even among industrial companies there are tariff distortions, when few industries get subsidies in the form of reduced energy prices65. Such a policy does not stimulate industries to use energy more efficiently.

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62 Ministry of Natural resources and Environmental Protection of the Republic of Belarus
64 Ibid
Industry
In Belarus, the main industries generating GHGs are: metallurgy, engineering and metalworking, petrochemical sector, construction sector, wood-working plants, pulp and paper mills and glass industries.

The primary problems of the industrial complex as a whole are deterioration of the basic physical assets, the lack of deployment of more efficient technology in some cases, underinvestment, and competitiveness reduction under the conditions of price rises for energy carriers. These factors together with a marked production growth are responsible for GHG emission increase in industry66.

The implementation of enhanced energy efficiency measures set out by the National Energy Safety Program for 2006-2010 will allow keeping the energy consumption of 2005 level by 2010 level. Such policy aims to achieve the value of GDP energy intensity reduction by 31% in 2010 compared to the 2005 value67.

Transport Infrastructure
Belarus has relatively energy efficient transport sector infrastructure with very high share of railway transport. The structure of freight turnover is dominated by railway transport, 78% and the rest is motor transport – 22%68.

In 1990-2005 among different transport types main focus was given to the development of motor ways, which length increased half as much. The length of the railways is almost unchanged. Today Belarus has substantially less transport per person than Western European countries. It is likely that the transport will grow as the economy grows: the number of private cars is already increasing and will continue to grow considerably.

Housing
District heating plays an important role in Belarus, providing more than half of the heating for households. The district heating sector consumes annually about 8 bcm of gas or 40% of the country’s gas consumption69.

It is expected that the energy efficiency measures in the housing sector could result in reduction of heat consumption by houses in Belarus up to 30-40% by 2020-2025. The long-term potential is estimated to be as high as 75%, to be reached in 40-50 years, if heat insulation is effectively integrated in renovation of buildings as well as in new constructions. The use of this potential would reduce today’s heat consumption of about 250 kWh/m² annually to about 160 kWh/m² in average by 2020 and to a level as low as 60 kWh/m² in 2025.

66 Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, Information and views on the means to achieve climate change mitigation objectives, including information on the potential environmental, economic and social consequences and spillover effects, 2008.
67 ibid
68 ibid
The National Energy Efficiency Program for 2006–10 includes some investments in the district heating (DH) sector, however it is not enough to exploit the sector’s energy efficiency potential.

**Appliances**
The current household electricity consumption in Belarus is not high compared to many Western countries with a similar climate. It is estimated that efficiency can be more than doubled in 10-20 years, if activities to save electricity are introduced. This can lead to substantial reductions in electricity consumption, but also economic growth will lead to increase of the number of electricity consuming equipment considerably.

**Renewables potential**
Renewable energy, mainly biomass, accounts for 3.7 % of total primary energy supply in Belarus in 2004 (TPES).

Belarus enjoys significant wood resources and has a hydropower potential suitable for small hydropower generation plants. The wide-scale use of other renewable options such as wind, solar, and geothermal currently seem to be less attractive from an economic standpoint because of Belarus’ geographical and geological conditions.

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Government plan by 2010, Mtoe</th>
<th>Government estimation of economically feasible RES in 2010, Mtoe</th>
<th>Infors estimation by 2050, Mtoe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood &amp; wood residues</td>
<td>1.57</td>
<td>2.1</td>
<td>4.9</td>
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<tr>
<td>Hydro</td>
<td>0.05</td>
<td>3.354*10^{-5}</td>
<td>0.035</td>
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<tr>
<td>Wind</td>
<td>0.014*</td>
<td>53.75*10^{-5}</td>
<td>0.23</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.26**</td>
<td>0.053</td>
<td>0.71</td>
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<tr>
<td>Solar Energy</td>
<td>-</td>
<td>0.002</td>
<td>1.62</td>
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<tr>
<td>Ethanol &amp; Biodiesel</td>
<td>-</td>
<td>0.0104</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Table 4: Official estimation of potential for renewable energy sources development in Belarus: total potential and economically feasible levels in 2006 and 2010

* including utilization of municipal waste as energy, no number for wind separately

**The main document for the energy sector development is the State Integrated Program on modernization of the Belarus energy system, energy supply and increasing the share of own...**

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energy resources in 2006-2010. Among renewable energy sources biomass is planned to be highly developed, reaching the level of 2.24 Mt of coal equivalent by 2010 or 6% of all energy sources in 2010, other renewable energy sources to be developed are wind, hydro and biogas from the municipal solid waste. [7]

**Hydro**

The maximum quantity of small hydroelectric power stations in Belarus has been fixed in 1960 - in operation there were 64 such stations with the established capacity 12,8 MWt, including 46 stations capacity of 2,79 MWt on balance of collective farms and state farms.

Now on balance of a power supply system of Belarus are 18 hydro power stations with the established capacity around 9,3 MWt. According to the State Program on Design, Reconstruction and Building of new small hydro power plants, which was adopted by the Ministry of Fuel and Energy of Belarus in 1996, in 1997-2010 it is planned to restore and construct 29 small hydro power plants 75.

The official government estimations is that total hydro energy potencial is 850 MWt, technically available – 520 MWt, economically feasible – 250 MWt 76.

**Wind**

An official government estimate is that there is a potential of 1600 MW of wind power capacity with an annual production of 3.3 TWh 77. This is equal to 2062 annual average full load hours or an average capacity factor of 24%. This is better than many sites used in Germany, but is not a high capacity factor compared with other leading wind power countries 78.

**Solar**

The International Network for Sustainable Energy INFORSE together with “Belaya Rus” experts have estimated that the potential for solar energy systems in Belarus could be 10% of the in-coming solar energy for solar electricity (PV). This would give an annual output of 100 kWh/m² for solar electricity, given that the solar energy influx is 1000 – 1100 kWh/m² in Belarus. The maximal area used for solar PV is set as 3.9 m² per person. With this use of solar energy, the output of the solar installations could be 12 PJ of electricity by 2050 79.

The output of solar collectors is estimated to be 40% of the in-coming solar energy for solar heating. This gives annual outputs of respectively 400 kWh/m², given that the solar energy influx is 1000 – 1100 kWh/m² in Belarus. The maximal area used for solar heating is set to be 3.3 m² per person. With this use of solar energy, the output of the solar installations could be 56 PJ of heat by 2050 80.

76 State complex program on upgrade of the Belarus energy supply system, energy efficiency, and increase of the share of local energy resources during 2006-2010, available at http://www.minenergo.gov.by/pk/p1.htm
77 ibid
79 ibid
80 ibid
Bioenergy
An official estimate is that 1.48 million ton/year would be available from agricultural residues for energy. INFORSE together with independent Belarus experts estimate potential of 2 mill ton/year. With an energy content of 4.1 kWh/kg of straw (15% humidity), the potential is thus 8.2 TWh/year equivalent to 30 PJ by 2050\(^\text{81}\).

The official government estimate is that the maximum quantity of the wood as energy source is 25 million of m\(^3\). This number is estimated from the level of annual wood growth in Belarus. Since only 85% of the country forests can be used commercially the maximum wood for energy source is 21.25 million of m\(^3\)\(^\text{82}\). Belarus has 9 million ha of forest of which 53% is commercial. If each of these 4.5 million ha of commercial forest produces forest residues with an energy content of 5 MWh, the potential energy use from this is 23 TWh/year.

An official estimate is that 3.5 million ton of oil equivalent (Mtoe) can be used in 2020 with 2.02 used in 2010, equivalent to respectively 23 and 147 PJ. Probably this includes removals from forests that are contaminated with radioactivity from the Chernobyl disaster, and that must be treated specially. It does not include major developments of energy-forests\(^\text{83}\). It is expected that 4000 km\(^2\) of land can be set aside for energy forest. This equal to about 7% of the arable land or 4.5% of the land used as arable land, for hayfields and pastures. The output is expected to be 10 tons/ha, equal to output of high-yielding willow, or miscanthus. The energy content is expected to be 4 kWh/m\(^2\) (14.4 GJ/tons). The total energy output would be 16 TWh or 58 PJ per year.

An official estimate of the biogas potential is 0.16 Mt of coal equivalent, equivalent to 25 PJ/year by 2050. [7]

Policies to promote renewable energy
Belarus has not implemented the law on support of renewable energy sources and such a law is not planned to be developed by the parliament in the recent future. There is a program for hydro energy development; the program on wind energy is being discussed in the Parliament.

Belarus has highly centralized and monopolized energy system. There are no sufficient policies to stimulate independent power producers to develop renewable energy sources. The procedure to obtain permission for distributed energy source is extremely complicated and allowance can be obtained only through the government decision. Such conditions in fact detract from the renewable energy development.

Other critical barriers to distributed power generation in Belarus are depressed prices for competing fuels (namely natural gas) and unfavorable power pricing rules.

\(^{81}\) ibid
\(^{82}\) State complex program on upgrade of the Belarus energy supply system, energy efficiency, and increase of the share of local energy resources during 2006-2010, available at http://www.minenergo.gov.by/pk/p1.htm
\(^{83}\) Belaya Rus and International Network for Sustainable development Inforse, Possibility of using of renewable energy in the republic of Belarus, short English version, June 2004, available at www.inforse.org
### CANADA

- **% of world total CO₂ emissions (excludes LULUCF)** (2004): 1.85%
- **Rank of world polluters (2004):** 10<sup>th</sup> place
- **% emissions change since 1990 (2005):** +25.7%
- **Tons CO₂ per person (2004):** 9.2
- **World ranking in per capita emissions (2004):** 10<sup>th</sup>
- **Total GHG emissions, including LULUCF and bunkers (2005):** 750.0 MtCO₂-e
- **Total GHG emissions, without LULUCF (2005):** 767.1 MtCO₂-e
- **Total CO₂ emissions, including LULUCF and bunkers (2005):** 568.7 MtCO₂
- **GHG emissions from bunkers (2005):** 11.5 MtCO₂-e
- **GHG emissions from LULUCF (2005):** -17.2 MtCO₂-e

Source: CAIT (www.cait.wri.org)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Industrial facilities</strong></td>
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<td>Electricity generation</td>
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<td>16.4</td>
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<td>Oil and gas production, transmission and distribution</td>
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<tr>
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<td>74</td>
<td>10.0</td>
<td>11</td>
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<td>41</td>
<td>5.5</td>
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<tr>
<td><strong>Buildings</strong></td>
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<td>Commercial buildings</td>
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<td>37</td>
<td>4.9</td>
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<td><strong>Agriculture (apart from energy use)</strong></td>
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<td></td>
<td>7.7</td>
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<td><strong>Landfills</strong></td>
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<td></td>
<td>3.9</td>
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<td>3.7</td>
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<tr>
<td><strong>Other</strong></td>
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<tr>
<td></td>
<td>0.9</td>
<td>4</td>
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<td>Federal government operations&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.7</td>
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<td>0.4</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td></td>
<td>747</td>
<td></td>
<td></td>
<td>25</td>
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</table>

Table 5. Canada’s main sources of GHG emissions.<sup>85,86,87,88</sup>  
<sup>a</sup> These emissions have already been counted once in the preceding sources.  
<sup>b</sup> Change 1990–2002.

<sup>84</sup> Megatonnes of carbon dioxide equivalent.  
<sup>85</sup> Environment Canada, 12, 581.
Table 5 summarizes Canada’s most recent complete annual GHG emissions data, showing Canada’s main sources of emissions in 2005 and the amount by which each has increased or decreased since 1990. Emissions have risen in nearly every category, in some cases dramatically. In March 2008, Environment Canada projected that under business-as-usual conditions, Canada’s GHG emissions would rise from about 750 Mt in 2005 to 940 Mt in 2020.\textsuperscript{89}

Eighty-two\% (82\%) of Canada’s total emissions come from the production or burning of fossil fuels for energy\textsuperscript{90}— especially coal-fired plants in electricity generation, natural gas-fired units in other industrial facilities and buildings, and gasoline and diesel engines in transportation. Thus, the federal policies needed to effectively reduce Canada’s emissions must focus on bringing about near-term investments in energy conservation, energy efficiency and cleaner energy. This covers the large majority of Canada’s GHG emissions that result from the production or burning of fossil fuels for energy. In addition, the government must implement policies to induce the deployment of technologies and/or practices to reduce the minority of national GHG emissions that are unrelated to energy, including those in agriculture, forestry, waste management and industrial operations.

In 2006, 58\% of Canada’s electricity came from hydro power, 18\% from coal, 17\% from nuclear energy and 5\% from gas. Less than 1\% of Canada’s electricity came from renewable or biomass energy.\textsuperscript{91}

Given Canada’s very high per-capita emissions and relatively high emissions intensity,\textsuperscript{92} there is significant room for improvement in all sectors. The extremely rapid growth in emissions from oil and gas production, freight transportation and commercial buildings suggests that these sectors merit special attention; in addition, the very low level of deployment of renewable energy (apart from large hydro) shows that very significant opportunities exist in the electricity generation sector.

Economic analysis performed in Canada indicates that Canada can meet targets in the range of 25\%–40\% below 1990 by 2020. For example, an assessment by the International Institute for Sustainable Development (IISD) found that a carbon price in the range of $250/tonne,\textsuperscript{93} with some revenues re-invested in deploying low-emission technologies, would reduce Canada’s domestic emissions to 25\% below 1990 in 2020. The authors note that:

\begin{itemize}
  \item [88] All data has been derived from Environment Canada’s \textit{National Inventory Report}, except for the cars and trucks data which has been derived from Natural Resources Canada’s \textit{Energy Use Data Handbook Tables}, and the federal government operations data, derived from the \textit{Federal House in Order} report.
  \item [91] \textit{Ibid}
  \item [92] Canada ranked 48\textsuperscript{th} in the world for the GHG intensity of its economy using 2004 CO\textsubscript{2} data that excludes land-use change (see www.caит.wri.org).
  \item [93] Unless noted, all dollar figures are in Canadian dollars. $1 CDN = $0.95 USD (August 28, 2008)
\end{itemize}
“even with the most stringent of the possible mitigation targets [40% below 1990 in 2020] there is likely to be continued growth in Canada. Further, there are opportunities to minimize compliance costs through either efficient policies, such as economy wide carbon pricing, but also through using carbon price proceeds to recycle revenue.”

The National Round Table on the Environment and the Economy (NRTEE), an advisory body to Canada’s Environment Minister, found that Canada could reach the government’s current target of 3% below 1990 in 2020 with a carbon price of about $75/tonne ($2003) and complementary regulatory policies. The NRTEE notes that “the likely impact on economic growth [from reaching this target] is limited and not significant.”

A 2008 study by the David Suzuki Foundation, a Canadian environmental organization, again found that Canada could reduce its domestic emissions to 19% below 1990 by 2020 using an economy-wide carbon price. In their assessment, the carbon price required was about $200/tonne; this study did not include complementary policies (such as regulations to increase energy efficiency) which can reduce the cost of reaching the target.

Clearly, a target in the range of 25–40% below 1990 in 2020 is feasible for Canada, and a carbon price is one of the major policy tools needed to reach that target. The modelling studies cited above did not include opportunities for emission reductions from non-energy related emissions (e.g. agricultural emissions); these present important sources of low-cost emission reductions that would contribute to Canada’s making a fair contribution to avoiding dangerous climate change.

Potential for emissions reductions from energy efficiency

Working papers prepared for the energy ministers from Canada’s federal, provincial and territorial governments confirm that major energy efficiency improvements in all sectors are both possible and cost effective. However, making those improvements will require governments to set much more aggressive regulations for equipment, buildings and vehicles than they have to date. (For example, Canada’s current federal vehicle efficiency standards are voluntary. The government has committed to regulations that would take effect in the 2011 model year, but has not yet stated what standard it will set.) The following targets were identified as feasible in working papers prepared for Canada’s energy ministers:

- Over the next 20 years, all existing buildings and homes could be retrofitted to provide, on average, 30% or more savings in heat and electricity.

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• Over the next 20 years, all new buildings and houses could have net zero energy requirements (where annual energy used is equal to annual energy produced on site).
• Industrial energy intensity could be improved by up to 4% each year.98

Renewables potential
Given its abundant renewable energy resources, Canada has the potential to become a global leader in renewable energy. However, as noted above, to date less than 1% of Canada’s electricity comes from low-impact renewable energy. Comparisons with peer jurisdictions reveal the inadequacy of Canada’s current rate of deployment of renewable energy. For example, Germany already has more than 20 times the amount of installed wind power than Canada with a land mass a fraction of Canada’s size.99 A forthcoming Pembina Institute analysis found that the province of Alberta, Canada’s largest producer of coal-fired electricity, could phase out coal altogether by 2028 by deploying renewable energy at the rates seen in peer countries such as Germany and Spain and by switching to cleaner fuels in industrial production.100 Similarly, a 2007 assessment of electricity demand in Canada’s most populous province, Ontario, found that a full coal phase-out is possible by 2012. In addition, a scenario that (i) matched energy efficiency in Ontario to the levels reached in leading US and EU jurisdictions and (ii) aggressively deployed cogeneration technology and renewable technologies such as wind, solar and low-impact hydro would reduce the province’s projected electricity emissions for the next 20 years by 50%.101

Potential external emissions reductions through REDD, technology and finance
Canada’s high level of emissions per capita, cumulative emissions, and per capita wealth allow it to make a significant financial contribution to emissions reductions internationally. Unfortunately, Canada has not yet pledged money to combat global warming in developing countries on anything close to the scale required, and Canada’s government has also ruled out any public spending through the Kyoto Protocol’s Clean Development Mechanism (CDM).102 This lack of meaningful commitment to date — and the fact that Canada’s emissions are more than 29% above the country’s Kyoto target — leaves Canada with an urgent obligation to ramp up its investment in external emission reductions through REDD, technology and finance.

100 Forthcoming Pembina Institute analysis (expected publication date: Fall 2008). The Pembina Institute is a Canadian sustainable energy think tank.
102 For a listing of Canada’s commitments to international climate adaptation and mitigation, see Clare Demerse, Climate Change at the G8 Leaders’ Summit in Hokkaido, Japan (July 7–9, 2008) at http://pubs.pembina.org/reports/G8_2008_Backgrounder2008.pdf.
EUROPEAN UNION

| % of world total CO₂ emissions (excludes LULUCF) (2004) | 13.51% |
| Rank of world polluters (2004) | 3rd |
| % emissions change since 1990 (2005) | -1.6% |
| Tons CO₂ per person (2004) | 9.2 |
| World ranking in per capita emissions (2004) | 37th |
| Total GHG emissions, including LULUCF and bunkers (2005) | 4,157.4 MtCO₂-e |
| Total GHG emissions, without LULUCF (2005) | 4,472.6 MtCO₂-e |
| Total CO₂ emissions, including LULUCF and bunkers (2005) | 3,438.1 MtCO₂ |
| GHG emissions from bunkers (2005) | 276.5 MtCO₂-e |
| GHG emissions from LULUCF (2005) | -315.2 MtCO₂-e |

Source: CAIT (www.cait.wri.org), all figures and relate to the EU-25

Overview
The EU itself describes its mitigation potential as “large”\(^{103}\). Although the EU’s energy intensity per unit GDP is lower than the OECD average and considerably lower than that of Russia, Belarus, Ukraine, Canada and the USA, there is huge scope to improve efficiency economy-wide and to introduce renewable energy on a large scale. Figure 16 shows a scenario for reducing EU domestic emissions, the first to 2050, while figure 17 tabulates a second, very recent, scenario showing the EU can achieve a domestic emissions reduction of 30% from 1990 levels by 2020. Both demonstrate the unambiguous scope there is for emissions reductions within the EU.

The EU’s energy demand continues to grow, 4% overall from 1900-2005, as is clear in figure 15. Although the share of fossil fuels declined slightly, it has grown in absolute terms. The greatest investments in new capacity have been in natural gas (82.2GW, renewables 41.8 and, unfortunately, coal 14.80GW, all in the period 1996-2005\(^{104}\). Public electricity and heat production has increased 6% (1990-2005). Transport is a particular problem area, overall increasing by nearly 20%. Road transportation is the biggest contributor, accounting for the greatest growth. However, although a smaller sector overall, emissions from international bunkers grew by 67% in the same period. Emissions from biomass are also increasing substantially, up 52% since 1990. There has been a decline in emissions from the manufacturing industries (including ferrous and non-ferrous metals, chemicals and pulp/paper/print) and construction sectors since 1990, of about 11%.

\(^{103}\) EU Commission 2007 “Limiting Global Climate Change to 2°C: Policy Options for the EU and the World for 2020 and beyond”. (SEC(2007)7). An earlier, unpublished draft used the, more accurate, word “huge”\(^{104}\)

European Renewables Energy Council 2007 “Renewable Energy Technology Roadmap Up to 2020”
The EU is in the process of passing legislation including on emissions reductions, the EU Emissions Trading Scheme for the post 2012 period, renewables and CO₂ emissions from cars. The EU has done much to integrate its climate and energy policies. Energy efficiency has so far taken a less prominent role, but the Commission is due to publish new proposals later this year. Although emissions have not grown greatly in the buildings sector, there is huge potential in most Member States to achieve real emissions reductions: the Commission is due to propose amendments to the existing legislation in this sector later this year.

Figure 16: EU domestic mitigation potential in the energy sector through to 2050, excluding addition mitigation potentials in non-energy sectors, such as LULUCF and agriculture.¹⁰⁷

¹⁰⁵ http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20041007132150/IAssessment1196270721954/view_content
¹⁰⁶ ibid
Potential for emissions reductions from energy efficiency

The Greenpeace Energy [R]Evolution scenarios, illustrated in figure 16, demonstrates the importance of energy efficiency in the EU reducing its demand for energy over the medium and long term. There is great scope for this in all sectors, with potential for supply side reductions through increasing in energy efficiency of new power production plants and on the demand side through areas including: reduction of standby losses, increased use of efficient motor technologies and increased efficiency of household appliances, efficient lighting and cooling for households. Some temperate EU countries, such as the UK and the Scandinavian countries, are showing an unwarranted dash to installation air conditioning. Throughout Europe, owing to inadequate legislation to control their use, F-gases are used in air-conditioning units, adding to the greenhouse burden already inherent in the high energy use of these units.

WWF’s ‘-30% Policies and Measures’ scenario\(^\text{109}\) demonstrates some of the emissions reduction potentials of the EU. The greatest absolute reductions come from reducing energy demand: the scenario foresees a reduction of 6.5% (2005-2020) with around half coming from the residential sector: this report reinforces the need for rigorous energy efficiency

\(\text{Table 6: Total GHG emissions in WWF’s Policies and Measures scenario by gas and UNFCCC source category}\(^\text{108}\), based on data from the UNFCCC, European Environment Agency and Wuppertal Institute)

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\(^{108}\) Wuppertal Institute for WWF 2008, “Updated Study on: How to Achieve a Domestic 30% GHG emission Reduction Target in the EU by 2020?” in press

\(^{109}\) ibid
measures. Renewables also play a critical role in reducing EU emissions: the current share of 13.5% for electricity production becomes almost 36% by 2020.

There is substantial mitigation potential in residential buildings: starting in 1996, the Netherlands achieved more than 5% per year improvements in energy efficiency resulting from a progressive standard on newly built dwellings. A 2005 WWF report estimated that with further developments in insulation materials, solar water heaters, heat pumps, storage systems and building systems, efficiencies of nearly 7% per year can be achieved in the EU\textsuperscript{110}.

There is massive scope for greater efficiency in new cars, although the EU is in the process of changing a voluntary 120g CO$_2$/km fleet-wide target agreed with the car industry, to a 130g mandatory target. The WWF study found potential for a more-than 5% per year efficiency improvement.

The same report found that manufacturing industry has a potential, through deployment of efficient technologies and methods, of 5% per year. Additional improvements can be met through recycling (especially carbon-intensive products such as steel and aluminum).

The EU’s Emissions Trading Scheme has helped to promote the realization of some of this industrial mitigation potential, although over-allocation of credits in the first phases has meant that changes have not been as rapid or as great as is needed. The WWF ‘30% Policies and Measures’ scenario underscores the importance of emissions reductions in the ETS sectors (energy-intensive industries): nearly 55% of all GHG emissions reductions need to be achieved in these sectors\textsuperscript{111}.

The EU has introduced legislation on energy efficiency in buildings, in energy-using products, on energy labeling, on combined heat and power and on end-use efficiency and energy services\textsuperscript{112}, but has so far not put in place an overall binding target to drive Member States to realize these often no-lose emissions reductions. An indicative target of 20% by 2020 was adopted by European Energy Ministers in 2006.

**Potential for emissions reductions from renewables**
The EU has significant potential in renewables generation, as is clear from figure 17 and table 7, and is making progress in realizing some of it, with the share of primary energy consumption having risen from 4.4% in 1990 to 6.7% in 2005. Wind and solar are being deployed at increasing rates, but biomass has increased by the most in absolute terms, by 80% in that time period for EU-27. The EU has an indicative target to get 12% of its primary energy consumption from renewable sources by 2010, but will need to work hard in the remaining time to achieve it. Earlier this year, the EU Commission proposed legislation to operationalize the agreed target that 20% of overall EU final energy consumption should come from renewables sources by 2020. This metric currently stands at 8.5%.

\textsuperscript{110} WWF 2005 “Powerswitch: The Energy Efficiency Challenge Achieving Higher Energy Efficiency in the EU”

\textsuperscript{111} Wuppertal Institute for WWF 2008, “Updated Study on: How to Achieve a Domestic 30% GHG emission Reduction Target in the EU by 2020?” *in press*

\textsuperscript{112} http://ec.europa.eu/energy/demand/index_en.htm
Figure 17: Growth of RES electricity generation and the projection of RES capacity for electricity generation under the Energy Evolution Scenario, the table’s figures are in MW$^{113}$

![Graph showing growth of RES electricity generation and projection of RES capacity for electricity generation.]

### Final energy from renewable sources indicators

<table>
<thead>
<tr>
<th>Final energy from renewable sources indicators</th>
<th>BAU 2005</th>
<th>BAU 2020</th>
<th>P&amp;M 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of biofuels in transport sector</td>
<td>0.9%</td>
<td>5.7%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Share of biomass in other fuels</td>
<td>9.1%</td>
<td>10.5%</td>
<td>13.4%</td>
</tr>
<tr>
<td>Share of renewables in electricity</td>
<td>14.9%</td>
<td>20.2%</td>
<td>35.9%</td>
</tr>
<tr>
<td>Share of RES in heat from CHP</td>
<td>24.0%</td>
<td>30.5%</td>
<td>45.7%</td>
</tr>
<tr>
<td>Total share of final energy from renewable sources</td>
<td>8.3%</td>
<td>12.5%</td>
<td>23.1%</td>
</tr>
</tbody>
</table>

### RES share in primary energy demand

| RES share in primary energy demand | 6.8% | 10.0% | 18.8% |

### Table 7: The role of renewable energies in the framework of the WWF 30% Policies and Measures Scenario$^{114}$


http://www.greenpeace.org/raw/content/eu-unit/press-centre/reports/energy-revolution-a-sustainable.pdf

114 Wuppertal Institute for WWF 2008, “Updated Study on How to Achieve a Domestic 30% GHG Emission Reduction Target in the EU by 2020?” in press

Final energy from renewable sources indicators

<table>
<thead>
<tr>
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<th>BAU 2005</th>
<th>BAU 2020</th>
<th>P&amp;M 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>by fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>808'982</td>
<td>880'120</td>
<td>614'447</td>
</tr>
<tr>
<td>of which transport fuels</td>
<td>355'335</td>
<td>431'823</td>
<td>304'687</td>
</tr>
<tr>
<td>Biomass</td>
<td>44'585</td>
<td>72'949</td>
<td>73'259</td>
</tr>
<tr>
<td>of which transport fuels</td>
<td>3'206</td>
<td>25'954</td>
<td>33'689</td>
</tr>
<tr>
<td>Waste</td>
<td>n.a.</td>
<td>n.a.</td>
<td>10'149</td>
</tr>
<tr>
<td>Solar thermal and other renewables</td>
<td>1'381</td>
<td>6'064</td>
<td>31'625</td>
</tr>
<tr>
<td>Electricity</td>
<td>237'814</td>
<td>303'129</td>
<td>255'633</td>
</tr>
<tr>
<td>from renewable sources</td>
<td>35'424</td>
<td>61'239</td>
<td>91'749</td>
</tr>
<tr>
<td>Heat (from CHP and District Heating)</td>
<td>62'031</td>
<td>91'566</td>
<td>91'566</td>
</tr>
<tr>
<td>from renewable sources</td>
<td>14'893</td>
<td>27'949</td>
<td>41'868</td>
</tr>
<tr>
<td>Total final energy from renewable sources</td>
<td>96'283</td>
<td>168'201</td>
<td>250'650</td>
</tr>
<tr>
<td>RES share</td>
<td>8.3%</td>
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RES share in primary energy demand

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Table 7: The role of renewable energies in the framework of the WWF 30% Policies and Measures Scenario$^{114}$, sources are Wuppertal Institute 2008, BAU from EU Directorate-General Transport and Energy 2008, P&M is the policies and measures scenario.
Should the EU realize the potential of its renewable resources, it will reap the benefits of the creation of jobs: the Commission itself estimates that 250-300,000 additional jobs could be created inside the EU simply in achieving the aims of its Biomass Action Plan\textsuperscript{115}, with additional job creation potential in other sectors: wind energy already provides employment for 64,000 people in Germany, 35,000 in Spain and 21,000 in Denmark, the three leading countries of the EU on wind\textsuperscript{116}. Greenpeace’s scenario, in figure 18, concurs that moving to renewables will create hundreds of thousands of new jobs.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure18.png}
\caption{job creation in the EU through deployment of renewables technologies\textsuperscript{117}}
\end{figure}

\textit{Wind}

Wind is a fast-growing sector in the EU, and could contribute 12\% of electricity by 2020, with one-third most likely from offshore installations. Offshore wind currently accounts for around 2\% of EU installed wind capacity, but it is expected that between 20 and 40GW will be generated by 2020. Europe has the potential to generate 300GW installed wind power in the EU by 2030, with half from offshore wind\textsuperscript{118}, meeting 23\% of European electricity generation, assuming demand grows at the rate predicted by the EU Commission. With greater ambition for energy efficiency, wind’s share could reach 30\% by 2030. Spain and Germany have had strong growth, but the greatest potentials are in the UK and Ireland.

\textit{Solar}

Solar accounts for only 0.5\% of EU, but is fast-growing, owing to feed-in tariffs in several Member States, notably Germany and Spain. In 2006, Spain passed a law making solar panels compulsory in new and renovated buildings, a precedent that other Mediterranean countries could follow. So far, solar is dominated by solar thermal technologies, but Spain launched a concentrating solar power plant in 2007, and although PV use is currently limited, it is seen as having potential over the mid- to long terms, see figure 3. Figure 5 shows the areas of the EU with the greatest solar potentials: the so-far low deployment of solar technologies in Malta and Cyprus in inexplicable with their outstanding potentials. Europe should continue to actively explore the feasibility of strategic partnerships with North

\textsuperscript{115} EU Commission COM (2005) 628, 7.12.2005
\textsuperscript{118} European Wind Energy Association: http://www.ewea.org/index.php?id=203
African countries with a view to developing large-scale imports of solar electricity (generated from concentrating solar power units located there) in the medium-term.

![Photovoltaic Solar Electricity Potential in European Countries](image)

Figure 19: areas of Europe with the greatest solar potentials

**Biomass**

Biomass and waste is the most widely deployed renewable energy source in the EU, accounting for two thirds of the total of EU renewables capacity. Latvia, Sweden and Finland are particularly strong in utilizing this resource[^119].

**Hydro**

Hydropower capacity increased in the EU in the period 1990-2005, but output has declined owing to lower rainfall. This resource is not expected to add considerably to growth in EU renewables generation, owing to environmental concerns and lack of suitable sites[^120]. Ocean energy is an area yet to be exploited to anywhere close it its full potential. Countries with Atlantic coasts, with the Atlantic’s long fetch in the prevailing winds, have enormous potential for energy generation.

**Geothermal**

Geothermal is another sector with potential for growth. Italy is responsible for the greatest proportion of geothermal energy use (90% of the 4% of geothermal’s contribution to EU renewables), but parts of Austria, Germany, Romania, Bulgaria, Greece, Slovenia and Poland have high potential, which could allow electricity generation. Other parts of Europe have scope to increase their use of geothermal for heating.

[^120]: ibid
Emissions from the Land Use Sector
In 2005, the EU’s agricultural/forestry/ fisheries CO₂ emissions were around 2% that of it energy emissions. However, there is scope to reduce emissions quickly and easily by ending extraction of peat from these carbon-rich ecosystems. Europe deforested years ago, and unlike the US, has not experienced significant regrowth. Rehabilitation of forests can expand Europe’s sink capacity, and help improve its biodiversity. A severe risk for future emissions form European lands is climate change itself: the 2003 heatwave resulted in an estimated 30% reduction in gross primary production, which led to a strong anomalous net source of CO₂ of 0.5Pg C per year, reversing the effect of four years of net ecosystem carbon sequestration 121.

Transport
Transport is the EU’s greatest problem area, with growth of more than 24% in the old and new member states. The EU could help to fulfill the emissions reduction potential in this sector by ensuring that its structural and cohesion funds to the new member states are invested only in sustainable transport infrastructure, namely enhancing the existing public transport infrastructure. The new Member States have an almost unique opportunity to build new, clean infrastructure with the billions of Euros currently flowing to them. The older Member States have a responsibility to limit and reduce their transport emissions by investing in public transport, and ensuring that no new runways are built that would contribute to the 3% of CO₂ emissions that air travel contributes to the EU emissions budget (2004): this figure grossly underestimates the impacts of aviation, however, as it does not include the impacts of NOₓ, contrails or cirrus clouds, which in aggregate are 2-5x greater than of CO₂ alone 122.

***
The countries of the EU, particularly those of western Europe, are wealthy by global standards and have great historical responsibility for the current climate crisis. The EU has a responsibility to reduce its emissions by at least 30% domestically, in order to place it on the path to a sustainable future. Because of its historical responsibility, the EU has an additional responsibility to provide its fair share of funding, technology and capacity building for adaptation and mitigation measures in developing countries.

ICELAND

% of world total CO₂ emissions (excludes LULUCF) (2004) 0.01%
Rank of world polluters (2004) 136th
% GHG emissions change since 1990 - 2005 (excludes LULUCF) +9.3%
Tons CO₂ per person (2004) 7.9
World ranking in per capita emissions (2004) 45th
Total GHG emissions, including LULUCF and bunkers (2005) 6.3 MtCO₂-e
Total GHG emissions, without LULUCF (2005) 4.6 MtCO₂-e
Total CO₂ emissions, including LULUCF and bunkers (2005) 4.6 MtCO₂
GHG emissions from bunkers (2005) 0.4 MtCO₂-e
GHG emissions from LULUCF (2005) 1.8 MtCO₂-e

Source: CAIT (www.caitim.org)

Overview
Iceland is a small and affluent country of approximately 304,000 people, ranking top of the Human Development Index. It is responsible for approximately 0.01% of global emissions, but these have increased by 24% from 1990 to 2006. Iceland gets much of its energy from renewable sources, but still has considerable emissions reduction potential, particularly in the transport, fishing and industrial sectors. By its own reckoning, Iceland is the highest energy-using country per capita, largely as a result of is heavy industries. Fisheries account for 22% of emissions, transport, 20% and industry 36%, although the pernicious Decision 14/CP.7 means that this is an underestimation of Iceland’s real industrial emissions and therefore its contribution to climate change.

Figure 20: Iceland’s GHG emissions by sector, 2005

Renewables potential
Iceland already produces over 70% of its energy from renewables, hydro and geothermal. Almost all energy for stationary use comes from renewables; so much of the remaining potential is in reducing emissions from the transport and fisheries sectors.

![Evolution of Total Primary Energy Supply from 1971 to 2005](image)

Figure 21: Iceland’s primary energy supply by source

Transport sector
The transport sector is a key area where Iceland has significant potential to mitigate further. Iceland’s potential in this sector is considered to be moderate in the short term but significant in the long term. Emissions continue to increase, despite economic incentives for low-emission cars and the potential for mass transit in such a geographically centralized population.

Although 70% of the population lives in Reykjavik, public transport is only used in 4% of trips. Despite this high concentration of population, private cars make up 76% of all trips, with walking and cycling accounting for the remaining 19%. Around a third of trips are less than 1km long\textsuperscript{125}. Using its hydropower for public and private electric vehicles has potential to significantly reduce emissions from road transport: the hydroelectric dams have over capacity at night, the ideal time for recharging vehicles.

\textsuperscript{124}http://www.iea.org/textbase/stats/pdf_graphs/ISTPES.pdf

\textsuperscript{125}http://landbunadur.rala.is/landbunadur/wglgr.nsf/Attachment/Global_Forum_S305_Anna_Maria/Sfile/Global_Forum_S305_Anna_Maria.pdf
Fishing sector
Fishing is highly important to the Icelandic economy, accounting for 70% of export earnings and 6% of employment\textsuperscript{126}. However, it is also a significant emissions source. Fishmeal processing releases 122Gg CO\textsubscript{2} (2004) which could be reduced to zero if renewable energy sources were used. There is also potential for improving the energy management of ships through practical and informational technologies. The Icelandic government needs to show leadership in overcoming resistance of the industry to changing the types of fishing gear used.

Industrial sectors
Iceland is host to a certain amount of heavy industry, including aluminum and steel plants, drawn in part by Iceland’s cheap and reliable energy resources. Use of renewable energy helps to reduce the emissions from energy use in metal purification compared to many other countries; however, a large proportion of emissions from both steel and aluminum manufacture come from the use of carbon as a cheap, readily available redox agent\textsuperscript{127}. However, transportation of the source ores is an unaccounted-for emissions source – and bauxite can be brought to Iceland from as far away as Australia, a 20,000km trip. Emissions from the production of the ores themselves are also unaccounted for: bauxite mining in some areas is a driver for tropical deforestation, while also acidifying ground water.

Despite the high emissions, the aluminum industry has plans to increase the smelter capacity in Iceland by around 600,000 tons in two new smelters (1 tonne of Al gives rise to 1.5 tonnes of CO\textsubscript{2}), in addition to increasing capacity in existing plants. In addition to the CO\textsubscript{2} emissions, PFC emissions are another contribution to dangerous climate change by the industry.

Iceland exploits the terms of Decision 14/CP.7, which excludes accounting of CO\textsubscript{2} emissions from single projects, up to a limit of 1.6 million tons CO\textsubscript{2} per year on average in the first commitment period. This pernicious decision reduces the environmental integrity of the Kyoto framework and dilutes the already-weak Kyoto target of Iceland.

Land Use Sector
Iceland has suffered significant deforestation over its long history and large areas of barren land remain. In 872AD, birch woodlands covered 27% of the land; this has been reduced to 1.2% coverage as of 1990\textsuperscript{128}. Rehabilitation of these ecosystems has significant sequestration potential. Wetlands have also suffered extensive drainage; conservation and restoration could additionally help to reduce Iceland’s emissions. Agriculture is practiced on 0.07% of the land area, but contributes a high 13% of the islands’ emissions\textsuperscript{129}.

\begin{itemize}
\item[\textsuperscript{126}] https://www.cia.gov/library/publications/the-world-factbook/geos/ic.html
\item[\textsuperscript{127}] As Alcoa itself points out, it takes 95% less energy to make a can out of recycled aluminum and produces 95% fewer GHGs emissions. http://www.alcoa.com/alcoa_recycling/en/home.asp These savings are from lower energy requirements: not needing to melt and electrolyze bauxite, and from not reducing the naturally-occurring aluminum oxide using carbon anodes.
\item[\textsuperscript{128}] KS Gunnarsson, T Eysteinsson, SL Curl, T Thorfinnsson, 2005
\item[\textsuperscript{129}] https://www.cia.gov/library/publications/the-world-factbook/geos/ic.html
\end{itemize}
Overview
Japan’s GHG emissions in fiscal year 2006 amounted to 1.34 billion tons (CO₂ equivalent), representing a 6.2% increase compared to the base year, and a 12.2% gap compared to the target reduction of 6%. Carbon dioxide (CO₂) emissions account for about 90% of the total GHG emissions, and CO₂ emissions have increased by 11.3% since 1990 (Figure 22).

Figure 22. Trends in Japan’s GHG emissions

Sector-by-sector, one notices a remarkable increase in CO$_2$ emissions since 1990 in the transport, commercial and residential sectors, calculated using emissions from the power generation sector (energy conversion sector) allocated to the final consumption sectors (transport sector showing a 16.7% increase, residential sector a 30.0% increase, and commercial sector a 39.5% increase), but the industrial sector (manufacturing) continues to account for a large part of emissions (a 4.6% reduction since 1990, but this sector accounts for 36% of total emissions).

The emissions from the power generation sector (energy conversion sector) are the largest, and the most noticeable increase is also in power generation (Figure 23). More than half the increase in Japan’s emissions from 1990 to 2006 was from power plants. The reasons for this increase are an increase in electricity consumption in the commercial and residential sectors, as well as a deterioration in emission factors in the electricity sector. The reason behind this major increase in emission factors is the dramatic increase in emissions from coal-fired power plants. The increase in these emissions since fiscal 1990 is greater than the increase in emissions from Japan overall.

Potential for emissions reductions from Energy Efficiency

Electricity generation

- Commercial power plants
  
  * 30% of Japan’s CO$_2$ emissions are from fired plants and it increased by 90MtC from 1990 to 2006. Government estimates that electricity consumption will increase 10% from 2006 level, up to 1005 TWh, but it reflects less energy efficiency of industry sector (final energy consumption is only 1.5% reduction from 1990 level). When energy efficiency of the industry sector, electricity consumption could stabilize at 2006 level, 20% increase from 1990 level.
  
  * The average efficiency of fire-power plants in fiscal 2006 is 40%, whereas “top-runner” power plants are 53%. When switching to efficient facility and improve efficiency, CO$_2$ emissions factor could be improved 25%.
  
  * Fuel switching from oil/coal to gas, the CO$_2$ emissions factor could be improved by 28%.

131 Prepared from GHG emissions inventory by Japan’s National Institute for Environmental Studies
132 METI, Long term energy demand and supply outlook (2008)
134 Agency for natural resources and energy, Energy Balance Sheet
* Currently renewables accounts for 10% including large hydro. Increasing to 20% mainly from wind and biomass utilization would mean that the emissions factor could be improved by 20%.
* In total (demand control, energy efficiency in power plants, fuel-switch, renewables), CO₂ emissions could be halved from 1990 levels, and total emissions could be reduced 40%, which accounts for 12% of Japan’s emissions.

- **On-site electricity generation**
  * Efficiency to power generation is 43%, which is 10% lower than the most efficient commercial power generation. Through a 10% improvement of efficiency in the next 12 years, CO₂ emissions factor could be improved by 19%.
  * By fuel switching from oil/coal to gas, the emissions factor could be improved 25%.
  * In total, 40% reduction from on-site electricity generation can be met, which accounts for 2% of Japan’s total CO₂ emissions.

- **Industry steam**
  * Fuel switch from oil/coal to gas, CO₂ emissions factor of industry steam could be improved 30% from 2006 level, which accounts for 1.2% of Japan’s total CO₂ emissions.

**(B) Industry Sector**
- **Steel**
  * Detailed data from steel sector are not available to the public, but the sector agreed that energy efficiency varies between facilities and the gap would be up to 30%. If energy efficiency is improved by 10% and CO₂ emissions factor is improved 5% by fuel-switching, 15% reduction is possible in total, which accounts for 2% reduction from Japan’s total CO₂ emissions.

- **Cement**
  * While Japan’s cement industry is the most efficient in the world, the most commonly used energy source is coal. And production will be decline. Energy efficiency can be improved when all facilities will be switched to top-runner facilities. A 35% reduction from fuel switching can be met. A 50% reduction in total is possible, which accounts for 1% of total CO₂ emissions.

- **Chemical**
  * 10% reduction from fuel switching is possible, which accounts for 0.4% of Japan’s total CO₂ emissions.

- **Others**
  * Other sectors such as food, fiber, etc. consume coal and oil as energy. Fuel switching in these sectors could reduce 30% energy-related CO₂, which accounts for 1.6% of Japan’s CO₂ emissions.

**(C) Transport**
- **Passenger**
Passenger transportation is estimated to be increasing. But CO$_2$ emissions factor improved one third, as well as 25% vehicle becomes hybrid car$^{135}$, emissions factor will improve by half, which could result in 20% reduction from 1990 level.

- **Freight**
  Freight transportation will stabilize at 1990 levels$^{136}$. Truck efficiency will be improved 10% by energy standards and joint transportation will reduce 10% transportation length. That results in 20% emissions reduction from the 1990 level.

(C) **Commercial/ Household**
A 30% reduction from 1990 levels in both sectors is possible, by switching efficient appliances, improving insulator of housing/buildings, and others$^{137}$.

(D) **HFC/PFC/SF6**
Switching not-in-kind technology and limiting use of F-gases only to where it is essential, as well as severe control of the gases, an 85% reduction from 1995 levels is possible (Japan’s F-gases base year), which accounts for a 3.6% reduction of Japan’s total GHG emissions.

(E) **CH4, N2O**
CH$_4$ and N$_2$O emissions have reduced by 1.4% in 2006 from 1990. If this trend continues, a 5% reduction of total GHG emissions can be met.

**By aggregating (A) to (E) reductions, it is clear that Japan’s reduction potential will be more than 30% in 2020.**

**Renewables potential**
20% share of primary energy in 2020
Mainly through electricity mentioned above.

**Emissions from the Land Use Sector**
* 70% of Japan’s land is covered by forest and the majority of them are human-planted trees. As those trees are still growing, there is the potential for further removals from forest management. The 1st commitment period sinks potential is estimated to be about 7%. It is assumed that removal potential of consecutive periods may be about the same as 1st CP or less. There are not specific problem of deforestation.

**Potential external emissions reductions through REDD, technology and finance**
* Japan is obligated to support developing countries mitigation activities through technology and finance. Japan is a wealthy nation and ranks 8th on the Human Development Index, and having industrialized has historic responsibility for climate change. If emissions reductions from actions in developing countries are counted, Japan’s emission reduction potential will be more than 30% accordingly.

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$^{135}$ Ministry of Environment estimation
$^{136}$ METI, Long term energy demand and supply outlook (2008)
$^{137}$ Kiko Network
NEW ZEALAND

<table>
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<tr>
<th>% of world total CO₂ emissions (excludes LULUCF) (2004)</th>
<th>0.11%</th>
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<td>GHG emissions from LULUCF (2005)</td>
<td>-24.5 MtCO₂-e</td>
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Source: CAIT (www.cait.wri.org), all figures from 2005

Overview

New Zealand is a small country with an unusual emission profile: almost half of emissions are CH₄ and N₂O from the agricultural sector.

This is a consequence of:

- Very small domestic markets
- An economy based on agriculture, forestry, tourism and fisheries
- A relatively high (although reducing) proportion of hydro and renewables in the stationary energy sector
- A major shift in the relative economic value of dairying versus planted production forest

Despite a Kyoto target of stabilizing GHG emissions at 1990 levels, emissions are rising rapidly and are at 26% above the Kyoto target, an increase worse even than the US has achieved. Per capita emissions of around 18tCO₂eq place New Zealand at the high end of the scale, almost twice that of the UK, and only a little smaller than profligate Australia and the US.

The greatest growth is CO₂ in energy use, primarily transport and electricity generation. Overall CO₂ emissions are up 38% on 1990 levels.

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139 Greenpeace 2007 “New Zealand Energy Revolution: How to prevent Climate Chaos”
Half of emissions are from the agricultural sector, which are being included in New Zealand’s ETS, but a growing dairy herd means that without the needed intervention emissions are expected to rise to an 70% above 1990 levels.

Despite these large increases, New Zealand has the potential to do a 72% domestic CO₂ reduction by 2050. [CO₂ or CO₂ equiv?] A -30% target (1990 base year) is achievable if New Zealand implements an effective moratorium on building new fossil power (without exemption), retires carbon-intensive energy infrastructure and replaces it with renewables, invests in research to reduce agricultural emissions through sustainable practices, implements a moratorium on the expansion of the dairy industry, and offers a price incentive for a transition to sustainable, low input farming.

Ending the $100 million subsidies that New Zealand has earmarked for gas exploration would also contribute. The graph demonstrates that New Zealand still relies heavily on fossil fuels for energy production, despite well-developed renewables and hydro capacity [confusing energy use for transport with stationary energy – should differentiate]. Peaking fossil energy use in 2015 would contribute greatly to a -30% goal, with additional emissions achievable internationally through REDD, technology transfer and the use of other mechanisms.

Evolution of Total Primary Energy Supply* from 1971 to 2005

New Zealand


140 ibid
141 this is split between:
* funding seismic exploration to increase understanding of New Zealand’s petroleum basins (~$15mn);
* active marketing of New Zealand as an exploration destination, including facilitation of exploration activities (~ $5 million);
* temporary adjustments to the petroleum royalty regime (up to around $80 million).

142 WWF “Submission on Transitional Measures and Submission on Post 2012 measures”
The emissions trading scheme is a new policy tool to help reduce emissions using the flexibility of markets. It includes forest carbon and creates liabilities for landowners that deforest. By 2013 it should include all sectors and gases, including agricultural non-CO2 gases. However, it does not impose a cap that would lead to the certainty that emissions reductions were being achieved; rather it leaves open the option that polluters can simply pay to pollute.

Emissions from transport are a problem, with road transport a notable issue, having increased by 61% since 1990. Civil aviation is also a growth industry increasing emissions by 31% in the same timeframe. Significant potential for reduced emissions can come from modal shift, particularly by shifting transport in the largest city Auckland from private car to public transport and walking and by shifting freight from road to rail and coastal shipping. Government buy back of failing rail services and electrification of the Auckland rail system will help.

Industrial fishing in New Zealand is particularly emissions intensive (1 tonne of fuel for 1 tonne of fish). Measures to improve sustainability of fishing are likely to reduce emissions from the fishing.

Energy Efficiency
New Zealand can realize substantial emissions reductions from the industrial, transport, buildings and appliances sectors. Building codes do not reflect the full potential for efficiency in buildings, and there is a need to put in place programs to support retro-fitting of homes with adequate insulation. The government’s modeling of emissions reduction opportunities in all energy sectors neglects the opportunities in electricity demand reduction possible through more efficient appliances and other demand side management measures. Significant public investment is needed to facilitate energy efficiency and conservation measures.

Renewables potential
New Zealand already generates 67% of its electricity from renewable sources, and has a great potential to increase this further. The government has set itself a 90% renewable electricity target to be reached by 2025, reachable through energy efficiency and new renewable generation; however, there is certainly scope to go beyond this, to 100% renewables by

\[\text{New Zealand report to the UNFCCC 2005}\]

http://www.med.govt.nz/upload/52338/fig7-large.jpg
The country is well-endowed with wind, hydro, biomass, geothermal, solar, wave and tidal energy resources, and has experience in using them.

**Geothermal**

6.5% of New Zealand’s electricity comes from geothermal power, and there is considerable scope for this to be increased, particularly to provide reliable supply.

**Wind**

Perhaps the greatest scope for growth in renewables capacity in wind, although biomass has potential to substantially expand its contribution to the energy mix. Lying across the prevailing westerly winds, the ‘Roaring Forties’, New Zealand has one of the best wind resources of any country. At present 321MW has been installed with another 164.6MW under construction. 1914MW’s worth of projects are seeking or have been granted resource consent.

**Solar**

New Zealand currently produces more than 40GWh equivalent of electricity consumption per year through solar water heating. The government has a proposed target of increasing deployment of solar water heaters from 15,000 to 20,000 by 2010, but lacks a policy for after this time. Photovoltaics do not currently contribute significantly to New Zealand’s energy mix.

**Hydro**

There is some potential for new micro-hydro and improving the output of existing hydroelectric plant. However, new large-scale hydro is limited by the considerable environmental impacts it would cause.

**Emissions from the Land Use Sector**

Agricultural emissions are a significant problem from New Zealand, with enteric fermentation the country’s single biggest source of emissions. This is exacerbated by nitrous oxide emissions (which now exceed those from transport) and competition for land between forestry and agriculture.

Government figures, using the IPCC LULUCF inventory guidelines that its LULUCF sector is a net sink, accounting for removal of 29% to the country’s total emissions – this includes all emissions and removals by all forests (planted and natural over all years, not the same as Kyoto’s ‘sinks since 1990’).

**Deforestation**

Deforestation in New Zealand is unusual in that it is primarily the removal of planted production forest to convert land for agricultural production (primarily dairying). This is the result of high dairy prices, low log prices and the solving of nutrient deficiency problems in the central North Island that is enabling previously forested land to be used for agriculture.

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145 Greenpeace 2007 “New Zealand Energy Revolution: How to prevent Climate Chaos”
146 New Zealand Wind Energy Association http://www.windenergy.org.nz/
147 WWF “Submission on the New Zealand Energy Efficiency and Conservation Strategy”
There is very little deforestation of old growth forests as most natural forest is in public ownership; there is no native forest logging on public land; and most privately owned natural forest has restrictions on logging.

**Dairy expansion**

New Zealand’s agricultural emissions have already increased by 15 per cent since 1990. The dairy sector is responsible for this entire increase. There has been a 58 per cent rise in dairy cow numbers from 3.39 million to 5.28 million over the period 148.

Government figures project that the number of dairy cows in New Zealand will increase dramatically, by up to a further 21 per cent by 2010, to 6.4 million dairy cows. 149

According to the Ministry of Agriculture and Forestry (MAF) some 455,000 hectares of forestry land is at risk of being deforested and converted into pastoral use – the majority for dairying. 150 This is equivalent to 910,000 rugby fields or over seven times the size of Lake Taupo.

The national forestry plantation estate is currently 1.8 million hectares. This means that over 25 per cent of the nation’s plantation is at risk of being deforested to convert into mainly industrial dairy farming, without Government intervention.

Dairy conversion of forestry land functions as a ‘double whammy’ on the climate, as it destroys forests and replaces them with dairy farming which is one of the most greenhouse gas intensive forms of land use.

The agricultural sector is exempt from taking real action to reduce its greenhouse gas emissions until 2013, as it is not until this time that the sector comes into the Emissions Trading Scheme (ETS). Currently nothing is being done to prevent the rapid expansion and industrialisation of the dairy industry.

Even when it is brought into the ETS, the sector will be subsidised by the taxpayer to the tune of 90 per cent of its emissions (due to the amount of free permit allocations given to it by the government).

Chemical nitrogen fertiliser use in NZ has increased 617% since 1990 - mainly in the form of Urea. Since 1990 nitrous oxide emissions have increased by 27% and now account for 16% of all NZ greenhouse gas emissions – more than total road transport emissions.

Using the chemical fertiliser short cut to achieve short bursts of pasture growth is also allowing farmers to maintain and increase high stocking numbers per hectare which has a direct impact on soil structure through compaction.

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48
Allowing high numbers of stock to graze on degraded high fertilized soils produces much greater quantities of greenhouse gas emissions, and also damages soil, animal and pasture growth. Herds are also more prone to rumen digestion problems and a host of other animal health/veterinary issues. Rumen digestion problems are directly linked to increased methane production from the rumen.

**UN report slams intensification; backs more traditional farming methods**

Touted as to agriculture what the Intergovernmental Panel on Climate Change’s reports are to climate, a five year scientific assessment of global agriculture was recently undertaken by multiple stakeholders including the UN and released in April this year. ([http://www.agassessment.org/](http://www.agassessment.org/))

The report’s findings slam intensive, high input based approaches to food production and find that traditional, holistic farming practices increase productivity and benefit communities.

**Solutions**

So what can be done? Well the good news is there are solutions that are not only better for the climate and the environment, but also good for farmers’ bottom lines.

Ironically, smart farming is about reverting back to more traditional farming practices. It’s about less input, and better output. It’s about cutting down on chemicals, cutting back on herd numbers and looking after soil so that pasture thrives and lasts. Generations of farmers have successfully used this method in New Zealand - they knew how to work with the land and doing so is how they survived. In a way it’s time to go back to basics.

Bio-logical farming takes advantage of natural processes, which promote good soil, healthy crops, and healthy animals. These natural processes include: best tillage methods; proper livestock manure use; promoting soil life; reducing compaction from overstocking of livestock; using rotational grazing to maintain pasture root health through leaving residual pasture cover, and balancing the soil's minerals through the use of soil conditioners. Essentially it’s using natural systems to improve soil structure and pasture quality and to control weeds, pests and diseases.

To some degree, bio-logical farming involves farming the soil, rather than the pasture or herd. It encourages beneficial organisms in the soil. These organisms make the soil alive and fertile, which also feeds pasture forages. As one New Zealand bio-logical dairy farmer recently told the media: “If you look after the stock below the ground, they’ll look after the stock above the ground”.

Sounds too good to be true. Does it actually work? Yes. Lower stocking per hectare has indeed been shown to increase milk and meat production from each animal. As well, lower costs for inputs such as fertilizers and the resulting reduction of expensive animal health problems allows farms to become more profitable and sustainable.

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NORWAY

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<td>GHG emissions from LULUCF (2005)</td>
<td>-27.2 MtCO₂-e</td>
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Source for all figures in table: CAIT (www.cait.wri.org)

Overview

The main reason for Norway’s high per capita emissions is the offshore oil and gas production, which accounts for 29% of all Norwegian GHG emissions (2007). Oil and gas production has increased sharply since 1990, and over the last few years there has also been a slight increase in the industry’s carbon intensity. As a result of this, GHG emissions from Norwegian oil and gas production have almost doubled from 1990 to 2007. The oil and gas industry constitutes Norway’s main challenge on the path to a low-carbon economy. Emissions from other industries have decreased over the last decade, but land-based industry still accounts for about 1/3 of total GHG emissions. There is a big potential to reduce these emissions through, among other things, energy efficiency and fossil fuel phase-out.

Apart from the oil and gas industry, transportation is the most important and fastest growing source of GHG emissions. Road traffic generates 19% of total emissions (2007), while domestic marine transport and aviation accounts for around 9%. Current infrastructure investment continues to favor road and air transport, instead of contributing to a shift towards railroad and public transport.

Hydropower accounts for more than 99% of Norwegian electricity production. Although electricity consumption is extremely high, there are therefore practically no GHG emissions from the power sector. For heating purposes, oil and to a limited extent natural gas is used, generating around 8% of total GHG emissions.

152 Source for all the following figures is Statistics Norway (SSB). For a full and updated overview of Norway’s GHG emissions, please visit http://www.ssb.no/english/subjects/01/04/10/klimagassn_en/
Potential for emissions reductions

The government-appointed Commission on Low Emissions concluded in 2006 that Norway has a big potential for reducing its GHG emissions. The commission identified 15 distinct measures that would reduce the Norwegian emissions by 16% on 1990 levels in 2020, and by 62% on 1990 levels in 2050. The cost of these 15 measures on the economy as a whole was generally to small to measure, and in some calculations even negative. Combining these 15 “no-cost” measures with other actions to reduce emissions from oil production, industry and transport would make it possible for Norway to reduce its domestic emissions by more than 30% in 2020, on 1990 levels.

- Potential in the oil and gas sector: There is a big potential for emissions reductions in the Norwegian oil and gas industry. If the oil industry’s access to new offshore areas is restricted, the production and its corresponding energy use and GHG emissions will gradually decline. This potential for long-term reduction of Norway’s emissions is left untapped by the current government, which has been awarding more licenses for new oil and gas activity than any previous government in Norwegian history. In addition to an overall reduction of production volume, massive amounts of GHGs can be kept out of the atmosphere if current offshore power-generation is replaced with emissions-free power from the Norwegian mainland. Studies suggest that bringing renewable electricity to offshore oil and gas installations could reduce Norwegian GHG emissions by somewhere between 6 and 12% on 1990 levels by 2020.5

- Potential in the transport sector: The Norwegian Pollution Control Authority (SFT) has estimated that a reduction of 4.6 Mt CO2e from the transport sector is possible within 2020.55 The estimate includes a range of measures, from increased fuel taxes to improved public transport and incentives for more efficient road vehicles. In the long run, Norway’s transport-related emissions could be brought down significantly.

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55 Norwegian Pollution Control Authority, http://www.sft.no/publikasjoner/2254/ta2254.pdf
through shifting investment from road to rail and other forms of public transport, as well as phasing in zero-emission road vehicles.

- **Potential in the industrial sector:** The Norwegian Commission on Low Emission and the Norwegian Pollution Control Authority has identified several measures that would reduce emissions from Norwegian industry. These measures could reduce Norwegian GHG emissions by 4% in 2020 and 10% in 2050, compared to 1990 emission levels.

- **Potential in the buildings sector:** Some positive steps have been taken to introduce regulations that will improve overall energy efficiency in buildings. But the potential is still big, and the government should move further in this direction. The Commission on Low Emissions calculates that by 2020, reducing the heating needs in commercial buildings and private households could reduce emissions by 1 Mt CO2. Switching from fossil to renewable heating could bring emissions down by another 2 Mt, bringing the total reductions in the buildings sector up to 6% on 1990 levels.

### Renewable energy and energy efficiency

The most important effect of increased energy efficiency in the buildings sector will most likely not be a direct reduction of GHG emissions, but a substantial reduction in electricity consumption. Studies indicate that by 2020, the total Norwegian electricity consumption could be reduced by more than 10%. The electricity made available through energy efficiency measures could replace fossil fuels in other sectors, or be exported to neighboring countries.

Norway is in most years a net exporter of electricity. There is a significant potential to increase the export of renewable electricity through domestic energy savings measures and development of new renewable production. New technologies such as offshore wind power, in combination with existing renewable energy technologies, represents an almost unlimited potential for renewable energy production along the Norwegian coastline. There is an urgent need for improved support schemes to facilitate this development.

### Potential external emissions reductions through REDD, technology and finance

In addition to domestic emissions reductions, Norway has a big potential – as well as a heavy moral obligation – to contribute financially to emissions reductions internationally. Revenues from oil and gas production has made Norway one of the world’s wealthiest nations, with a Sovereign Wealth Fund of almost US$ 400 billion.

If Norway were to use only around 20% of the annual growth of its oil revenue fund for climate change mitigation, it would be sufficient to reduce global emissions from deforestation to zero (using Stern Review estimates on costs of reducing deforestation). While the recent pledge by the Norwegian government to spend more than US$500 million a year on early action projects to reduce deforestation is laudable, Norway could easily do a lot more to contribute to external emissions reductions.

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158 The Stern Review and IIED estimates the cost of halving the world’s deforested area to be around US$ 5 billion a year. Based on this estimate, zero emissions from deforestation could cost around US$ 10 billion – less than 20% of the annual growth of the Norwegian Government Pension Fund.
RUSSIAN FEDERATION

% of world total CO₂ emissions (excludes LULUCF) (2004) 5.30%
Rank of world polluters (2004) 4th
% GHG emissions change since 1990 - 2005 (excludes LULUCF) -28.7%
Tons CO₂ per person (2004) 11.0
World ranking in per capita emissions (2004) 24th
Total GHG emissions, including LULUCF and bunkers (2005) 2,309.6 MtCO₂-e
Total GHG emissions, without LULUCF (2005)
Total CO₂ emissions, including LULUCF and bunkers (2005) 1,917.5 MtCO₂
GHG emissions from bunkers (2005) 18.7 MtCO₂-e
GHG emissions from LULUCF (2005) 156.6 MtCO₂-e

Source: CAIT (www.cait.wri.org)

Figure 27: changes in Russia’s primary energy supply 1990-2005

Overview
Russia is a large, high latitude country with a dispersed population. It has undergone significant changes in its economy since 1990, but despite significant improvements in

159 http://www.iea.org/textbase/stats/pdf_graphs/RUTPES.pdf
efficiency, there is still a massive potential for emissions reductions, partially through remaining efficiency potential and partially through moving away from fossil fuels.

Gas production and transportation is Russia’s biggest source of energy consumption accounting for 36.7Mtoe in 2005. Production of ferrous metals is also a significant source, accounting for 36.1Mtoe. Pulp and paper (6.9Mtoe) production is also a significant source of emissions. Other major energy-using sectors include: cement (5.72Mtoe); small industries including textiles, leather footwear, meat products, sugar and bread (4.1Mtoe). Road transport (48Mtoe) is a fast growing sector, having grown by more than 80% since 1990. As it grows, so use of public transport declines. Aviation is also a fast growing sector. Transport as a whole is responsible for 25% of final energy consumption and 15% primary energy consumption. These figures are for 2005, but there is evidence that emissions from industry in 2006 were rather higher.

By ignoring the fall out from its CO₂ emissions, Russia wastes more than US$10billion in direct economic benefits and the associated NOₓ and SOₓ emissions from fossil fuel use have adverse impacts on the health of the population: 15-17% of mortality cases in towns in Russia might be due to air pollution.

Gas flaring remains a great inefficiency in the Russian production of oil and gas – and a lost opportunity as Russian gas production declines. The IEA estimates that Russia flares as much as 60bcm per year, or nearly twice the volume of gas it sold to Germany.

**Potential for emissions reductions from energy efficiency**

Russia has a huge potential for energy efficiency. Despite having reduced the energy intensity per unit GDP by an impressive 24%, and electricity intensity by 21%, in 2000-2006, Russia remains one of the least energy efficient countries in the world, with GDP energy intensity over twice the global average and that of the US, and three times that of the EU-15 and Japan. One assessment demonstrates that Russian energy efficiency potential amounts to 42% of primary energy consumption in 2005, or 276 Mtoe (289 Mtoe if gas flaring is eliminated): this is roughly equal to the annual primary energy consumption in France, the UK or Ukraine, or half that of Japan, accounting for around 2% of global primary energy consumption. Another assessment calculates that Russia has the potential to reduce its CO₂ emissions by 793Mt per year, about 50% of its 2005 emissions by reducing its energy intensity.

Russia’s primary energy consumption is expected to increase by no more than 60-140Mtoe in the period 2006-2020, so utilizing this efficiency potential, could lead to continued growth and substantial further reductions in emissions over this period. And that’s before Russia’s renewables potential is considered.

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The energy efficiency potential in the electricity generation sector has been estimated to be 43.4 Mtoe, or 22% of 2005 consumption. In manufacturing, the potential is estimated to be 41.5 Mtoe, reaching 96.4 Mtoe if indirect energy savings from energy production and transformation sectors is included. This is greater than overall annual primary energy consumption in Poland, the Netherlands or Turkey\textsuperscript{166}. There are technologies available that would reduce Russia’s emissions from its ferrous metals production, and over 20 potential technologies to improve pulp-making energy efficiency. The mitigation in the transport sector has been assessed to be 37.9 Mtoe, or 38% of 2005 use.

The residential, public and commercial buildings sector is responsible for 144.5 Mtoe of final energy use (34%) and for 360 Mtoe primary energy – it has been assessed as having a mitigation potential of 688.6 Mtoe (see figure 3). This sector has the greatest potential to improve energy efficiency in Russia, but will require a multi-pronged approach and strong government commitment to realize.

\textsuperscript{165} Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database

\textsuperscript{166} Bashmakov, I, K Borisov, M Dzedzichek, I Gritsevich and A Lunin 2007, “Resource of Energy Efficiency in Russia: Scale, Costs and Benefits”, Center for Energy Efficiency
Renewables potential
While Russia’s greatest short- and medium term emissions reduction lies in efficiency, the country has real potential to increase the share of certain renewable energies, such as biomass, while some areas of the country have great potential for increasing the use of wind energy. The renewables share of total primary energy supply in 2005 was 646,680 ktoe.
## SWITZERLAND

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<td>World ranking in per capita emissions (2004)</td>
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<td>Total GHG emissions, including LULUCF and bunkers (2005)</td>
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<td>Total CO(_2) emissions, including LULUCF and bunkers (2005)</td>
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<td>GHG emissions from bunkers (2005)</td>
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<tr>
<td>GHG emissions from LULUCF (2005)</td>
<td>-0.2 MtCO(_2)-e</td>
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</tbody>
</table>

Source: CAIT (www.cait.wri.org)

### Overview

Switzerland’s main sources of GHG are the transport and building sectors. Electricity production is based on hydro power (almost 60%) and nuclear power (almost 40%). Heavy industry left Switzerland long ago, leaving cement production as the major industrial polluter.

Modest building quality, cold climate, and a very high share of oil heating systems are responsible for high CO\(_2\) emissions per m\(^2\) heated space. Due to the high GDP per capita there are also more than 44 m\(^2\) of heated space per person.

Although Switzerland is proud owner of an excellent public transport system, car ownership, car usage and especially car power are amongst the highest worldwide. The specific fuel use of the Swiss fleet is the highest in Europe together with Sweden. Further, aviation contributes heavily to the Swiss global warming potential.

LULUCF emissions are a minor issue since forest area and stock tends to grow additionally triggered by climate warming in the Alps.

Net GHG emissions abroad for Swiss consumption are estimated to be between 40 and 60 million tons CO\(_2\)-eq per year. This is the same magnitude as the domestic emissions. Therefore, the challenge will include the reduction of trade related emissions.
**Potential for emissions reductions from Energy Efficiency**

Investigations\(^{169}\) show that the huge cost-effective efficiency potentials that are shown by IPCC or the cost curves of McKinsey can be confirmed for Switzerland. The efficiency of the building envelopes can be doubled. If new cars emit from 2012 less than 120 grams CO\(_2\) per kilometer (discussed EU target) this would reduce road traffic related emissions by 30% through 2020.

While forthcoming building codes for new buildings are designed to trap this potential, policies to improve the existing building stock is weak or inexistent. The same applies for cars where no relevant measures have been implemented so far.

There is an official strategic goal of the government to reduce per capita primary energy consumption from more than 5000 to 2000 Watts. Investigations by the Swiss Federal Institute of Technology have shown that such a goal is achievable with existing technology without hampering our living standard. However, so far energy consumption has only stabilized.

**Renewables potential**

From the IEA figure below one can see that Switzerland relies heavily on oil and the share of renewable stays below 20%. While the capacity of hydro power is already used today there remain huge potentials of solar, geothermal, biomass, and wind (order shows relevance).

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\(^{168}\) http://www.iea.org/textbase/stats/pdf_graphs/CHTPES.pdf


Alliance for a responsible climate policy http://www.wwf.ch/de/index.cfm?uNewsID=913

Swiss CO2 Cost Curve by McKinsey (forthcoming)

Infras/WWF, Options for combining economic prosperity and strong mitigation goals (forthcoming)
There exist governmental scenarios that show how the renewable share in electricity production can be raised from 60% to 100% by 2035\textsuperscript{170}. Such a scenario does assume that efficiency increases have to be realized by relying on best practice strategies for new appliances, motors and electronics.

For transport, heating, and cooling relevant increases in the share of renewable can be realized by domestic sources. However, this has to go along with significant increases in the efficiency of cars, buildings and processes\textsuperscript{171}, and a switch from car and truck traffic to public and human-powered transport.

The government decided in February 2008 to increase the relative share of renewables by 50% through 2020. Since much of this increase will be achieved by reducing total energy consumption and the already agreed feed-in tariff law for electricity, more ambitious goals would be easily achievable.

**Emissions from the Land Use Sector**
Growing forest size and forest stock results in a net sink unless major storms destroy forests. In future, wood for construction, paper, and energy may reduce the potential of the forest as a net sink. Emission reductions in agriculture are possible but minor. Switzerland imports almost half of its food and fodder needs.

**Potential external emission reductions through REDD, technology and finance**
Due to Switzerland’s wealth, its historical responsibility, its export oriented technology industry and its responsibility of around 40 to 60 million tones of trade related CO\textsubscript{2}-e there is a lively debate on external emission reductions. Some proposals include the idea of becoming climate neutral by 2030. However, this would actually mean that trade related emissions abroad are reduced to zero and domestic emissions remain.

However, Switzerland’s great wealth and its historical responsibility mean that it has the ability, and the obligation, to contribute substantial financial and technological resources to reducing emissions in developing countries.

**Popular initiative on post 2012-goals**
A coalition of organizations from faith, policy, development, unions, and environment request in a popular initiative that the constitution is amended by the goal to reduce domestic greenhouse gas emissions by 30% from 1990 through 2020. The necessary signatures (100’000) were easily collected in a short period of time. The public vote is expected for 2010 unless the parliament decides on a law with comparable targets.

A domestic reduction target of 30% can be achieved by efficiency improvement and increasing use of renewable at no extra costs to the economy at large.

\textsuperscript{171} See Road Map for renewable energies in Switzerland, http://www.satw.ch/aktuell/roadmap_EN
**TURKEY**

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<th>% of world total CO₂ emissions (excludes LULUCF) (2004)</th>
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<tr>
<td>GHG emissions from LULUCF (2005)</td>
<td>No data</td>
</tr>
</tbody>
</table>

Source: CAIT (www.cait.wri.org)

**Overview**

Turkey is an Annex I country not listed in Annex B – in fact Turkey has not yet ratified the Kyoto Protocol, although this is reported to be under current consideration. It is also one of only three OECD countries not to have a QELRO for the first commitment period. However, Turkey ranks only 84ᵗʰ in the Human Development Index.

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Figure 31: Share of total primary energy supply in 2005 ¹⁷², 85 Mtoe total

The main source of GHG emissions in Turkey is in energy production, with industry and waste as additional significant, and growing, sources. Although Turkey has invested in hydro power and to a lesser extent renewables, fossil fuels continue to make up the bulk of the energy mix, with coal providing the greatest source, and a rapidly growing one, of Turkey’s GHG emissions, contributing also to air pollution: there is significant potential for co-benefits to be realized. Since 1990, major growth sectors for emissions include electricity production, industrial energy consumption and transport. Waste is a relatively small contributor to overall emission, but has emissions in this sector have chance by 465% from 1990 to 2005.

Potential for emissions reductions from Energy Efficiency
Unlike most members of the OECD with the exception of Spain, Turkey did not made significant overall progress in increasing its energy efficiency in the period 1990-2004 and there is as a result real scope for improvements. Having not been a signatory to the global climate change regime, Turkey lacked the external stimulus to act, and its total primary energy supply per unit GDP decreased by only 6% (Poland and Ireland achieved -43% and -40% respectively in the same time period)\textsuperscript{173}.

However, by fuel switching to natural gas and by increasing efficiency in its iron/ steel sector, Turkey saved a total of 19.5 million tonnes CO\textsubscript{2}eq from 1990 to 2004, meaning that the country’s overall GHG emissions increase would have been 86%, rather than the 74% observed in that period\textsuperscript{174}.

Renewables potential
Turkey has significant renewables potential, particular from solar, wind and geothermal sources. The country has made some moves to exploit these resources, but there remains considerable untapped potential, which could help to reverse its substantial emission growth since 1990. The government points to the potential of its rivers for hydroelectricity, but some of the projects have been highly controversial, with fears for reduced access to water for downstream co-riparian states having been raised.

Solar
Turkey’s solar potential is undeniable – the country receives sunlight equivalent to 11,000 times the amount of electricity generated in 1996 - with some estimates suggesting potential as high as 26.4Mtoe as thermal and 8.8 Mtoe as electricity. There has been a large increase in the use of solar, from 5ktoe in 1986 to 335ktoe in 2003\textsuperscript{175}. To date, solar water heating has been granted the greatest emphasis, but PV is expanding and is expected to be 3MW in 2020\textsuperscript{176}. The market for solar hot water systems has grown massively. Investment was in 3\textsuperscript{rd} greatest in the world in 2006 and the total existing capacity was 2\textsuperscript{nd} in the world, whereas,

\textsuperscript{174}ibid
\textsuperscript{175}Balat, H Energy Exploration and Exploitation 2005, 23 p61-70 http://www.ingentaconnect.com/content/mscp/eee/2005/00000023/00000001/art00006;jsessionid=4i649fj80qki.alexandra
\textsuperscript{176}Hepbasli, A, K Ulgen and R Eke Energy Sources 2004, 26, 551-561 http://www.ingentaconnect.com/content/tandf/ueso/2004/00000026/00000006/art00003
PV installation or existing capacity is negligibly small\textsuperscript{177}. The potential and capacity of solar hot water shows possible growth of PV.

**Wind**

Turkey has an estimated wind potential, mostly in the north west of the country, of 160TWh per year\textsuperscript{178}. A number of wind farms have been erected to date. According to Electrical Power Resources Survey and Development Administration (EIE) study about wind energy potential, technical potential for wind energy is around 48,000 MW\textsuperscript{179}.

**Geothermal**

Turkey lies on a plate boundary, and as a result has been estimated to have an eighth of the world’s geothermal potential\textsuperscript{180}. Much of this potential is not suitable for electricity production but is still useful for direct heating applications; at the end of 1999, Turkey's total installed capacity for direct heating was 820 thermal megawatts (MWth), of which about 390 MWth provided residential heating, about 100 MWth provided heating for about 45 hectares of greenhouses, and about 330 MWth was used to provide heated water for spas. By 2010, as many as 500,000 residences could be heated by geothermal power, which would represent the use of about 3,500 MWth. In addition to existing capacity, six other potential geothermal fields have been identified, all in the southwest of the country. Turkey hopes to generate 500 MWe from geothermal energy by the year 2010 and 1,000 MWe by the year 2020\textsuperscript{181}.

**Biomass**

Turkey has potential to increase its use of biomass, with fuel wood having been identified by the government as the most interesting source. The government estimates that total forest potential of Turkey is around 935 million $m^3$ with an annual growth of about 28 million $m^3$\textsuperscript{182}. Overall potential of biomass for energy use exceeds 17 Mtoe, which is about 27% of the actual total energy consumption in Turkey.

**Emissions from the Land Use Sector**

Traditional agriculture accounts for 35% of employment\textsuperscript{183} in Turkey, and overall, the land use sector is a net sink, with forests, followed by croplands, acting as the main removals. Emissions from agriculture fell by 14.6% between 1990 and 2005.


\textsuperscript{179} For further details, please see presentation of Mehmet Caglar, Deputy General of Electrical Power Resources Survey and Development Admin.;www.cedgm.gov.tr/dosya/enerjisenaryo/tryenilebilirenerji.ppt


\textsuperscript{181} ibid

\textsuperscript{182} ibid

\textsuperscript{183} https://www.cia.gov/library/publications/the-world-factbook/geos/tu.html
UKRAINE

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<td>GHG emissions from LULUCF (2005)</td>
<td>-58.6 MtCO₂-e</td>
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**Overview**

It is technically and economically feasible for Ukraine to adopt the target of stabilization of greenhouse gas emissions by 2020 or 0% growth from the current level of emissions. Ukraine can take international commitment to reduce GHG emissions by at least 55% by 2020 from the level 1990. Such target could be achieved through both energy efficiency programs both in supply and demand side and from increasing the use of renewable sources in the energy mix.

Ukraine has huge energy efficiency potential, being among countries with the highest energy intensity level in the world. Ukrainian energy intensive industries consume 2-3 times more energy per unit of GDP, most of the energy companies are very inefficient, there is up to 60% potential to reduce energy consumption in households, etc.

The target of stabilization of energy consumption by 2020 (with doubled GDP growth) would mean that in 2020 Ukrainian industry will reach the energy intensity level, which is the world average today. Therefore the proposed target for Ukraine can still be considered as a modest, since the energy intensity level in Ukraine in 2020 will still be higher than the average energy intensity level in the world in 2020.

Energy efficiency in Ukraine is economically feasible: it is 4 times cheaper to invest into energy efficiency rather than in development of new energy supply facilities.
Ukraine has economically feasible potential for renewable energy sources on the level of 14% of total primary energy sources in 2030, which is 2.25 times higher than the official government energy strategy. With the growth of prices for oil and gas the economic potential of renewables can be higher.

Figure 32: GHG emissions in Ukraine with removals from LULUCF, 1990-2004, mtCO2-e

Figure 33: GHG emissions projections by 2030 in%age to 1990 level for the different scenarios of economic development. “Optimistic” and “pessimistic” are linked by Ukraine to economic growth scenarios, and take into account neither the possibility of decoupling economic growth from emissions growth, nor the desirability of do so.

ibid
Analysis of Sources of Emissions and Potential for Emissions Reductions

The main problems for GHG emissions in Ukraine are:

1. Huge energy inefficiency in most industrial sectors. According to IEA, as in figure 34, Ukraine is among most energy inefficient countries in the world.

![Energy Intensity in Belarus and Other Countries, 2007](image)

Figure 34: The energy intensity of Ukraine in 2007, compared with countries

2. Ukrainian industry is dominated by energy-intensive sectors, such as mining, metallurgy and chemicals, which negatively influences the country’s energy intensity and consumes 40% of all energy sources in the country.

3. The high share of GHG emissions coming from fossil fuel extraction, processing, distribution and transit. In 2006 these emissions accounted for 17% of total GHG emissions in Ukraine (52.8 Mt CO\textsubscript{2}e) [7].

**Energy sectors**

Ukraine’s power plants tend to be quite inefficient, a function of both design and age. Ukraine also has some of the highest volume losses from power transmission and distribution in the world\textsuperscript{186}. From 1999-2004, transmission and distribution losses were more than 18%. However, in 2005 they dropped to 14.7% as a result of targeted actions by the Ministry of Fuel and Energy and local distribution companies\textsuperscript{187}.

Most of Ukraine’s thermal power plants are power-only (also known as condensing power plants). Only three of the 17 major power plants are combined heat and power plants, with 1670 MW of installed capacity. Thus, only 17% of Ukraine’s thermal power capacity is from combined heat and power plants\textsuperscript{188}, despite Ukraine’s substantial demand for district heating.

\textsuperscript{185} IEA, 2008
\textsuperscript{186} OECD/IEA, Ukraine. Energy policy review 2006
\textsuperscript{187} ibid
\textsuperscript{188} ibid
The Energy Strategy of Ukraine by 2030 is planned with an extremely high growth of energy consumption. Most of the budget money is invested into increase of production capacities rather than efficiency improvements. The energy efficiency improvements, which are planned in Energy Strategy, do not reflect the existing potential: by 2030 Ukraine will reach the level of energy intensity which Poland has already reached now.

The analysis of the investment costs into energy sector by IEA shows that it is at least 4 times more profitable to invest into energy efficiency than into new production utilities in Ukraine.

Figure 35: investment results: investment cost vs. change in energy balance 2005-2030\textsuperscript{189}

Up to 2008 the tariffs on electricity from nuclear and coal power plants are lower than their production costs, which is due to government subsidies. Every year the country spends billions to support these sectors. Subsidies for producing coal in past years have amounted to more than UAH 6 billion annually (1.2 billion USD) \textsuperscript{190}.

The government plans to increase coal production by 50\% by 2030, which will be 101 Mtce [2]. According to the Energy Strategy to 2030 the government plans to give 48 billion UAH (USD 9.6 billion) to the technological development of the coal sector by 2030 [2].

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\textsuperscript{189} OECD/IEA, 2006.
\textsuperscript{190} OECD/IEA, Ukraine. Energy policy review 2006
\textsuperscript{191} Cabinet of Ministers of Ukraine “Energy Strategy of Ukraine by 2030”, Decree number 145, 15 march 2006, Cabinet of Ministers, Kiev
Main industries
In 2004 Ukrainian industry accounted for 40% of total final consumption of energy. The most energy-intensive sectors are metallurgy and chemicals: together, they account for 86% of total industrial energy use\(^{192}\).

The ratio of energy consumed per tonne of industrial output is very high in Ukraine compared to other industrialized countries of the OECD. According to IEA and Ukrainian estimates, Ukrainian metallurgy companies consume three times as much energy to produce one tonne of cast iron and twice as much to produce steel as the OECD European average\(^{193}\). Ukraine produces over half of its steel in inefficient open-hearth furnaces. In fact, the share of open-hearth furnaces in Ukrainian iron production decreased only slightly, from 50% to 47% between 1996 and 2004. More modern electric arc furnaces represent less than 10% of Ukraine’s steel production (compared to 40% in OECD Europe)\(^{194}\).

The second most energy-inefficient industry – the chemicals sector – produces large amounts of energy-intensive ammonia and other fertilizers. Ukraine produces three times as much electricity to produce 1 tonne of ammonia as the United States and about two times as much as Russia [3]. The manufacture of ethylene and propylene is quite limited in Ukraine; still, the manufacturers that produce these materials use two to three times more energy per unit that such facilities in OECD countries\(^{195}\).

After metallurgy and chemicals, one of the most energy-intensive processes is cement production. Cement is manufactured using an inefficient wet process, rather than a dry process. Ukraine consumes 70% more energy to produce a tonne of cement than OECD countries\(^{196}\).

Transport infrastructure
The share of the transport sector in Ukrainian energy consumption is small (15% in 2004) compared with that in the OECD area (34%). According to official data, the structure of the transport sector remains relatively energy efficient. Rail transport dominates, representing about half of total freight turnover in Ukraine and about 40% of passenger turnover\(^{197}\).

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</table>

Table 8: Breakdown of total fright turnover 1990-2004 (%)\(^{198}\)

\(^{192}\) OECD/IEA, Ukraine. Energy policy review 2006
\(^{193}\) ibid
\(^{194}\) ibid
\(^{195}\) ibid
\(^{196}\) ibid
\(^{197}\) ibid
\(^{198}\) OECD/IEA, 2006

68
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</table>

Table 9: Breakdown of total passenger turnover 1990-2004 (%)\(^{199}\)

However, according to IEA the data do not seem to adequately capture the growing use of private cars. In 2005 the share of automobile passenger turnover exceeded the share of rail transportation. From 1990-2004, car ownership increased from 3.3 million (63 per 1000 residents) to 5.1 million (108 per 1000 residents)\(^{200}\). It is expected that the number of private cars will continue to grow in Ukraine.

**Housing**

Residential and public buildings are responsible for a considerable share of national energy consumption. Residential buildings alone consume more than 30% of the energy used in Ukraine; commercial and public services (which are often located in buildings) consume another 10%.

65% of Ukrainian homes and offices are heated through the District Heating Systems. There is a huge potential for efficiency in each part of the district heating chain: production, transmission, distribution and end use. The exact amount of losses is difficult to measure because of a lack of metering equipment, but the Ministry of Construction estimates that up to 60% of energy is wasted within the district heating chain – and that the largest losses occur at the end user facilities\(^{201}\).

Energy consumption for heating in Ukrainian buildings is two times higher than in OECD Europe. Most district heating distribution networks are outdated and poorly insulated, with losses of up to 30%. In addition, poorly isolated buildings lose about 30-50% of the heat delivered\(^{202}\).

For housing sector the *Energy Strategy by 2030* plans efficiency improvements only in the production part: at heat and combined heat and power plants. It is estimated to decrease 8% by 2010 and 16% by 2030 of fuel use at per unit of generated heat. Additionally, The Ministry of Construction, Architecture, Housing and Communal Services had announced plans to launch an innovative UAH 750 million (USD 150 million) investment fund in the housing sector; however, it has not been set up by 1 August 2008.

\(^{199}\) ibid
\(^{200}\) ibid
\(^{201}\) ibid
\(^{202}\) ibid
Appliances
Ukraine is experiencing a boom in electric appliances; retail sales of some durables tripled or even quadrupled during this period [3]. This trend of increasing use of appliances inevitably puts domestic electricity demand under high pressure. In 2003 Ukraine introduced energy-based appliance standards and labeling. This document envisages adopting standards in Ukraine based on the EU appliance standard directive. Although the standards have been adopted, they are not being enforced. Enforcement is a critical to making progress in appliance efficiency.

Renewables potential
Renewable energy, including large hydro, accounts for some 0.08-0.14 % of total primary energy supply in Ukraine in 2004 (TPES)203. Large hydro comprises 80% of the total figure, and only 20% comes from other renewable sources. By 2030, Ukrainian government plans to increase the share of renewable energy sources to 6% of total primary energy supply; envisioned in the Energy Strategy to 2030.

In 2006, the group of environmental organizations and research institutions in Ukraine developed an alternative nuclear-free energy scenario for Ukraine. The authors provided numbers for technical and economic potential for different renewable energy sources by 2030 and 2050. Renewable energy sources are estimated to constitute from 11 to 14.2% (depending on different figures for TPES) in the country’s TPES in 2030204.

Figure 36: Consumption of RES in Ukraine in 2005 and according to approved Energy Strategy to 2030 and alternative scenario205


204 ibid

**Hydro**

Hydropower is the most developed renewable energy in Ukraine. The total installed hydropower capacity is 4600 MW, majority of which is large-scale hydro. In 1950s-1960s in Ukraine there used to be 956 small hydro power plants, but only 72 are still operating. The Ukrainian Renewable Energy Agency estimates that by 2030 Ukraine has potential to install 15.1 TWh/year of middle and small scale hydro power plants.

**Wind**

The Ukrainian Renewable Energy Agency estimates the technical potential of wind energy capacity in Ukraine as 16 GW, which could generate up to 30 TWh/year.

**Photovoltaic**

The Ukrainian Renewable Energy Agency estimates overall technical potential for solar energy in Ukraine as 16 TWh/year. The technically feasible potential by 2030 is estimated on the level of 2TWh/year, by 2050 – 9 TWh/year.

**Biofuels**

The Ministry of Agriculture, several regional administrations and private companies recently announced plans to build at least 4 plants for biofuels production, each producing 100 000 tonnes of biofuels per year. Ukraine produces up to 300 000 tons of rapeseed over last years and by 2010 the Ministry of Agriculture plans to increase the surface of rapeseed fields from 234 000 ha in 2005 to 1.3-1.5 million ha by 2010 to supply the proposed biofuel plants. The Ukrainian government has not introduced any state regulation to support biofuel use within Ukraine and therefore all produced rapeseed and biofuels are mainly being exported to the European Union.

**Bioenergy**

The Ukrainian Renewable Energy Agency and the Scientific Engineering Centre Biomass estimates bioenergy potential in Ukraine on the level of 16.52 Mtoe/year. It mainly consists of existing wood waste, agricultural residues, liquid fuels from biomass, biogas and energy plants.

<table>
<thead>
<tr>
<th>Type of fuel</th>
<th>Energy potential (Mtoe per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw of cereal crops (excluding corn)</td>
<td>3,92</td>
</tr>
<tr>
<td>Corn stalks, ears and grain</td>
<td>1,68</td>
</tr>
<tr>
<td>Sunflower stalks and husks</td>
<td>1,61</td>
</tr>
<tr>
<td>Biogas from manure</td>
<td>1,12</td>
</tr>
<tr>
<td>Biogas from sewage water</td>
<td>0,14</td>
</tr>
<tr>
<td>Wood waste</td>
<td>1,4</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>0,21</td>
</tr>
<tr>
<td>Combustible pellets from municipal solid waste</td>
<td>1,33</td>
</tr>
<tr>
<td>Liquid bio-fuels (bio-diesel, bio-ethanol)</td>
<td>1,54</td>
</tr>
</tbody>
</table>

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206 OECD/IEA, Ukraine. Energy policy review 2006
207 Mama-86, National ecological centre of Ukraine, Ecoclub Rovne, The Voice of Nature and others, Concept for nuclear free energy development of Ukraine, 2006
208 ibid
209 ibid
210 OECD/IEA, Ukraine. Energy policy review 2006
211 OECD/IEA, Ukraine. Energy policy review 2006
212 Mama-86, National ecological centre of Ukraine, Ecoclub Rovne, The Voice of Nature and others, Concept for nuclear free energy development of Ukraine, 2006
Solar collectors

The Ukrainian Renewable Energy Agency estimates total technical potential of the solar collectors for heating and hot water in Ukraine on the level of 75 TWh/year. The economically feasible potential for solar collectors in Ukraine by 2050 is 23 TWh/year\textsuperscript{213}. These numbers were also used in the Draft Energy Strategy of Ukraine (2002).

Geothermal

The Ukrainian Renewable Energy Agency and the Scientific Engineering Centre Biomass estimates that geothermal energy use could be equivalent to 8 TWh/year by 2030 and 14 TWh/year in 2050\textsuperscript{214}.

Policy to promote renewable energy sources

One of the biggest constraints to the renewable energy sources development in Ukraine is lack of effective policies. Over last 10-15 years, Ukraine has adopted some laws and programs related to renewable energy. However, the existing legislation is not enforced and almost no provisions are implemented in practice. Ukraine has not introduced a feed-in-tariff system for renewables, successful in counties such as Germany and Spain. The direct state subsidies to the renewable energy development are either zero or provided in an inefficient way. Another important constraint to the development of renewables in Ukraine is extensive subsidies for fossil fuels and other price distortions. Subsidies for producing coal in past years have amounted to more than UAH 6 billion annually (1.2 billion USD).

\begin{tabular}{|l|c|}
\hline
Energy crops (willow, poplar etc.) & 3.57 \\
\hline
Total & 16.52 \\
\hline
\end{tabular}

Table 10: Bioenergy potential in Ukraine
UNited States of America

| % of World Total CO₂ Emissions (Excludes LULUCF) (2004) | 19.80% |
| Rank of World Polluters (2004) | 1st |
| % GHG Emissions Change Since 1990 - 2005 (Excludes LULUCF) | +16.3% |
| Tons CO₂ Per Person (2004) | 20.1 |
| World Ranking in Per Capita Emissions (2004) | 7th |
| Total GHG Emissions, Including LULUCF and Bunkers (2005) | 6,549.0 MtCO₂-e |
| Total GHG Emissions, Without LULUCF (2005) | 7,358.6 MtCO₂-e |
| Total CO₂ Emissions, Including LULUCF and Bunkers (2005) | 5,358.2 MtCO₂ |
| GHG Emissions from Bunkers (2005) | 98.2 MtCO₂-e |
| GHG Emissions from LULUCF (2005) | -809.5 MtCO₂-e |

Overview
As the United States is one of the last industrialized countries to implement a meaningful policy to mitigate greenhouse gas emissions, there are still many cost-effective opportunities for mitigation that have not been realized. Under current economic, energy and environmental policies there has been little incentive for American businesses or households to transition to low carbon technologies, maximize the efficiency with which they use energy, or utilize clean renewable energy. Therefore, available analysis shows that there is tremendous opportunity for affordably reducing greenhouse gas emissions in the U.S.

Since the early 1990s there has been a steady release of studies documenting the existence of technology and policy options which might deliver significant cost-effective reductions in greenhouse gas emissions within the United States. In 1991, for example, a consortium of research groups indicated that it would be possible to achieve a 70 percent reduction in carbon dioxide emissions by 2030, and to do so at a substantial net savings to American consumers and businesses. In 1997 the same research consortium charted what it called an “innovation path” that might still achieve a 62 percent reduction in carbon dioxide emissions by 2030 despite a much delayed start compared to the previous analysis. Moreover, the report indicated that the reductions would provide an economic benefit that would be 1.7 times the cost—these results relied largely on existing technologies within the United

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Shortly thereafter, a group of national energy laboratories found that an advanced policy and technology path might provide cost-effective emissions reductions of up to 29 percent compared to the 2020 reference case. And, finally, a meta-review of 48 different state and regional assessments conducted within the U.S. over the past 16 years showed an average 23 percent efficiency gain with a nearly 2 to 1 benefit-cost ratio. In analyzing this set of studies, a recent analysis estimated that a 20 percent to 30 percent energy efficiency gain within the U.S. economy – with a concomitant drop in energy-related carbon dioxide emissions – might lead to a net gain of 500,000 to 1,500,000 jobs by 2030. Based on these studies, the authors concluded that efficiency-led policies would likely increase the nation's GDP by about 0.1 percent, also by 2030.

Unfortunately, many of the more recent analyses of mitigation potential for the U.S. tend to overlook the evidence of significant cost-effective emissions reductions. Still, even the worst case scenarios offered by these newer assessments continue to highlight opportunities to achieve substantial emissions reductions at a small net cost to the economy. Indeed, if we really examine the notion of an economic cost, what we might actually find is that there is not really a cost as such, but merely a postponement of economic growth by only a few months out into the future. One recent analysis suggests that at worst, a one percent GDP loss in the year 2020, for example, was really nothing more than postponing economic growth for less than five months. So the good news about potential U.S. climate policies is that we can achieve the substantial benefit of large-scale emissions reductions and still maintain a healthy level of economic activity. In the best case we may grow somewhat faster and in the worst case we only postpone that growth for some short period of time.

Still, it is a useful exercise to summarize the critical findings of these more recent policy assessments to provide useful insights for policy makers and business leaders. That said, it’s difficult to highlight these varied outcomes as a single numeric value or range of values. Therefore, the following submission on U.S. mitigation potential summarizes existing analyses of approaches to economy-wide emissions reductions and then elaborates on potential in specific sectors through a more detailed sectoral analysis. New analysis is being undertaken in a number of fora that can provide further insights into these questions. As these results become available, we will provide further input into the discussions of the UNFCCC. The intent of this document is to outline some of the opportunities for mitigation and parameters to project potential cost in order to support well-founded expectations of the mitigation potential in the United States.

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219 Personal communication with John A. “Skip” Laitner, Director of Economic Analysis, American Council for an Energy-Efficient Economy, Washington, DC. According to Laitner, using data from the Annual Energy Outlook 2008, the U.S. economy might grow just short of $16 trillion dollars by 2020 (when measured as Gross Domestic Product in constant 2000 dollars). A one percent loss in 2020 implies a penalty of about $160 billion dollars. But, in fact, that higher level of growth would likely be achieve just a few months later – about May of 2021 – so that the economic loss is really no more than a postponement of some future economic activity.
II. Economy Wide Analyses

Several useful economy-wide analyses of mitigation efforts in the U.S. have been released within the past 2 years. These reports fall into two categories: 1) analysis of mitigation potential; and 2) analysis of cost of mitigation associated with the specific levels of emissions reduction. The two tables below summarize the findings of some leading studies in each area. 220

Mitigation Potential

The first group of studies considered the vast potential for emissions mitigation available if the United States exploits opportunities to maximize energy efficiency and utilize our abundant renewable energy resources. Adapting to Uncertainty: A Scenario Analysis of U.S. Energy and Technology Futures221 finds that a smart investment path, one that emphasizes both energy efficiency improvements and advanced energy supply technologies, can provide economic growth and reduce greenhouse gas emissions. Tackling Climate Change in the U.S.222 finds that improvements in energy efficiency in buildings, transportation, and industry along with six renewable energy technologies (concentrating solar power, photovoltaics, wind power, biomass, biofuels, and geothermal power) can displace about 1.2 billion tons of carbon emissions annually by 2030. Energy Revolution: A Blueprint for Solving Global Warming223 finds that renewable energy and energy efficiency can meet half of the world’s energy needs by 2050. The following table highlights key findings from these reports.

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The next set of studies considered the economic impacts of various predetermined levels of greenhouse gas reduction in the US. With the exception of the first study listed in Table 3, the majority of the studies below are projections of cost for carbon and macroeconomic impacts associated with the Lieberman/Warner Climate Security Act that was considered in the U.S. Senate in 2008, as this was the recent focus of extensive consideration within the US Senate. An unpublished modeling analysis of the Climate Stewardship Act (S 139) completed by the U.S. Environmental Protection Agency and released by the National Wildlife Federation in 2003 suggested a roughly 33 percent reduction in emissions by 2025.

Cost of Mitigation

The next set of studies considered the economic impacts of various predetermined levels of greenhouse gas reduction in the US. With the exception of the first study listed in Table 3, the majority of the studies below are projections of cost for carbon and macroeconomic impacts associated with the Lieberman/Warner Climate Security Act that was considered in the U.S. Senate in 2008, as this was the recent focus of extensive consideration within the US Senate. An unpublished modeling analysis of the Climate Stewardship Act (S 139) completed by the U.S. Environmental Protection Agency and released by the National Wildlife Federation in 2003 suggested a roughly 33 percent reduction in emissions by 2025.

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at essentially zero net loss to the economy. A different sort of analysis was undertaken in *Assessment of U.S. Cap-and-Trade Proposals* a study from MIT analyzing macroeconomic cost associated with reducing U.S. emissions to 50% and 80% below 1990 levels by 2050. Some of the key findings from all of these reports are summarized in the following table.

<table>
<thead>
<tr>
<th>Study (Lead organization/author)</th>
<th>Emissions Reductions (MMtCO₂ eq)</th>
<th>Cost per ton ($ per ton CO₂ eq)</th>
<th>Macroeconomic Impacts (% chg from BAU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA Preliminary Analysis of S 139 (NWF, 2003)</td>
<td>33% below projected reference case levels for 2025</td>
<td>$50 in 2025</td>
<td>-0.01 GDP while percent consumption and investment were +0.1% and +0.8%, respectively</td>
</tr>
<tr>
<td>Assessment of U.S. Cap-and-Trade Proposals (Paltsev et al., MIT, 2007)</td>
<td>50% below 1990 in 2050</td>
<td>$41 in 2050</td>
<td>-0.32</td>
</tr>
<tr>
<td>80% below 1990 in 2050</td>
<td>$53 in 2050</td>
<td>-0.55</td>
<td>-1.79</td>
</tr>
<tr>
<td>Cutting Global Warming at Least Cost with the Lieberman-Warner Climate Security Act (NRDC, 2008)</td>
<td>6.3 Gt</td>
<td>$12</td>
<td>$20 by 2030</td>
</tr>
<tr>
<td>26.4 Gt by 2030</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007 (EIA, 2008)</td>
<td>959 to 1819 MMT CO₂eq</td>
<td>2262 to 3224 MMT CO₂eq by 2030</td>
<td>$29</td>
</tr>
<tr>
<td>EPA Analysis of the Lieberman-Warner Climate Security Act of 2008 (EPA, 2008)</td>
<td>2908 MMT CO₂eq</td>
<td>40% lower than ref case in 2030 (11% below 1990)</td>
<td>$28-37</td>
</tr>
<tr>
<td>The Lieberman-Warner Climate Security Act-- S. 2191: A Summary of Modeling Results from the National Energy Modeling System (CATF, 2008)</td>
<td>$22</td>
<td>$48</td>
<td>-0.5%</td>
</tr>
</tbody>
</table>

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227 See Appendix A for a more detailed citation, explanation of the model utilized, and key features of the analysis and model.
228 NRDC analysis considered two different cases—one with a more aggressive learning in the case of renewables. Range is based upon the results for the two scenarios.
These studies vary in terms of key assumptions such as reference projections; cost curves and technology assumptions; feasibility of penetration; the gases that are covered and available for mitigation; and where the emissions reductions. Each of these factors is important to keep in mind when comparing the results from the various studies. However, it is interesting to note that in all cases, GDP levels will have grown significantly above the current level—essentially meaning that the same level of GDP occurs only a couple of months later than without the emissions reduction programs. In addition, it must be remembered that the GDP impact does not take account of the “costs” on the US of inaction, which according to one study could cost 1.8 percent of U.S. GDP per year by 2100 as a result of just four global warming impacts. The total cost of continuing on a business-as-usual path could be even greater—as high as 3.6 percent of GDP when economic and non-economic costs such as health impacts and wildlife damages are factored in (Ackerman et al., 2008).231

III. Emissions Reductions in Specific Sectors

Electricity Generation

America’s current energy system is dominated by fossil fuels. A combination of policies to promote efficiency and renewable energy sources – such as wind, solar, bioenergy and geothermal – can help reduce our dependence on these sources of global warming pollution.

A 2001 report by UCS, ACEEE and the Tellus Institute, Clean Energy Blueprint232, shows that, by 2020, the U.S. can meet 20% of its electricity needs from renewable sources. Increased energy efficiency and combined heat and power (CHP) has the potential to deliver 2,512 billion kilowatt-hours of electricity savings by 2020, which amounts to a reduction of 3.47 quadrillion Btu of fossil fuel savings. The policies that motivate these reductions include a Renewable portfolio standard, public benefits fund, net metering, production tax credits for renewables, CHP improved efficiency standards, enhanced building codes and industrial efficiency measures.

A detailed summary of results is below:

<table>
<thead>
<tr>
<th>Benefits from the Clean Energy Blueprint</th>
<th>Benefits in 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Savings</td>
<td>750 million short tons</td>
</tr>
<tr>
<td>Natural Gas Savings</td>
<td>11 Quadrillion Btu</td>
</tr>
<tr>
<td>Oil Savings (not including transportation)</td>
<td>4 billion barrels</td>
</tr>
<tr>
<td>Household energy bill savings</td>
<td>$350/year</td>
</tr>
<tr>
<td>CO₂ Emissions from power plants</td>
<td>47% below 1990 levels</td>
</tr>
</tbody>
</table>

Therefore, the presented results reflect the range from the two models.

http://www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf


In 2007, UCS modeled a National Renewable Electricity Standard of 20% by 2020\textsuperscript{233}, using EIA’s NEMS model. The results of this modeling show that an RES would save consumers money, while simultaneously reducing global warming emissions. A detailed summary of results is below:

<table>
<thead>
<tr>
<th>Benefits from a 20% RES by 2020</th>
<th>20% by 2020 UCS case</th>
</tr>
</thead>
<tbody>
<tr>
<td>New capital investment in renewable energy</td>
<td>$66.7 billion</td>
</tr>
<tr>
<td>Consumer energy bill savings (through 2030)</td>
<td>$31.8 billion</td>
</tr>
<tr>
<td>Natural Gas savings</td>
<td>3.2 trillion cubic feet</td>
</tr>
<tr>
<td>Coal Savings</td>
<td>476 million short tons</td>
</tr>
<tr>
<td>Annual CO\textsubscript{2} emissions savings from power plants</td>
<td>223 million metric tons</td>
</tr>
</tbody>
</table>

*Source: UCS, 2007. Cashing in on Clean Energy*

A 2007 report by the American Solar Energy Society (\textit{Tackling Climate Change}) shows that the U.S. has the potential to greatly reduce emissions from electricity generation by implementing a wide array of policies. Their summary results show:

<table>
<thead>
<tr>
<th>Potential Carbon Reductions (in MtC/yr in 2030)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency</td>
</tr>
<tr>
<td>Concentrating Solar</td>
</tr>
<tr>
<td>Photovoltaics</td>
</tr>
<tr>
<td>Wind</td>
</tr>
<tr>
<td>Biofuels</td>
</tr>
<tr>
<td>Biomass</td>
</tr>
<tr>
<td>Geothermal</td>
</tr>
</tbody>
</table>

\textbf{Transport}

American driving habits and vehicle preferences, combined with stagnant fuel economy standards, has resulted in a dramatic increase in U.S. oil consumption and associated global warming emissions. A 2008 study by UCS (\textit{Setting the Standard: How Cost-Effective Technology Can Increase Fuel Economy}\textsuperscript{234}) shows that, by improving fuel economy standards of light duty vehicles (LDVs) to 39 miles per gallon (mpg) by 2020 and 55 mpg by 2030, the U.S. can reduce emissions by 263 million metric tons CO\textsubscript{2} eq by 2020 and 755 million metric tons CO\textsubscript{2} eq by 2030 (approximately 10% below 2000 levels). These improvements in fuel economy can be achieved by a combination of wider deployment of conventional technologies (such as continuously variable transmission, automated manual transmission, variable valve lift and timing, electric power steering, turbocharging, low

\textsuperscript{233} This standard was chosen based on legislation that was being considered in the U.S. Congress. It does not represent what UCS considers the full potential for renewables. Also, due to exclusions in the legislation, it actually works out to a 12-13% RES.

rolling resistance tires etc.) and advanced technologies (such as hybrid gasoline-electric drivetrains).

Measures to increase the use of advanced alternative fuels and lower vehicle miles traveled can deliver substantial additional reductions in GHG emissions.

**Buildings**

Buildings account for a tremendous amount of US energy use: about 37 percent of total U.S. energy consumption and about 70 percent of total electricity consumption (U.S. Climate Action Report, 2006). There are approximately 121 million households in the U.S., 62 percent of which were single, detached dwellings, and 4.9 million commercial buildings with more than 6.7 billion square meters of floor space. Residential buildings account for approximately 1,210 megatons of CO₂ per year while commercial buildings are responsible for approximately 1,020 megatons of CO₂. In 2001, the carbon associated with energy services to United States buildings alone constituted 8 percent of total global emissions of CO₂, equal to all emissions from Japan and the United Kingdom combined.

There are a number of policies available to reduce emissions in this sector including: new building codes, new appliance standards, tax incentives for the purchase of high efficiency products, a national public benefits fund, expanded research and development, voluntary agreements and support for combined heat and power. According to a green building report by the Commission for Environmental Cooperation, rapid market uptake of currently available and emerging advanced energy-saving technologies could result in over 1,700 fewer megatons of CO₂ emissions in 2030, compared to projected emissions that year following a business-as-usual approach. A cut of that size would nearly equal the CO₂ emitted by the entire US transportation sector in 2000. According to the CEC report, it is common now for more advanced green buildings to routinely reduce energy usage by 30, 40, or even 50 percent over conventional buildings, with the most efficient buildings now performing more than 70 percent better than conventional properties, according to the report. Another analysis by the U.S. Climate Change Science Program finds that current best practices can reduce emissions from buildings by at least 60% for offices and 70% for homes.

**IV. Emission Mitigation from Land Use Change and Forestry**

Forest and agricultural lands currently comprise a very significant sink for U.S. greenhouse gas emissions, totaling almost 830 MMt per year according to the U.S. GHG inventory in 2005. More than 90 percent of the U.S. net carbon sink occurs on forestlands, which currently offsets 12 percent of U.S. GHG emissions from all sectors of the economy on an annual basis. The agricultural sector however is a net emitter of GHGs with agricultural CH₄ and N₂O emissions responsible for over 6 percent of all annual U.S. GHG emissions.

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Therefore the forest and agriculture sectors comprise a net GHG sink that is equal to almost 6 percent of total U.S. GHG emissions. The existing sink should not be confused, however, with the potential emissions mitigation that might be pursued in this sector.

According to a recent EPA report, *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture*\(^{238}\), mitigation activities in forestry and agriculture can reduce emissions of CO\(_2\), N\(_2\)O and CH\(_4\). According the EPA, GHG reduction incentives can generate national mitigation of 640 MMt CO\(_2\) eq/yr in the first decade and 655 MMt CO\(_2\) eq /yr by 2025, with a relatively modest price of $15/tCO\(_2\) eq. In this scenario mitigation then declines to about 85 MMt CO\(_2\) eq/yr by 2055 as the result of saturating carbon sequestration in the sector and carbon losses after timber harvesting.

V. Mitigation Potential From International Efforts

The U.S.’ participation in the effort to slow global warming must principally come through cutting its domestic production of greenhouse gas, which amounts to almost 25% of the world’s emissions. However it can also contribute by funding the reduction of emissions from deforestation and forest degradation in developing countries, commonly referred to as “REDD” and by supporting the transition to clean energy technology in developing countries.

a. Reducing Emissions from Deforestation in Developing Countries (REDD)

There is high potential for REDD in part because of low opportunity costs of tropical land for agriculture and ranching. The U.S has the potential for a significant contribution through REDD financing. Regardless of the type of positive incentive, any financial mechanism should be effective, sustainable and predictable\(^{239}\). A range funding of options from non-market, market-linked and market sources have been proposed.

One recent analysis, based on three models of the economics of how REDD could function globally\(^{240}\) makes it possible to estimate the emissions reduction potential of different amounts of REDD funding\(^{241}\). The global cost curve derived from the average of the three models indicates that for $2 billion annually, emissions from deforestation could be reduced by 375 MMt CO\(_2\) in 2020; for $5 billion annually, the reduction would be 775 MMt CO\(_2\), and for $10 billion annually it would be just over 1200 MMt CO\(_2\)\(^{242}\). These amounts correspond respectively to 6%, 12% and 19% of the U.S.’ emissions in 1990. Another way of expressing


\(^{240}\) Kindermann, Georg. et al., Proceedings of the National Academy of Sciences 105: 10302-10307. Use of these models is conservative, since other methods to estimating REDD costs give lower estimates and thus greater potential for a given amount of funding.

\(^{241}\) These results are not specific to any method way of funding REDD.

\(^{242}\) All figures are in real (2005) U.S. dollars and include the costs of implementation, administration and transactions associated with REDD, as well as funding for stabilization (prevention of international emissions displacement, or “leakage”, from REDD countries to those that currently have low deforestation rates. These estimates are for the U.S. only; if other countries contributed to the effort the total reduction would be larger but the U.S. “share” would be smaller, because some of the low-cost REDD opportunities would be funded by other countries.
this is that for $5 billion in annual funding, the world’s emissions from deforestation could be reduced by more than 20%, and for $20 billion they could be reduced by about half.

b. Assisting in Technology Deployment in Developing Countries

The US could further support global steps to reduce GHG emissions by assisting and expediting the deployment of key technologies and practices in developing countries. Some measures are being undertaken by the US government to assist in these efforts, but more could be done with a targeted and scaled-up approach. Some of the effort can be focused on simply helping to redirect/refocus existing flows of investment from the private sector and international financial institutions (e.g., the World Bank). For example, existing quasi-US government agencies (e.g., Export-Import Bank) support private sector investment in developing countries through a number of mechanisms (e.g., providing risk coverage or loans.) A new technology support mechanism in developing countries could bring additional benefits both to developing countries and US companies.

It is difficult to estimate the cost of efforts and the scale of emissions reductions that would be supported by a targeted technology deployment effort, but further analysis could shed some light on this. These measures could provide additional emissions reductions on top of domestic US emissions reductions efforts to the extent that they are supported by mechanisms outside the scope of US cap on emissions and do not offset domestic obligations.