PART II

Chapter 6

Climate change and air quality

Rapid demographic and economic growth, and the resulting increase in energy and transport demands, are the main factors underlying an increase in greenhouse gas (GHG) emissions. While emissions of air pollutants have declined, air pollution hotspots remain at industrial sites and in major urban areas. The adoption of the Clean Air Law and of a national plan for reducing GHG emissions by 20% by 2020 represent major steps towards addressing these challenges. This chapter reviews these policy initiatives, the institutional framework and the mechanisms in place to monitor implementation. The energy and transport sectors are the major sources of emissions of GHG and air pollutants. The chapter assesses the policy measures implemented in these sectors, including those to promote renewables, energy efficiency and transport modes other than road transport. The opportunity of introducing economy-wide policy instruments such as a carbon tax is also discussed.

Assessment and recommendations

Between 2000 and 2008, Israel's greenhouse gas (GHG) emissions grew by about 5%, mainly due to rapid population and economic growth and the associated increase in energy demand, particularly that of electricity. However, the emission and energy intensities of the economy are close to the OECD average, while the energy supply remains more carbon-intensive than in most OECD countries. This is largely because electricity is generated entirely within Israel, using almost exclusively fossil fuels. Historically, coal and oil have dominated this mix. The discovery of off-shore gas and its progressive use for electricity generation since the mid-2000s have helped mitigate the increase in GHG emissions and contributed to a decrease in emissions of some air pollutants. GHG emissions are expected to continue increasing as a result of rapid economic growth. Some estimates suggest that, under business-as-usual assumptions, they will double by 2030 compared to the 2005 level.

Since it is not a party to Annex I of the United Nations Framework Convention on Climate Change, Israel is not committed to a binding GHG emissions reduction target under the Kyoto Protocol for the period 2008-12. Perhaps as a result, it has made a relatively late start in formulating a climate change mitigation policy. For much of the 2000s its approach was piecemeal. However, in 2009 it set the target of reducing GHG emissions by 20% by 2020 compared with a business-as-usual scenario. This was a positive step forward, although reaching the goal will entail a further increase in GHG emissions. While a national action plan for reducing GHG emissions was prepared, some uncertainty remains concerning the definition of both the target and the strategy to meet it, which may compromise their effectiveness in guiding and motivating implementation. Not only is the target defined against a business-as-usual scenario rather than in absolute terms, but it is not anchored in legislation. While the contribution of the electricity sector to the achievement of the target is reasonably clear, this is not the case for other sectors. An inter-ministerial committee, chaired by the Ministry of Finance, was established to oversee the implementation of the action plan and identify additional measures needed to achieve the GHG emissions reduction target. However, a more open and independent oversight mechanism could provide a broader basis for discussing the policy adjustments that may be needed to achieve this target. There is also room for improving data collection and reporting of GHG emissions trends to support decision making.

The main GHG emissions reduction measures are being developed at the sector level. According to the authorities' current plans, mitigation measures in the electricity sector will account for most of the targeted emissions reductions. As regards energy efficiency, there have been few effective initiatives over the review period. Hence, the National Energy Efficiency Programme, adopted in 2010, marks an important step; it aims to achieve a 20% reduction in projected electricity consumption by 2020. The main implementation instrument, the Energy Efficiency Fund, will need to be carefully designed to meet this objective. Opportunities exist to improve the energy performance of buildings through better performance standards and provision of information to households.

For many years, Israel has promoted solar water heating, which now accounts for 80% of all water heating requirements. However, renewable energy sources account for only a minor share of electricity production, well below Israel's objectives. The implementation of feed-in tariffs and production quotas has improved performance considerably. A number of obstacles need to be addressed if the goal of supplying 10% of electricity with renewable energy by 2020 is to be achieved. In particular, a variety of financial incentives are being used to support the use of renewables (with potential overlaps), while land use re-zoning and permitting procedures are complex and time-consuming.

Transport demand and private car ownership increased considerably in the 2000s. As in many other OECD countries, transport is a major source of GHG and air pollutant emissions. A number of measures have been introduced to reduce emissions from transport. Among them are the adoption of European standards for imported vehicles, fuel quality and vehicle tests. In 2009, the vehicle purchase tax, which has long been an important source of tax revenue, was restructured and is now linked to emissions of CO_2 and local air pollutants. As a result, the average emission performance of new vehicles has improved, especially with regard to emissions of local air pollutants such as nitrogen oxides (NO_X) and particulates. Nevertheless, the carbon efficiency of new cars is still well below the EU average. The introduction of an electronic toll system on the main highway to Tel Aviv is a positive step. If successful in reducing congestion and emissions, it provides a basis for considering the extension of road pricing to other congested motorway stretches and to metropolitan areas. Nevertheless, there is scope to improve the economic incentives to car use. Further efforts are also needed to integrate transport and land use planning and to improve alternatives to private car use.

Many measures to reduce GHG emissions would also help reduce emissions of the main air pollutants, and *vice versa*. Although emission intensities of sulphur and nitrogen oxides (SO_X and NO_X) have decreased since 2000, mostly due to the switch to natural gas and improved fuel quality, they remain above the respective OECD averages. Overall emissions of major air pollutants tended to decrease or stabilise during the 2000s, but there are still air pollution hotspots at industrial sites. Ambient air concentrations of NO_X, PM_{10} and ozone continue to exceed limit values in major metropolitan areas, mainly due to heavy transport pressures. The implementation of the Clean Air Law from 2011 represents a major step towards consolidating the regulatory framework for air pollution from both stationary and mobile sources. In addition, the Law creates a legal basis for imposing air emissions levies on large industrial facilities requiring an emission permit. The air quality monitoring network is among the densest in the world and data are made widely available to the public. However, lack of uniformity in data control among the different monitoring bodies may hinder data reliability.

Recommendations

- Consider expressing the target for reducing GHG emissions by 2020 in absolute terms and making it legally binding; fully integrate climate, environmental and health considerations into the government's long-term energy and transport policies.
- Set up a system to monitor the implementation of GHG emissions reduction measures; provide an annual assessment to the *Knesset* on progress in achieving targets, preferably by an independent body, and periodically (*e.g.* every three years) propose recommendations to adjust policy measures.
- Consider introducing an economy-wide carbon tax, or adjusted excise duties on fossil fuels, to reflect an appropriate carbon price.
- Rationalise the financial incentives for renewable energy projects, taking account of the full range of costs and benefits of renewables; provide consistent guidelines on the types of land used for, and the conditions that apply to, such projects; streamline the associated planning and permitting processes.
- Ensure that the Energy Efficiency Fund targets projects that are justified environmentally and economically by: establishing appropriate criteria for identifying eligible projects; applying instruments to provide targeted support and to leverage other resources; and establishing an independent mechanism to assess progress.
- Introduce mandatory minimum energy performance standards for buildings, and ensure that information on building energy performance is available to consumers.
- Better integrate transport and land use planning; further develop public transport networks; improve the integration of public transport services and networks.
- Extend the use of road tolls on congested motorway stretches and consider introducing congestion or pollution charges in major metropolitan areas.
- Using the legal basis provided by the Clean Air Law, introduce an air emissions levy targeting priority pollutants emitted by large and medium stationary sources.
- Building on the voluntary emissions reporting scheme, establish a mandatory Pollutant Release and Transfer Register that includes GHG emissions; strengthen data quality control across the various ambient air quality monitoring networks.

1. Introduction

Israel is a party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. However, as it is not a party to Annex I of the Protocol, it has no specific greenhouse gas (GHG) emissions reduction commitments in the period to 2012. Israel has increasingly taken on responsibilities commensurate with its status as a developed economy at international climate negotiations, as well as in its implementation of domestic climate policy. It is committed to reduce its GHG emissions by 20% compared to a business-as-usual (BAU) scenario in the period to 2020 (Section 3).

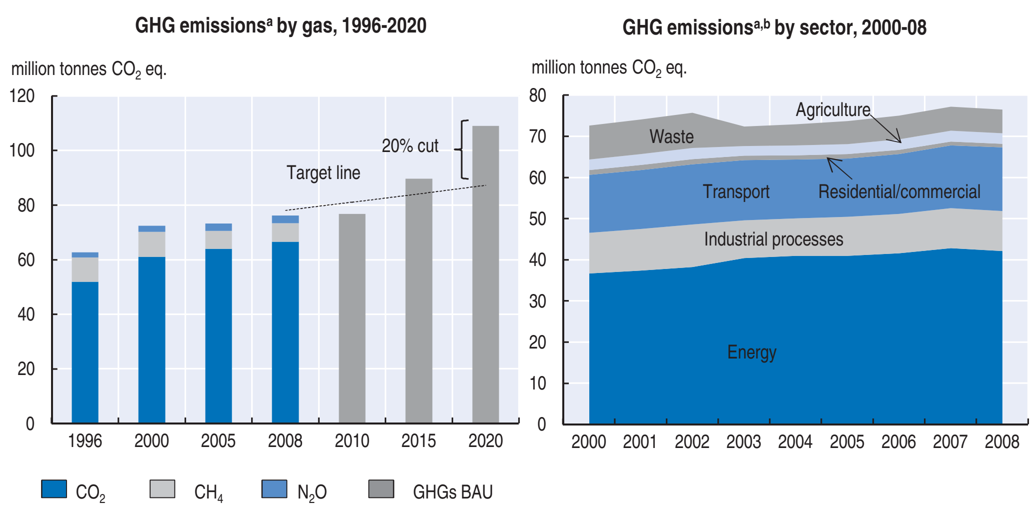
Israel is not a party to any regional or global conventions on transboundary air pollution, including the UNECE Convention on Long-range Transboundary Air Pollution and its eight protocols (Chapter 3). Therefore, unlike most OECD countries, it is not committed to any official national emissions targets for major air pollutants such as sulphur oxides (SO_X), nitrogen oxides (NO_X), particulate matter (PM) or volatile organic compounds (VOCs). Nonetheless, air quality has long been a priority in Israel's environmental policy. Several pieces of legislation have long regulated air emissions from stationary and mobile sources, as well as establishing air quality standards. The approval of the Clean Air Law in 2008 is a major step forward: it is the first attempt to provide a comprehensive regulatory framework for air management policy, and can be used as a tool for future GHG emissions monitoring (Section 3).

2. Emissions performance and projections

2.1. Greenhouse gas emissions

Israel's GHG emissions have grown rapidly since the mid-1990s. Its emissions were 78 Mt CO_2 eq in 2008, including removals from land use, land use change and forestry (LULUCF) and emissions of "F gases", the latter accounting for 1.8 Mt CO_2 eq.[1] Carbon dioxide (CO_2) is the main greenhouse gas emitted, accounting for more than 85% of all emissions. Nearly 9% of emissions are methane (CH_4) and 3.6% are nitrous oxide (N_2O). "F gases" account for the remaining 2.3% (Figure 6.1).

Figure 6.1. **GHG emissions trends and projections**



a) Excluding F-gases.
b) Excluding emissions/removals of the land use, land use change and forestry sector.
Source: CBS (2011), *Statistical Abstract of Israel 2010*; MoEP (2010).

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Although GHG emissions (excluding removals from LULUCF and emissions of F gases) increased by nearly 16% between 1996 (the first year for which data are available) and 2000, a more moderate increase in emissions of about 5% was recorded between 2000 and 2008. Most of this increase in the 2000s occurred between 2003 and 2008, corresponding to an acceleration of growth in GDP. Rapid population and economic growth – and an associated increase in demand for energy, particularly electricity – are primarily responsible for the upward trend in emissions. Broken down by gas, CO_2 emissions increased by 9% in 2000-08 and N_2O emissions by nearly 26.5%, mostly due to emissions from agricultural soils, while CH_4 emissions fell by 26% due to increased collection of biogas from landfill and improved solid waste management.

According to Heifetz and Co. and DHV MED (2009), GHG emissions are projected to grow by 63% in the period 2000-25 under a business-as-usual scenario, reaching 118 Mt CO_2 eq

(MoEP, 2010). This projected increase would largely be due to increases in three major sub-sectors: energy industries (+49%), transport (+43%) and manufacturing and construction (+250%). According to McKinsey & Company (2009), if Israel's current GHG emissions growth trajectory continues, GHG emissions by 2030 will be twice as high as in 2005, reaching 142 Mt CO_2 eq in 2030. This growth exceeds that in other OECD countries, primarily due to Israel's large population and high level of economic growth.

CO_2 emission intensities

CO_2 emissions from fuel combustion per capita decreased only slightly during the review period. They were 8.6 t CO_2 eq in 2008, below the OECD average. CO_2 emissions per unit GDP (at purchasing power parity) have fallen consistently since 2000, albeit at a lower rate than in many other OECD countries. While the carbon intensity of Israel's economy is in line with the OECD average, it is still at the upper end of OECD countries (Figure 6.2). CO_2 emissions have increased less rapidly than total primary energy supply (TPES), mostly due to a change in the fuel mix in favour of natural gas. This has resulted in a decline in CO_2 emissions per unit of TPES. Nonetheless, Israel's energy supply remains more carbon intensive than that of most OECD countries, owing to its high dependence on oil and coal for electricity generation, the low share of renewables, and the absence of nuclear power (Section 5).

Emissions trends by sector

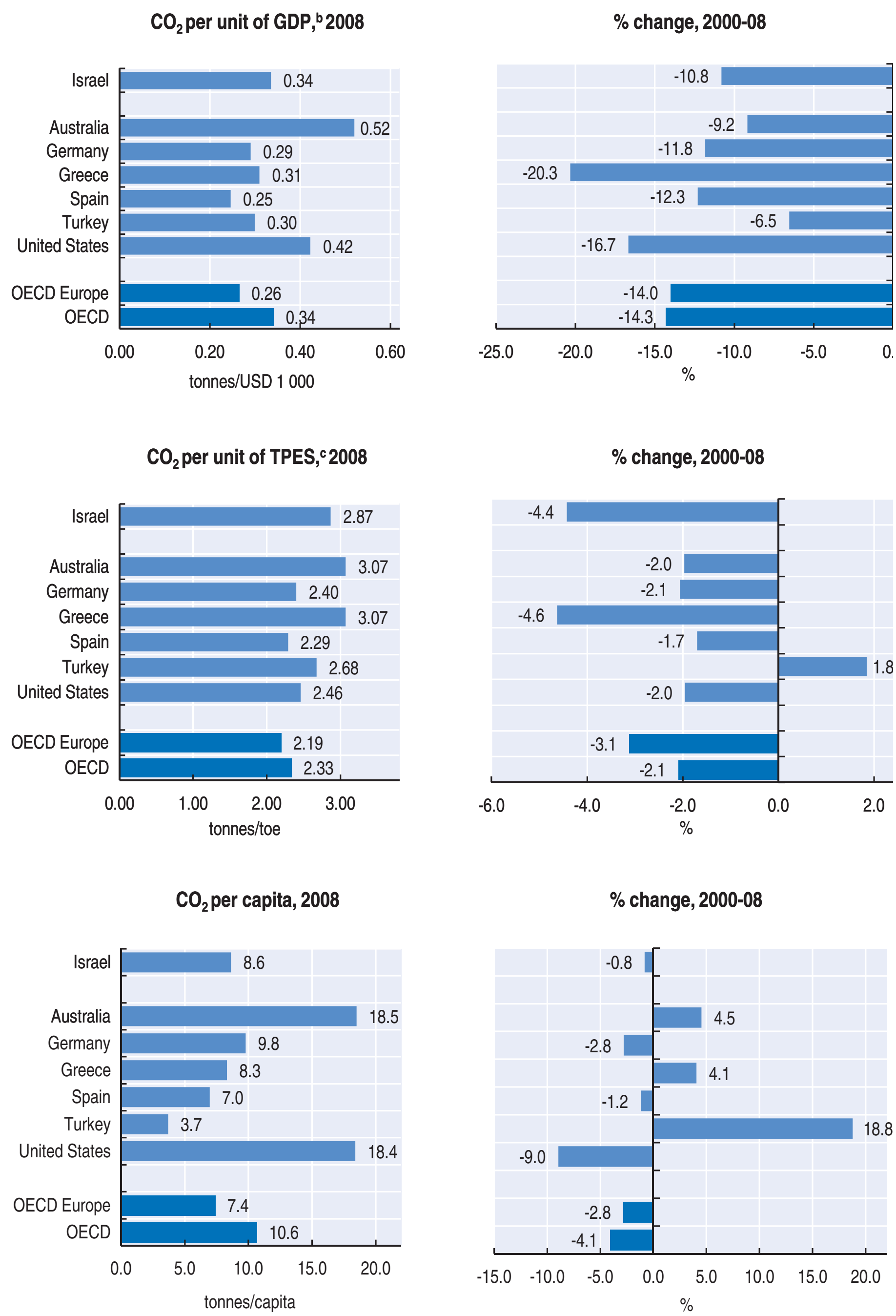
The energy industries (including both power generation and refining activities) are by far the largest sector from a GHG emissions perspective, accounting for more than 55% of Israel's total emissions.[2] Electricity production alone accounts for over half of GHG emissions. It increased dramatically between 2000 and 2008, by more than 30%. The upward trend in emissions from increased electricity generation has been offset to some degree by the integration of gas into the generation portfolio of the Israel Electric Corporation (IEC) (Section 5).

The transport sector, the second largest source of GHG emissions, was responsible for 15.5 Mt CO_2 eq of emissions in 2008, a 10% increase compared with 2000 levels and approximately 40% above 1996 levels.[3] Growth in transport sector emissions can be attributed to a significant increase in car ownership and in usage rates (Section 6).

Emissions from manufacturing industries, industrial processing and construction accounted for 9.74 Mt CO_2 eq in 2008, representing a slight decrease (2%) during the review period. An 11% decrease in direct emissions from fuel combustion (mostly of oil products) in manufacturing industries (including pharmaceuticals, electronics, agro-technology, telecommunications, fine chemicals and computers) between 2000 and 2008 was partly offset by a 6% increase in emissions from industrial processing, mostly arising from cement production. Cement production is the second largest source of CO_2 emissions after fuel combustion. On the other hand, electricity consumption by the industrial sector has increased, in parallel with the increase in industrial production. If indirect emissions arising from industrial electricity use and energy refining (both included in the energy industries) are included, emissions from the industry sector account for almost 30% of overall emissions.

Emissions from the residential and commercial sectors are relatively small, as electricity is the predominant energy source and emissions are therefore considered to

Figure 6.2. **CO_2 emission intensities**[a]



a) Includes CO_2 emissions from energy use only; excludes international marine and aviation bunkers; sectoral approach.
b) At 2005 prices and purchasing power parities.
c) Total primary energy supply.
Source: OECD-IEA (2010), *CO_2 Emissions from Fuel Combustion*; OECD (2010), *OECD Economic Outlook No. 88*; OECD-IEA (2010), *Energy Balances of OECD Countries Database*, OECD-IEA (2010), *Energy Balances of Non-OECD Countries Database*.

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come from the energy industries sector. This sector accounted for approximately 0.87 Mt CO_2 eq emissions in 2008, a fall of 29% during the review period.

Emissions from waste decreased by 30% between 2000 and 2008, a reduction in large part attributable to increased capture of methane from solid waste at landfills (Section 7). However, the contribution of waste to GHG emissions remains significant: it accounted 5.8 Mt CO_2 eq in 2008. This is due to high production of solid waste and to most waste being landfilled (Chapter 7).

Total emissions associated with agriculture were 2.6 Mt CO_2 eq in 2008. They remained broadly constant during the review period. N_2O is the dominant gas, arising mostly from agricultural soils, manure management and animal grazing. N_2O emissions have increased considerably since 2000, although this increase has been offset by a dramatic decrease in CO_2 emissions associated with agriculture.[4] In 2008, Israel's "Kyoto" forests sequestered 0.37 Mt CO_2 eq, an increase from 0.21 Mt CO_2 eq in 2000, owing to the continuous expansion of forested areas (Section 7).

Impacts of climate change

According to the findings of an inter-ministerial steering committee on Israel's vulnerability to climate change (Section 3.1), the average temperature is expected to rise by 1.5 °C by 2020 and by 3.5 to 5 °C in the years 2071-2100, compared with the years 1960-90. In addition, a 10% decrease in precipitation is expected by 2020, reaching a 20% decrease by 2050. This indicates a tendency towards a more arid climate, consistent with the 2010 Intergovernmental Panel on Climate Change (IPCC) forecasts (MoEP, 2010).

The impacts of climate change will also include: increased water demand (due to warming and increased evaporation); increased frequency of extreme events (heat or cold, floods); changes in crop yields; increases in agricultural pests, plant diseases and weeds; risk of damage to coastal infrastructures due to rising sea levels; morbidity and mortality due to heat waves, new disease vectors and increased risk of food-borne infectious diseases; increased energy demand arising from air conditioning and water desalination; changes in biodiversity, especially in the Mediterranean Sea; and an increased risk of forest fires.

2.2. Air emissions and air quality

As in many other countries, the main sources of air pollution in Israel are transport, electricity generation and industrial activities. Its high population density, the concentration of population and economic activities in coastal areas, and specific geographical and climate conditions tend to exacerbate the impacts of air pollution along the coast. While overall emissions of major air pollutants tended to decrease or stabilise during the 2000s, air pollution hotspots remain in Haifa Bay, the Ashdod area and Ramat Hovav.[5] Transport is the main source of pollution in the very densely populated centre of the country.

Sulphur dioxide

Power generation is the major source of emissions of sulphur oxides (SO_X) (Table 6.1). While GDP and fossil fuel supply grew considerably between 2000 and 2008, SO_X emissions decreased by about 35%. As a result, SO_X emission intensity also decreased considerably, although it remains well above the OECD average and is among the highest in the OECD (Figure 6.3). Major emission decreases occurred in power generation and in the industrial sector, mainly as a result of improvements in fuel quality (reduced sulphur content) and

Table 6.1. **Atmospheric emissions by source**

1 000 t

		SO_2	%	NO_X	%	NMVOCs	%	CO	%	SPM[a]	%
Power stations[b]	2000	209.1	*73.7*	110.7	*46.7*	2.1	*0.9*	7.6	*2.0*	11 404.7	*53.2*
	2008	126.0	*68.5*	119.5	*60.6*	2.6	*1.0*	9.9	*4.6*	7 788.8	*54.3*
Industrial combustion	2000	46.4	*16.3*	25.2	*10.6*	0.6	*0.3*	1.3	*0.3*	7 853.0	*36.6*
	2008	21.9	*11.9*	15.8	*8.0*	0.4	*0.2*	1.0	*0.4*	5 476.6	*38.2*
Non-industrial combustion	2000	4.2	*1.5*	2.3	*1.0*	0.1	–	0.5	*0.1*	64.4	*0.3*
	2008	0.7	*0.4*	1.5	*0.8*	0.1	–	0.5	*0.2*	46.5	*0.3*
Industrial processes	2000	19.0	*7.0*	4.9	*2.1*	83.5	*34.9*	–	–	..	..
	2008	33.0	*18.0*	1.2	*0.6*	74.4	*29.2*	–	–	..	..
Mobile sources	2000	4.8	*1.7*	94.1	*39.7*	152.8	*63.9*	366.5	*97.5*	2 120.6	*9.9*
	2008	2.2	*1.2*	59.1	*30.0*	177.2	*69.6*	202.7	*94.7*	1 043.2	*7.3*
Solvents	2000	–	–	–	–	..	..	–	–	..	..
	2008	–	–	–	–	..	..	–	–	..	..
Miscellaneous	2000	..	..	..	..	..	..	..	..	..	..
	2008	..	..	..	..	..	..	..	..	..	..
Total	2000	283.9	*100.0*	237.2	*100.0*	239.2	*100.0*	375.9	*100.0*	21 442.7	*100.0*
	2008	184.0	*100.0*	197.1	*100.0*	254.7	*100.0*	214.1	*100.0*	14 355.1	*100.0*
Change 2008/2000		–35.2		–16.9		6.5		–43.1		–33.1	

a) Suspended particulate matter.
b) Includes the refining sector.
Source: CBS.

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the conversion of some power plants from heavy oil to natural gas (Table 6.1). End-of-pipe emissions reduction technologies, such as scrubbers, have been installed at some power plants (*e.g.* in Ashkelon) and are set to be installed at other units in the future. Preliminary data for 2009 indicate a sharp decline in emissions from mobile sources due to the adoption of a stricter limit on sulphur content (10 parts per million) in transport fuels beginning in that year.

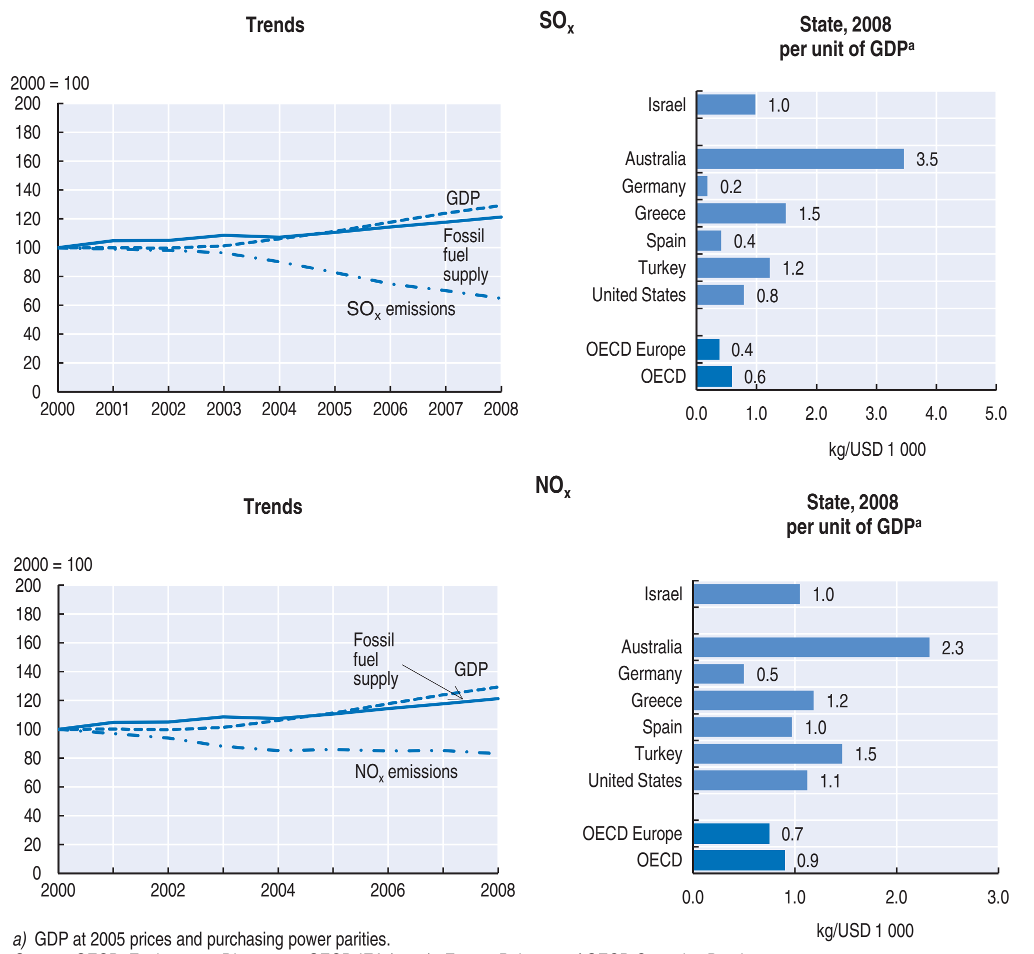
Reduced emissions have resulted in declining annual average sulphur dioxide (SO_2) concentrations throughout the country, including in major industrial areas (Haifa, Hadera, Ashdod, Ashkelon) and in Tel Aviv (Figure 6.4). Maximum annual concentrations remained below the annual standards at all monitoring stations. There was only one exceedance of the half-hour standard in 2008, in the area around Hadera and Haifa Bay.

Nitrogen oxides

Electricity generation and transport are the main sources of emissions of nitrogen oxides (NO_X) (Table 6.1). These emissions decreased by about 17% between 2000 and 2008, although they have tended to stabilise since 2004. This has resulted in their decoupling from GDP growth and fossil fuel supply and a decline in NO_X emission intensity. Nonetheless, NO_X emission intensity remains above that of most OECD countries and slightly above the OECD average (Figure 6.3). Despite the increase in road transport volumes, emissions from mobile sources have declined considerably owing to improved vehicle technology. This decline has been the major driver of NO_X emissions reductions (Table 6.1). While emissions from power generation have continued to increase, industrial emissions have decreased, resulting in lower concentrations of NO_X at major industrial sites.

Overall, annual average concentrations of NO_X have tended to decline slightly in Israel in the past decade. In the Tel Aviv metropolitan area this has been due, *inter alia*, to stricter vehicle emission standards, improved fuel quality, and more stringent vehicle inspections. However,

Figure 6.3. **Air pollutant emissions**



a) GDP at 2005 prices and purchasing power parities.
Source: OECD, Environment Directorate; OECD-IEA (2011), *Energy Balances of OECD Countries Database*; OECD (2010), *OECD Economic Outlook No. 88*.

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high annual average concentrations of NO_X continue to occur in the Tel Aviv and Jerusalem metropolitan areas due to heavy transport pressures while Israel's annual NO_2 concentrations exceed the recommendations of the World Health Organization (WHO) (Figure 6.4).

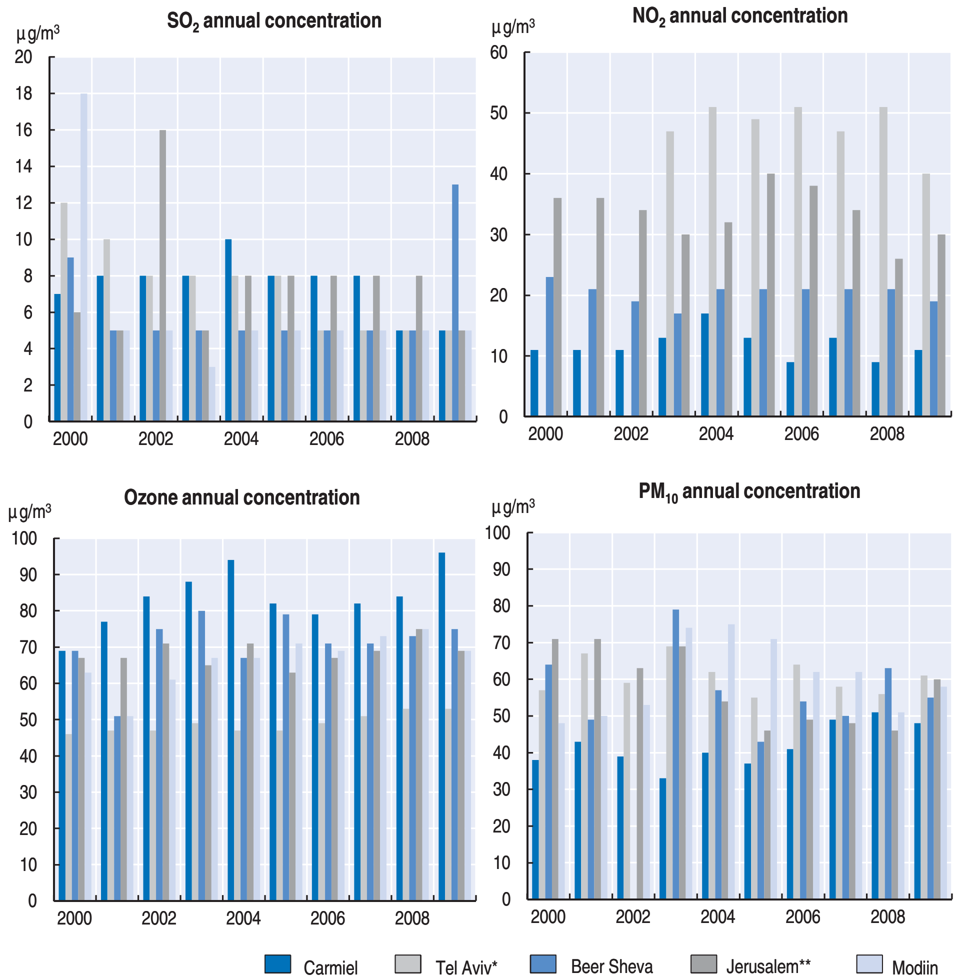
Non-methane volatile organic compounds and carbon oxide

Transport is also the major source of emissions of non-methane volatile organic compounds (NMVOCs) and carbon oxides (CO). Improvements in vehicle technology helped to reduce CO emissions by more than 40% between 2000 and 2008, whereas emissions of NMVOCs have continued to grow (Table 6.1).

Particulate matter

Electricity generation and industrial combustion are the main sources of suspended particulate matter (SPM) (Table 6.1). SPM emissions decreased by 33% between 2000 and 2008. Israel monitors both PM_{10} and $PM_{2.5}$. Annual average concentrations of PM_{10} are between 36 and 74 µg/m^3, depending on the location of the monitoring station. Israel has high background levels of PM, and concentrations tend to be higher at transport stations. In some areas, such as in Beer Sheva, there is a tendency for them to exceed the annual

Figure 6.4. **Air quality at selected locations**



*Tel Aviv monitoring sites: SO_2, NO_2, O_3 - central station; PM_{10} - Tahana Merkazit.
**Jerusalem monitoring sites: SO_2, O_3, PM_{10} - Safra; NO_2 - Efrata.
Source: MoEP.

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standard of 60 µg/m^3 (Figure 6.4). Annual concentrations of $PM_{2.5}$, which are very dangerous to public health, range between 17 and 29 µg/m^3 in some areas, above the European annual standard of 25 µg/m^3.

Ground-level ozone

Israel's ground-level ozone concentrations are high compared to WHO recommendations. Increasing annual average concentrations have been observed at most monitoring stations (Figure 6.4). Further, the WHO recommendation for an eight-hour value has been repeatedly and increasingly exceeded in recent years in many areas, including the largest urban areas of Tel Aviv, Jerusalem and Beer Sheva.

Ammonia

A national inventory of ammonia emissions was created only in 2011. Hence, no emission time series is available. It is likely that agriculture (livestock and use of fertilisers) is the major source of ammonia emissions, as in most other OECD countries. It seems probable that ammonia emissions have increased due to the growth in livestock numbers, although emissions might have been partly offset by the decline in inorganic fertiliser use (OECD, 2010).

Impacts of air pollution

Epidemiological surveys were carried out in Israel in the 1980s and 1990s to assess the health impacts of air pollution near power plants and industrial sites. The most recent assessment, carried out in 2003, compared public health risks from air pollution in two Israeli metropolitan areas, Ashdod and Tel Aviv. Based on 1995-99 data, it confirmed that air pollution in these regions increases both mortality and morbidity.[6] However, this was a one-off study. Reviews of the impacts of air pollution on human health, as well as associated economic and social costs, are not systematically performed nor are their results used to inform decision making. The impact of air pollution on ecosystems has not been examined.

3. Policy framework

3.1. Climate change

Israel ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1996. It is thereby committed to: periodically updating, publishing and making available national inventories of anthropogenic emissions of greenhouse gases; formulating, implementing, publishing and regularly updating plans to mitigate climate change; and formulating, publishing and implementing measures to facilitate adequate adaptation to climate change.[7] In 2004, Israel also ratified the Kyoto Protocol, which imposed greenhouse gas (GHG) emissions reduction quotas on developed countries. Unlike the majority of OECD countries, Israel is not an Annex I country and is not committed to achieve a specific GHG emissions reduction in the period 2008-12.

Further to UNFCCC ratification, the Israeli government established an inter-ministerial committee under the Ministry of Environmental Protection (MoEP) to develop a comprehensive emissions reduction strategy. The Committee produced Israel's first communication to the UNFCCC in 2000. In the early 2000s the Committee commissioned a number of expert studies to identify the potential for cost-effective emissions reductions. It failed, however, to secure cross-government support for a comprehensive emissions reduction strategy. Climate policy was subsequently developed in a piecemeal manner during most of the 2000s.

Notwithstanding this late start in formulating a climate change mitigation policy, Israel took important steps forward in the late 2000s. It made a commitment to reduce GHG emissions by 20% compared to a business-as-usual scenario in the period to 2020[8] through its association with the Copenhagen Accord, taken note of by global leaders at the 15th Conference of the Parties (COP) to the UNFCCC in December 2009.[9] Israel intends to fulfil its commitment primarily by achieving a 10% share of renewable energy in electricity generation and a 20% reduction in electricity consumption from a business-as-usual baseline (Section 5). This target was established on the basis of the aforementioned feasibility studies undertaken by the consultancy firms Heifetz and Co. and DHV MED (2009) and McKinsey & Company (2009). Four working groups were established in the areas identified as having the highest emissions reduction potential: energy efficiency, green buildings, transport, and renewable energy (Box 6.1).

Box 6.1. Israel's 2020 GHG emissions reduction target and mitigation potential

The Heifetz and McKinsey studies estimated that, under "business-as-usual" (BAU) scenarios, Israel's GHG emissions would be between 107 and 109 Mt CO_2 eq in 2020. Using these scenarios as a basis for calculation, Israel's target of reducing GHG emissions by 20% compared to BAU emissions by 2020 results in about 87 Mt CO_2 eq in 2020 or a reduction of about 22 Mt CO_2 eq (Figure 6.1). This constitutes an 18.7% increase in emissions during the period to 2020 calculated on a 2005 baseline. The following table compares this commitment with the emissions reduction commitments envisaged in selected OECD countries, with countries ranked according to 2008 GDP per capita.*

Emissions reduction commitments and GDP per capita of selected OECD countries

	% reduction on 2005 emissions	GDP per capita (USD 2008)[a]
Israel	+18.7	27 679
United States	–17.0	46 901
Ireland	–20.0	42 644
Canada	–17.0	38 883
Germany	–14.0	37 171
Spain	–10.0	33 173
Greece	–4.0	30 077
Portugal	+1.0	24 957
Poland	+14.0	18 062

a) At current prices and purchasing power parities.
Source: EU Decision No. 406/2009/EC; *OECD National Accounts Database.*

The table suggests that emissions reduction commitments adopted by other OECD countries broadly correlate with GDP per capita. This was the sole criterion used within the EU to share the aggregate EU commitment among Member States. Within such a framework, Israel is an outlier in that its commitment would constitute a significant emissions increase on 2005 levels. At the same time, its target implies decreases in GHG emissions per capita and per unit of GDP comparable to those that would be achieved in other OECD countries (OECD, 2011). In addition, Israel is not an Annex I country, which means that it does not have recourse to international carbon markets to meet its commitment.

Israel's mitigation potential is restricted due to both its rapid projected population and economic growth, and the relatively limited scope for abatement which has been identified by expert studies. The Heifetz study estimated a mitigation potential of approximately 31.7 Mt CO_2 eq in the period to 2025. According to the study, the measures with the highest abatement potential are energy efficiency in the building sector, appliance efficiency and solar energy. Some 73% of the abatement potential may be achieved at negative costs (Figure 6.5). If all the mitigation potential were to be exploited, in 2025 GHG emissions would be 19% higher than in 2000, as opposed to a BAU increase of 63%.

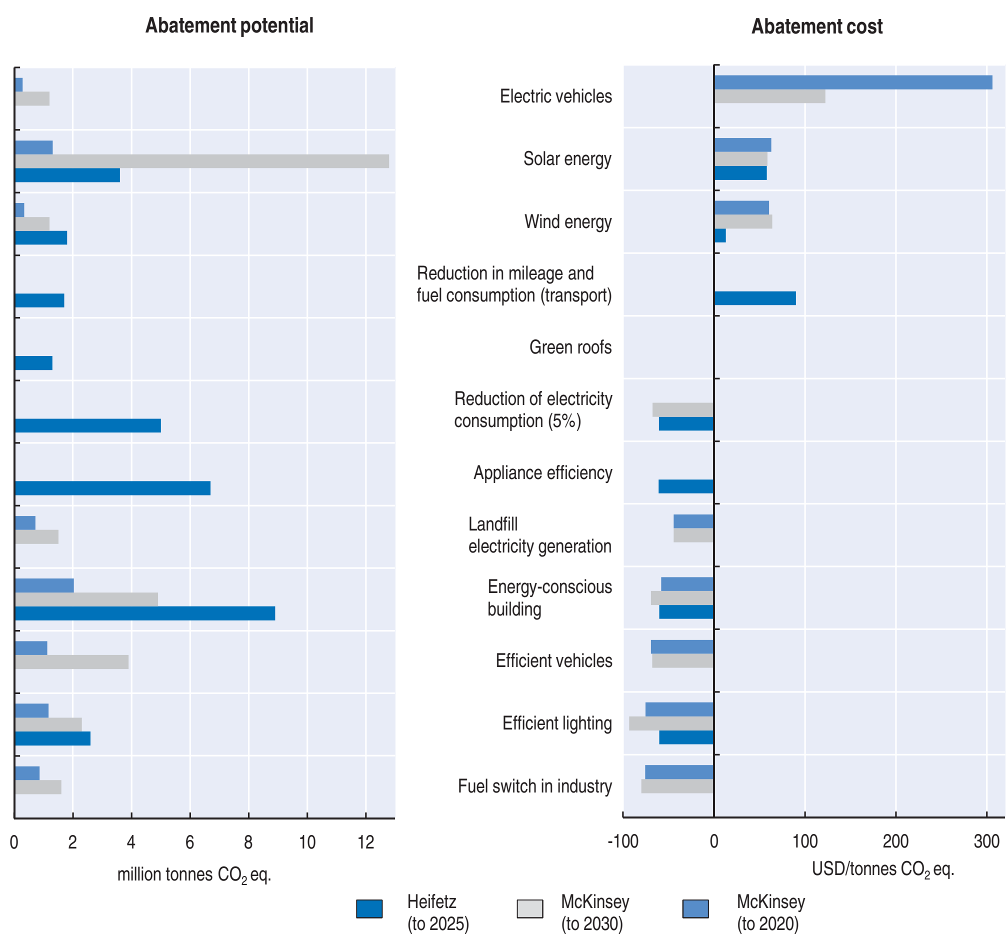
A subsequent analysis by McKinsey put Israel's abatement potential at approximately 45 Mt CO_2 eq in the period to 2030 (McKinsey & Company, 2009). Three broad measures would account for most of the abatement potential: higher energy efficiency in the building sector; the use of renewable sources for electricity generation; and improved vehicle efficiency, including the use of electric vehicles. Ten measures would account for 65% of total abatement potential to 2030, or 30 Mt CO_2 eq (Figure 6.5). The same measures would reduce

Box 6.1. **Israel's 2020 GHG emissions reduction target and mitigation potential** *(cont.)*

emissions by only an estimated 8 Mt CO_2 eq by 2020, and at a higher cost in view of the different level of technological maturity (Figure 6.5). As in the Heifetz study, many measures would have negative costs, or net benefits, for the economy. While the investment required to reach the full abatement potential is estimated at 1% of average GDP in 2011-30, this investment would be fully returned in the form of energy savings, implying that the total net cost of the abatement to the economy would be virtually zero. This analysis indicates lower abatement potential in Israel (32%) than in many other countries (where the average is around 50%) because of the low feasibility of many abatement measures, including hydroelectric power, biomass, and carbon capture and storage.

* Targets in the case of EU Member States relate to emissions not covered by the EU emissions trading scheme only. The aggregate EU target for emissions not covered by the ETS is –10%, (based on 2005 levels) by 2020. However, the aggregate emissions reduction envisaged under the emissions trading scheme across the EU is –21% (based on 2005 levels) by 2020. This is greater than the emissions reduction target envisaged by any Member State.

Figure 6.5. **GHG abatement potential and costs**



Source: MoEP (2010), Second national communication to UNFCCC; McKinsey & Company (2009); OECD (2010), *OECD Economic Outlook No.88*; OECD calculations.

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An inter-ministerial committee headed by the Director-General of the Ministry of Finance was established to identify the mitigation potential and economic impact of various measures, outline how measures would be implemented, and identify barriers to implementation. Following the Committee's recommendations, in November 2010 the government approved a resolution on the formulation of a comprehensive national plan for the reduction of GHG emissions. The government resolution allocates a budget of NIS 2.2 billion until 2020. NIS 540 million is allocated for the first biennium to specific broad emissions reduction measures, mostly reduction of household electricity consumption and an investment plan (subsidies for GHG emissions reduction projects) to be developed by the MoEP (Table 6.2). The government resolution also puts in place a follow-up and reporting mechanism. The MoEP is entrusted with the responsibility of overseeing implementation of the resolution, but implementation of each measure is assigned to identified ministries. The MoEP and the implementing ministries are required to report annually to the government. The inter-ministerial committee will continue to function for the purpose of monitoring implementation of the government resolution, as well as to evaluate the economic efficiency of the measures implemented until 2012 and recommend policy measures for the following period.

Table 6.2. **Budget allocations for GHG emissions reduction measures in 2011-12**

NIS million

Measures	Implementing ministries				
	National Infrastructures	Environmental Protection	Construction and Housing	Transport and Road Safety	Industry, Trade and Labour
Reducing electricity consumption in the domestic sector	269				
Support for investments in the reduction of GHG emissions, excluding the domestic sector		114			
Educational and information activities	30	11		5	
Support for initial installation of new technologies					40
Pilot project for new green building		16			
Survey of existing buildings		16			
Training for green building, including in academic frameworks		9			2
Support for energy surveys (including enforcement and follow-up)	8	5			
Pilot project for retrofit of existing buildings			7		
Standardisation for energy efficiency (including enforcement)	7				

Source: Government Resolution No. 2508/2010.

StatLink http://dx.doi.org/10.1787/888932495969

While a robust institutional infrastructure is in place to propose measures and instruments, and work is based on high-quality research, the mechanisms adopted to ensure implementation and monitoring of these measures (and the benchmarking of progress towards the target) appear to be insufficient compared to best practices in other OECD countries, such as in the UK.[10] The 2010 government resolution does not specify the implied emissions in the "business-as-usual" scenario, and therefore the implied emissions reduction target, which leaves room for possible reinterpretations of the target. Establishing a national target in legislation (expressed in tonnes of CO_2 eq in 2020) and formulating the comprehensive national action plan foreseen by the government resolution (November 2010) would aid effective implementation. This plan should encompass other strategies and plans, such the 2010 National Energy Efficiency Programme (Section 5), and identify a trajectory for meeting the target. To increase accountability for implementation, a progress report should be presented to the *Knesset* on an annual basis. Such a report should indicate progress in meeting the target, identify underlying sectoral drivers of emissions and obstacles to implementation, and evaluate the cost-effectiveness of emissions mitigation policy. Putting the inter-ministerial committee in charge of follow-up is a positive step. Opening the committee to independent experts and to parliamentary scrutiny would strengthen the review mechanism and provide a better basis for adjusting policy measures.

Adaptation to climate change

To address the challenges of climate change adaptation, the MoEP set up an inter-ministerial steering committee in 2006 headed by its Chief Scientist. The objective of the committee was to assess the potential impacts of climate change on Israel, and to recommend ways of preparing for and adapting to climate change as well as to promote the development of new concepts and technologies to address problems.

Adaptation measures are expected to be included in a national climate change adaptation plan. In line with best practices at international level, the national plan will consider the following issues: better integration of scientific considerations into decision making; methods and tools to assess adaptation actions; education, training and public awareness; technological development and effective use of resources and eco-innovation; promotion of local adaptation approaches; and proposals concerning legislation and standards that promote environment-friendly adaptation actions (MoEP, 2010). Table 6.3 shows the identified adaptation options. The ultimate goal is to integrate adaptation to climate change impacts in the sectoral, land use and environmental planning systems.

The MoEP has recently established an information and knowledge centre for adaptation to global climate change. This centre is expected to facilitate collection of information on adaptation to climate change in Israel, which will serve as a basis for the formulation of a national adaptation policy and a national action plan. It is also envisaged that establishing such a centre would facilitate the transfer of Israel's technology and know-how on climate change adaptation in fields such as water management (*e.g.* drip irrigation, leakage prevention), reuse of treated wastewater, seawater desalination, desert agriculture and afforestation.

3.2. Air emissions and quality

Israel's key air policy priorities are reducing air pollution from transport and at industrial hotspots. While it has not established official national emission ceilings for major air pollutants (Section 1), several pieces of legislation have long regulated air emissions from stationary and mobile sources, as well as establishing air quality standards.

The MoEP is responsible for the prevention of air pollution from stationary and mobile sources. The 1961 Abatement of Nuisances Law was the main legislative instrument for controlling air pollution until the Clean Air Law entered into force in 2011 (see below). Ambient air quality standards for 24 air pollutants, including SO_2, NO_X, CO, O_3, PM_{10}, heavy metals and chemicals, were set in 1992 and subsequently complemented by guidelines (not established in legislation) on alert procedures in case of high pollution. Most of these standards were less strict than those recommended by the WHO or adopted by the EU. Pollutant emissions from industrial and power plants were regulated by means of administrative orders,[11] specific air emission standards in business licenses, and pollution prevention plans for power plants. Several regulations have long been in place regulating vehicle emission standards, vehicle inspections and motor fuel quality, among others (Section 6).

Table 6.3. **Impacts of climate change and adaptation options**

Vulnerable sector	Possible impacts	Adaptation options
Water resources	• Reduction of water availability in aquifers and surface water bodies • Deterioration of water quality • Increased probability of flood events	• Expansion of desalination capacity • Efficient water use and effective water economy management • Improved modelling • Increased public awareness and change of consumption patterns • Enhanced water quality and quantity monitoring and modeling • Reassessment of water quality standards • Enhanced collaboration of authorities and institutions • Improved wastewater and drainage infrastructure • Enhanced management of the land-use interface in flood-sensitive areas
Agriculture	• Shortage of water supply for agriculture • Damages to crop productivity due to water deficiency and extreme climate conditions • Changes in crop growing seasons • Salination and erosion of soil • Reduced productivity of farm animals • Shortage of fresh animal feed • Increased risks of pests and farm animal diseases	• Increased use of treated effluents in agriculture • Efficient use of water and better adjustment of crop location to water availability • Better modelling and forecasts • Technological improvements in irrigation and cultivation methods and implementation of cultivation methods that prevent soil loss • Genetic improvements in crops and farm animals • Expansion and adjustment of crop varieties • Adjustment of planting and harvesting dates • Improvement of climate control systems in livestock farms • Development of substitutes for grains in animal feed • Selection of cattle species resistant to heat and pests and adaptation of animal husbandry methods
Coastal zone	• Coastal retreat • Sand removal • Damage to coastal infrastructure and tourism • Salination of the coastal aquifer • Damages to the coastal cliff • Increased probability of invasion of marine alien species • Coral bleaching in the Red Sea	• Incorporation of climate change implications into land use planning • Enhanced monitoring of sea level and coasts • Adaptation of coastal infrastructure • Use of sea protection and sand nourishment techniques • Enhanced international trade control to prevent invasion of exotic marine species • Prevention of sea pollution to reduce stress on coral reefs
Human health	• Increased incidence of parasitic and infectious diseases • Increased thermal stress • Increased risk of damage from extreme weather events	• Enhanced control and monitoring of disease-carrying vectors and risk assessment • Training of health experts • Improvement and adaptation of health systems to respond to climate change risks • Public education • Improved urban planning to reduce heat stress and air pollution
Ecosystems and biodiversity	• Loss of plant species in the semi-arid region due to desertification • Damage to local animal species populations • Changes in species composition in Lake Kinneret • Damage to nature reserves • Increased likelihood of forest fires	• Incorporation of climate change implications in the management of conservation areas and the establishment of ecological corridors • Research, monitoring and mapping of species vulnerability to climate change impacts • Enhanced management of forest resources along with their human interface • Forest thinning • Genetic improvements in forest tree species • Selection of resistant tree species for afforestation
Energy and infrastructure	• Increased energy demand due to greater heat stress, particularly during peak heat waves • Damage to infrastructure in vulnerable areas	• Use of renewable energy to meet increased energy demand • Increased energy efficiency • Adaptation of building regulations to new climatic conditions • Identification and protection of vulnerable infrastructure and industries • Enhanced resource management
Economy	• Damage to public and private property • Increased costs of goods and services • Higher burden on the insurance industry	• Cost-benefit analysis of adaptation action vs. inaction in selected fields • Economic incentives that promote adaptation to anticipated climatic changes • Risk analysis for the insurance industry

Source: MoEP (2010).

Approval of the Clean Air Law in 2008 (entered into force in 2011) is a major step forward, as this law provides a comprehensive regulatory framework for air management. It establishes a framework for setting emission standards for mobile and stationary air pollution sources and for the revision of ambient air quality standards. Regulations on ambient air standards were adopted in 2011. They include target values based on WHO guidelines, and ambient and alert values based on European standards.

The Clean Air Law establishes emission permitting requirements for large industrial facilities based on best available techniques (BATs). It foresees public participation in the permitting process.[12] All air permits must be issued by 2015 (Chapter 2). The law also strengthens the MoEP's enforcement powers and the response to non-compliance, allowing for the possibility of both administrative and criminal sanctions. About 150 industrial facilities, accounting for 80% of national air emissions from stationary sources, will be covered by the air permits. Air emissions from other facilities will continue to be regulated through business licenses and sectoral binding rules or general regulatory standards, based on the German TA-Luft regulation.[13]

The Clean Air Law mandates the formulation of a 2010-20 national programme, led by the MoEP, to guide government-wide air pollution abatement actions. Based on current and projected air emission trends, this programme will include a detailed set of policy measures in all sectors of the economy, chosen according to a cost-benefit analysis. An annual budget of NIS 1 million was allocated for the programme in the first two-year period. It is important for this programme to be co-ordinated with the action plan to abate GHG emissions and the sectoral plans for the energy and transport sectors, in order to increase efficiency and harness potential co-benefits.

Under the Clean Air Law, the MoEP remains the main authority responsible for air pollution management and enforcement. Local authorities, which are responsible for managing air pollution at the local level, can issue local regulations for this purpose. In case of frequent exceedances of ambient air quality standards, local authorities (individually or jointly) are required to formulate an action plan for improving air quality. The majority of Israeli municipalities have started to co-operate on the development of climate change and air pollution abatement plans, independently of the new legislative requirements (Box 6.2).

The Clean Air Law allows for the introduction of an air emission levy on large industrial facilities that require a permit. Proceeds can be earmarked for rewarding installations that reduce their emissions beyond the level required by the permit. Experience in other OECD countries (such as Japan and Sweden) shows that air emission levies can be effective in reducing emissions from stationary sources and in promoting innovation, and that they can be effective in combination with emission standards (OECD, 2010). The levy should be paid per unit of pollutant emitted, irrespective of the emission limit set in the air permit. It should be introduced for a limited number of priority pollutants, so that it may be set at a sufficiently high rate without entailing excessive costs to installations. Since the emission limit for a large installation is tailored to the installation itself on the basis of BATs (which imply economically reasonable requirements), there could be limited scope for further abatement in the short term for average companies. However, it can be useful to implement such a levy for smaller installations, which remain subject to sectoral and less flexible standards. An emission levy, as opposed to financial incentives to go beyond the emission standard, would

Box 6.2. **The Israeli Forum of Self-Governing Cities**

The Israeli Forum of Self-Governing Cities (or Forum 15) brings together 15 major, financially independent municipalities. They account for about 40% of Israel's population, although more than 80% of the population lives or works in their metropolitan areas.

In February 2008, Forum 15 mayors and those of another three municipalities signed the Convention of the Forum 15 for Reducing Air Pollution and for Climate Protection. This is a local Israeli version of the Cities for Climate Protection (CCP) Campaign initiated by ICLEI – Local Governments for Sustainability. The convention calls for the development of municipal master plans for the reduction of air pollution and greenhouse gas (GHG) emissions, with a view to:

- establishing a basic inventory and outlook for key sources of cities' air pollution and GHG emissions;
- setting targets for the reduction of air pollution and GHG emissions (no less than 20% by 2020 compared with 2000);
- developing and adopting a local action plan to reduce air pollution and GHG emissions;
- implementing all measures and actions derived from local action plans;
- monitoring and controlling air pollution and GHG emissions, and reporting on actions and measures implemented within the framework of local action plans.

Most municipalities have completed their baseline emissions inventory and outlook and are now defining their annual GHG emissions reduction targets. This is accompanied by the development of local action plans to reduce air pollution and GHG emissions in four main areas: transport and fuels; energy efficiency and environment-friendly construction; waste and recycling; and green spaces.

In 2010, the MoEP, the Forum 15 and the Union of Local Authorities in Israel decided to launch a NIS 1 million project to promote a climate protection project in all of Israel's local authorities (of which there are about 200), based on their different needs and conditions. The programme will be accompanied by training and capacity-building and will concentrate on reducing GHG emissions in three areas: electricity consumption; waste disposal; and wastewater treatment.

generate revenue and be more cost-effective than subsidising abatement beyond the allowed emission level.[14]

3.3. Monitoring and reporting

GHG and air pollutant emissions inventories

Comprehensive and regularly updated greenhouse gas (GHG) and air pollutant inventories are a necessary building block for the delivery of effective air management and climate policies. During the review period, significant progress has been made in developing a comprehensive emissions dataset and in the regular publication and communication of this information.

GHG emissions inventories for the years 1996 and 2000 were prepared on an *ad hoc* basis. The Central Bureau of Statistics (CBS) began compiling annual inventories in 2003 for emissions of the three main GHGs (CO_2, CH_4 and N_2O) and of indirect GHGs. However, the CBS compiles GHG emissions inventories on the basis of a general mandate to collect and produce environmental data and not of a specific government regulation or directive. In the EU, by comparison, the process of data monitoring, reporting and verification of emissions in Member States is prescribed by legislation (Directive 2003/87/EC). Data on emissions of the so-called "F gasses" were not collected in Israel until 2009.

An "air resources management system" tested in 2007 is expected to be fully operational in 2011. It includes the development and regular update of a National Emissions Inventory covering the major air pollutants (SO_X, NO_X, PM_{10}, NMVOCs and CO) and all emission sources throughout the country. It presents average maximum hourly emissions and the location of emission sources.

A voluntary GHG national reporting register was launched in July 2010. Companies and organisations may use it to report emissions. To reporting entities, the voluntary register will serve as a learning tool for quantifying GHG emissions, internalising and streamlining required procedures, managing business risks associated with GHG emissions, and identifying emissions reduction opportunities. The register could be a step towards establishing a mandatory register in the future. This would be consistent with Israel's commitment to implement the OECD Recommendation on implementing Pollutant Release and Transfer Registers (PRTRs) (Chapter 2).

Despite progress, current procedures for the collection and presentation of GHG and air emissions data could be strengthened. It remains illegal for the Central Bureau of Statistics to report and publish data which would identify specific installations. Data may therefore be published by the CBS only in aggregate form unless it obtains explicit consent from the surveyed installations. In the EU, by contrast, GHG and air emissions data from installations above a certain size are attributed to that installation. This transparency facilitates better understanding among policy makers and the public of the emissions performance and mitigation efforts of specific companies and installations. The Clean Air Law opens the door for GHG emissions from large stationary installations to be regulated and reported, and for emissions performance to be considered in the permitting process.[15] How this might work in practice remains unclear.

Procedures for reporting annual emissions inventories greatly improved during the review period, but they are not sufficiently detailed to form a basis for the development and implementation of comprehensive national plans to reduce GHG and air emissions. Nor would current reporting procedures enable effective ongoing monitoring of progress to meet commitments. This deficiency arises because annual reporting covers only trends for each GHG and air pollutant type and for macro-sectors; no sector-specific data are presented, and no analysis of the underlying drivers in each sector is undertaken or reported.[16] The publication of an annual report outlining key sectoral trends, and a brief analysis of the underlying drivers in each sector, would facilitate better understanding of climate and air policies, including their challenges and implications.[17]

Air quality monitoring network

With over 100 air quality monitoring stations, Israel's monitoring network is considered to be among the densest in the world. Air quality monitoring at specific sites dates back to the early 1970s. A national network was put in place in the late 1990s according to EU and US standards. The stations are operated by the MoEP (23 fixed stations and two mobile stations), municipal associations for the environment, the Israeli Electric Corporation and some industrial plants. Background or general stations measure SO_2, NO_X, O_3, CO and PM, while transport monitoring stations (located close to primary traffic nodes) measure concentrations of NO_X, CO, PM and hydrocarbons. The MoEP's equipment is certified by the United States Environmental Protection Agency and the location of transport monitoring stations is in accordance with the EU standards. Air quality data are published in real time, and on an annual basis, on the MoEP's website. Information on air quality is usually made available on request free of charge.[18]

Differences in measurements between monitoring stations in the same area may result from lack of uniformity in data control among different monitoring bodies. This problem should be solved with the entry into force of the Clean Air Law, which requires the MoEP to develop guidelines and procedures for air quality monitoring. Efforts are currently being made to prepare a laboratory quality and accreditation system for the air monitoring network operated by the MoEP. The air resources management system is also expected to allow for air quality forecasts, including alerts for high pollution.

4. Cross-sectoral policy instruments

While Israel has comprehensive legislation on air pollution, there is no specific legislation on climate change and economy-wide tools such as a carbon tax or an emission cap-and-trade system are not currently used.

The 2010 Government Resolution on the "formulation of a national plan for the reduction of greenhouse gas emissions in Israel" mandates the Ministry of Finance to formulate recommendations on the use of direct and indirect taxation incentives to reduce GHG emissions by August 2011. Although an economy-wide carbon tax has not been proposed, it is one of the instruments under consideration. A Bank of Israel study found that a tax per tonne of CO_2 emissions would significantly reduce emissions with only a minor economic impact, even if the rate of taxation were set at a relatively high level (Palatnik and Mordechai, 2010). Evidence from European countries supports these findings and demonstrates that carbon taxation can have a positive impact on economic growth and competitiveness (Andersen and Ekins, 2009). For example, the introduction of carbon or energy taxes with revenue recycling in Denmark, Finland, Germany, the Netherlands and Sweden had a positive effect on GDP compared with the counterfactual reference case of no environmental tax reform (Andersen *et al.,* 2007).

In the absence of a carbon tax, excise duties already imposed on fossil fuels could be adjusted to reflect a carbon price component. While this would not replicate a universal carbon tax, it would cover a large share of Israel's GHG emissions. At the beginning of 2011, the excise duty on coal was raised considerably (to NIS 43.3/tonne from NIS 8.6/tonne) and it is now higher than the tax on oil and gas. This is consistent with the higher carbon content of coal compared to that of natural gas. Tax rates on primary fuels (natural gas, coal and oil for electricity generation and industrial use) remain below the price of carbon prevailing, for example, in the EU CO_2 emissions trading system (EUR 15 per tonne of CO_2). Calculations suggest that the excise duty on coal should increase to NIS 162 per tonne to internalise the social cost of CO_2 emissions alone, without considering other environmental impacts and additional reasons to impose such taxes (Table 6.4).

The Clean Development Mechanism (CDM) has been used to reduce emissions in several economic sectors.[19] In 2004, a Designated National Authority was created to authorise CDM projects in Israel. By the beginning of 2009, 54 projects had been submitted for approval in the areas of waste, agriculture, fuel switching, energy, and industrial efficiency. Sixteen projects had been registered with the United Nations, amounting to an

Table 6.4. **Excise duties on fuels and implied carbon prices**

Fuel	Excise duty (NIS/unit)	CO_2 emission factor (kg CO_2/unit)[a]	Implied carbon price of excise duty (NIS/t CO_2)	Implied carbon price of excise duty (EUR/t CO_2)[b]	Implied excise at EUR 15/t CO_2 (NIS/unit)
Premium unleaded petrol (1 000 litres)	2 890.00	2 301.8	1 255.5	261.6	165.7
Diesel (1 000 litres)	2 760.00	2 641.3	1 044.9	217.7	190.2
Heavy oil (tonne)	13.99	3 190.0	4.4	0.9	229.7
Natural gas (1 000 m^3)[c]	14.09	2 023.0	7.0	1.5	145.7
Coal (tonne)	43.30	2 251.2	19.2	4.0	162.1
Light fuel oil for households (1 000 litres)	2 195.00	2 529.9	867.6	180.8	182.1
Light fuel oil for industry (1 000 litres)	13.62	2 529.9	5.4	1.1	182.1

a) UK Department for Environment, Food and Rural Affairs.
b) Assuming an exchange rate of NIS 4.8/EUR.
c) Excise duty: NIS 15.53/107 kcal; average gross calorific value of natural gas: TJ 38/million m^3.
Source: OECD-IEA (2011), *Energy Prices and Taxes Database*; OECD calculations.
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annual emissions reduction of 1.6 Mt. Permits (certified emissions reductions) equivalent to 0.44 Mt CO_2 eq from four projects have been issued.

Access to international funding under the CDM is one of the advantages Israel enjoys as a non-Annex I country. A disadvantage is that the Israeli government does not have recourse to international carbon markets to meet future mitigation targets, which must therefore be achieved through domestic measures alone. The 2010 Government Resolution requires the MoEP, in co-operation with the Ministry of Finance and the National Economic Council, to examine the possibility of integrating the country into the international GHG emissions markets.

5. Policies and measures in the energy sector

The extent to which sustainability objectives are integrated into decision making frameworks for energy policy was the subject of some debate during the review period. The master plan for electricity production of the Ministry of National Infrastructures (MoNI) for the period 2007-30, published in 2007, stated that one of its strategic targets was the "long-term reduction of greenhouse gas emissions per person so that it would not rise above a level acceptable in developed countries". The State Comptroller's Office (2009), however, found that in relation to this commitment "the master plan does not lay a foundation for achieving its strategic target but only serves as a general statement".

Progress has been made in addressing this imbalance. Common pricing of the environmental externalities associated with electricity generation originally proposed by the MoEP were agreed by all government departments. Since the EU ETS permit price was used as the shadow price for CO_2 emissions, the real environmental impact of emissions may be underestimated.[20] However, these values are used only for determining the feed-in tariff for generation of electricity from renewable sources, whereas a common and consistent shadow price for carbon, and trajectory for future carbon prices, should be applied in all policy assessments.

The electricity sector is expected to contribute to most of the targeted 22 Mt CO_2 eq emissions reductions by 2020. The government set the target of reducing electricity consumption by 20% by 2020, which would translate into GHG emission savings of about 12 Mt CO_2 eq in that year. This target has been supplemented by the goal of generating 10% of electricity from renewable sources by 2020, which would provide about 5 Mt CO_2 eq in additional GHG emission savings. It is not yet clear how the remaining emissions reductions are expected to be achieved, or what the relative role of the transport, waste and agricultural sectors will be. Promotion of renewable energy sources and of energy efficiency is expected to contribute considerably to the reduction of air pollution, although this contribution has not yet been quantified.

5.1. Fossil fuel supply

Israel's energy sector and electricity generation system stand out among those of OECD countries for a number of reasons. They include: geo-political limitations that do not permit Israel to connect to the electricity networks of neighbouring countries, thus requiring an autonomous electricity grid; limited land resources, which limit expansion of the electricity production system; and political obstacles to using nuclear power. Therefore, Israel's energy sector is isolated and heavily dependent on imported oil and coal. These factors underpin discussions on energy security. They are also relevant with regard to policies that seek to integrate intermittent electricity sources, such as some renewable sources, into the grid.

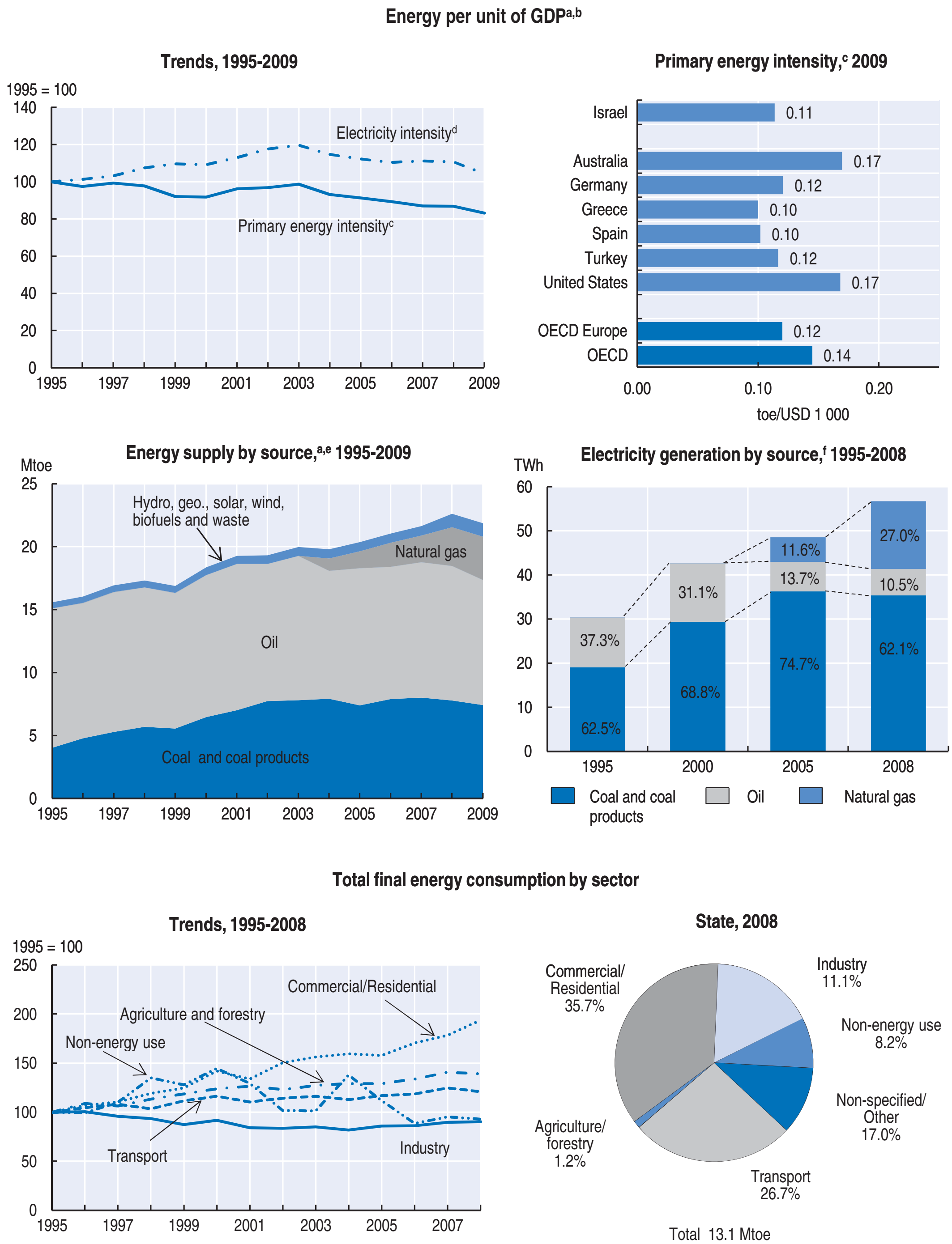
The discovery of about 33 billion m^3 (bcm) of natural gas at the Mari-B deposit off the Ashkelon coast in 2000 had a significant impact on Israel's generation portfolio during the review period. While coal still accounts for the greatest part of electric power generated, most of Israel's oil-based power generation has been displaced by gas since 2004. Use of natural gas to produce electricity increased from zero in 2003 to over 27% of power production in 2008 (Figure 6.6). As a result, between 2003 and 2008 the emission intensity of electricity production fell from 830 to 740 grams of CO_2 per kilowatt hour, partly mitigating the increase in emissions from this sector.

The fuel switch to natural gas has also contributed to a decrease in SO_X emissions, together with the use of low-sulphur oil and coal. Nonetheless, overall energy supply and electricity production increased considerably during the decade to meet demand from the growing economy and population (Figure 6.6). This has more than offset the impact of the fuel switch on GHG emissions and has been the main driver of increasing emissions. With more than 80% of its energy supply provided by coal and oil, Israel remains relatively dependent on these fuels compared with most OECD countries.

Further discoveries of off-shore reserves are expected to help Israel overcome its dependence on imported fuels and to reduce emissions.[21] The strategic implications of these gas discoveries, and the extent to which gas infrastructure might be developed to increase its potential share in the power generation portfolio, form part of an ongoing debate. Some government authorities argue that the share of natural gas could not rise beyond 50-55% by 2020 without compromising the security and flexibility of energy infrastructure and supply. Others believe this share could reach 70%. Within the context of this debate, construction of two additional 650 MW power plants in Ashkelon has been delayed several times due to differences of opinion among ministries concerning the trade-off between security/competitiveness of supply and environmental implications. A decision has finally been reached whereby a combined cycle gas-fired plant will be constructed with coal back-up.

The business-as-usual emissions scenarios in the Heifetz and McKinsey studies (used as a basis for defining the emissions reduction target) assume that natural gas accounts for about 45-50% of electricity generation. If recent gas discoveries enhance the medium-term

Figure 6.6. **Energy structure and trends**



a) Excludes international marine and aviation bunkers.
b) GDP at 2005 prices and purchasing power parities.
c) Total primary energy supply per unit of GDP.
d) Electricity consumption per unit of GDP.
e) Breakdown excludes electricity trade.
f) Including renewable energy sources (less than 0.5%).

Source: OECD-IEA (2011), *Energy Balances of OECD Countries Database*, OECD-IEA (2010), *Energy Balances of Non-OECD Countries Database*, OECD (2010), *OECD Economic Outlook No. 88*.

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potential of switching from coal to gas, the additional abatement potential should not be counted towards meeting Israel's target, as it could undermine the incentive to achieve the energy efficiency and renewable energy goals.

5.2. Renewable energy sources

Renewable energy sources hovered at around 3% of primary energy supply until 2007 (Figure 6.6). This is almost entirely due to the traditional widespread use of solar-thermal panels for water heating. Legal requirements for the installation of solar water heaters have been in force since 1980. Solar water heating accounts for 80% of all water heating requirements annually.

Government objectives to promote renewables in power generation have not been met. In 2002, the government established a goal of generating 2% of electricity from renewable energy sources by 2007, to be increased by 1% every three years so that 5% of total electricity would be produced from renewables by 2016. However, less than 0.1% of Israel's electricity was produced from renewable sources by 2007.

Implementation has been more successful since 2008. Overall, the renewable share of primary energy supply jumped to nearly 5% in 2008. The first feed-in tariff framework with production quotas was introduced for small-scale photovoltaic (PV) systems in that year. When quotas were exhausted, new quotas were introduced in 2010. Consequently, electricity generated from solar photovoltaic systems increased from 1 to 229 GWh in just one year and renewables reached 0.4% of electricity output in 2008, although still well below the 2007 target.

In 2009, the government established a goal of achieving 10% of total electricity supply from renewables by 2020, with an interim target of 5% to be achieved by 2014. This target was the result of a bottom-up analysis assessing the potential for renewable energy in Israel. The targets adopted for individual technologies and interim milestones are shown in Table 6.5. Technology-specific targets might limit investment decisions, thereby reducing efficiency. Large-scale solar and wind installations are expected to account for most additional renewable generation capacity. The renewables target is predicated on the achievement of the target for energy savings (Section 5.3). If the energy-saving target is not met, the total energy requirement will be higher. The renewables target would therefore not be met either.

Table 6.5. **Renewable energy and energy savings milestones by technology**

	2014/15	2016/17	2018/19	2020	% contribution to target
Energy savings goal %	7.0	12.0	17.0	20.0	
Consumption forecast (TWh)[a]	60.4	61.5	64.5	64.3	
Wind (MW)	250.0	400.0	600.0	800.0	29.0
Biomass and biogas	50.0	100.0	160.0	210.0	7.6
Large-scale solar (CSP and PV)	700.0	750.0	1 000.0	1 200.0	43.5
Medium-scale PV	350.0	350.0	350.0	350.0	12.7
Small-scale PV (up to 50 kW)	200.0	200.0	200.0	200.0	7.2
Total installed capacity (MW)	1 550.0	1 800.0	2 310.0	2 760.0	100.0
Renewable production %	5.3	6.5	8.3	10.2	

a) Assumes energy savings target is met.
Source: MoNI (2010).

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The government has established a complex system of incentives to promote renewable energy with a view to achieving the 2020 target. Quota-limited feed-in tariffs have been set for several technologies. Further feed-in tariffs are anticipated in 2011 (Table 6.6). The premium payment is determined, *inter alia*, on the basis of saved external costs due to air and GHG emissions avoidance. The full feed-in tariff is available to developers for 20 years. The feed-in tariff for current quotas is set to be phased out by 2020.[22] The cost of the feed-in tariffs is fully passed on to consumers through electricity tariffs. Feed-in tariffs need to be frequently reviewed to take account of decreasing technology costs; this is particularly valid for household PV systems, whose cost is dropping rapidly. Government tenders are also used to promote renewable energy policy development where land is state-owned, as is the case of the majority of Israeli land. Two types of tenders have been used, based either on land rental cost or electricity price. Finally, an accelerated capital depreciation allowance of 25% is available for solar PV and solar thermal energy investments. However, while a large share of the available or intended quotas has been allocated for solar electricity generation, little progress has been made on wind and biomass production.

Table 6.6. **Feed-in tariffs for renewable energy projects**

	Feed-in tariff	Planned mechanisms	Projects under development
PV commercial	Set in 2008 and 2010	Feed-in tariff, quota based	50 MW in 2008. 120 MW in 2010.
PV Residential	Set in 2008	Feed-in tariff, quota based	Quota of 15 MW set in 2008, unlimited quota set for 2010.
PV medium	Set in 2010	Feed-in tariff, quota based	300 MW quota has been made available. Applications exceed 650 MW. The guaranteed price is about USD 0.04/kWh.
Thermo-solar or PV large-scale	Set in 2011	Mixture of tenders on land rental, electricity price and quota-limited feed-in tariffs	500 MW quota has been made available. Tenders on the price of electricity for three plants located in Ashelim (totalling 250 MW) were issued in 2007. A price equivalent to about USD 0.03/kWh has been guaranteed, but the project has been delayed. 60 MW tender for Timna planned 2011. A tender for a thermal solar plant of 280 MW has been launched.
Wind, small-scale residential and commercial	Set in 2009	Feed-in tariff, quota based	Quota of 30 MW announced.
Wind, medium- and large-scale	Announced in 2011	Mixture of tenders and quota-limited feed-in tariffs	155 MW project planned. Quota of 800 MW.
Biogas, biomass	Anticipated in 2011	Feed-in tariff, quota based	3-5 MW Abudis landfill in progress. Quota of 160 MW.

Source: Adapted from MoNI (2010) and Renewable Energy Association of Israel.

Complex, differentiated and technology-specific instruments may be required to promote renewables to the extent that such measures aim at long-term cost reductions rather than only short-term emissions abatement. They can also be justified in the context of Israel's complex land ownership patterns. However, use of overlapping instruments creates challenges. For example, failure to complete the Ashalim tender for a large-scale plant has had the knock-on effect of delaying the announcement of the feed-in tariff available for additional large-scale solar plants for fear it might interfere with the tendering process.[23]

Several obstacles must be overcome if policy implementation is to be effective in the coming period. The field of renewable energy is regulated by government decisions which are not legally binding, the division or responsibilities is unclear, and policy co-ordination among actors responsible for meeting targets is poor. While, for example, the Ministry of

National Infrastructures has instructed the energy regulator (the Public Utilities Authority – Electricity, PUA) to introduce feed-in tariffs for various renewable technologies, the legal basis under which the PUA might do so is not clearly established. In particular, cross-subsidisation of tariffs remains prohibited.

Furthermore, financial incentives to develop renewable energy projects are inconsistent and, to some degree, offset by charges associated with re-zoning of land. In the case of privately owned land, re-zoning which increases the value of land will result in a 50% tax on the increased land value, to be paid to the local zoning committee. If the land is publicly owned, lease tariffs are set by a property evaluator appointed by the Israel Land Authority on a case-by-case basis. Several methods may be employed to conduct the evaluation, resulting in varied and unpredictable outcomes.

The re-zoning process itself is complex and time-consuming. The majority of land suitable for large-scale renewable energy projects in Israel is used for agriculture, and there is an ongoing debate concerning the use of agricultural land. There are further differences of opinion among government agencies regarding the extent to which natural spaces should be preserved. The Ministry of the Interior has been tasked with developing a strategic plan which would identify suitable areas for renewable energy development, with the objective of streamlining the re-zoning process. As part of this process, a National Master Plan for Solar Installations was developed in 2010.

Although the land requirements associated with renewable energy development are not insignificant, at an estimated 33 km^2 in the period to 2020, this represents only a small fraction of the total land area of the Negev and Arava regions (which have a total area of 14 200 km^2). The extent to which land shortages *per se* are the central obstacle is therefore debatable. These areas have become increasingly drought prone, and the impacts of climate change are projected to become more pronounced in the future. The cost of keeping desert land in agricultural use requires careful re-evaluation to take account of this evolving context.

A final challenge surrounds upgrading the grid to facilitate the increased penetration of renewables. For example, the grid in the Southern Arava region (which has the highest potential for solar power in Israel) can accommodate only 100 MW of electricity. The Timna tender envisages 60 MW in the region, and several additional projects are at various stages of development. Grid upgrades are the responsibility of the Israel Electric Corporation (IEC), yet approval by the MoNI is required and lack of co-ordination can delay projects considerably. Formidable procedural obstacles put in place by the IEC also make securing connection to the grid challenging for renewable projects, even when the necessary grid upgrades have been delivered (Mor and Seroussi, 2007).

If these difficulties are to be overcome, a firm sense of direction will be required from central government, along with a more co-ordinated approach to implementation involving all stakeholders and government agencies. To achieve renewable targets, it is essential for the Ministry of the Interior's strategic plan to bring forward clear and binding guidelines, to be followed by the relevant zoning committees and government agencies. There are also opportunities to speed up and twin-track the application process for building permits, electricity production licenses and grid connection licenses.

5.3. *Energy efficiency in electricity consumption*

Energy consumption grew dramatically during the last decade, especially in the residential and commercial sectors, which account for more than 35% of final energy use (Figure 6.6). Electricity demand, in particular, grew considerably due to rapid population growth and wider use of electrical appliances, including air conditioning, coupled with higher incomes.

An Energy Master Plan, published in 2004, first identified cost-effective savings equivalent to 20% of energy use. A limited number of initiatives were subsequently introduced. Energy service companies were licensed to harness energy efficiency potential, particularly in the public sector, and voluntary standards were developed to enhance efficient energy use in the building sector,[24] although these are seldom applied in practice.

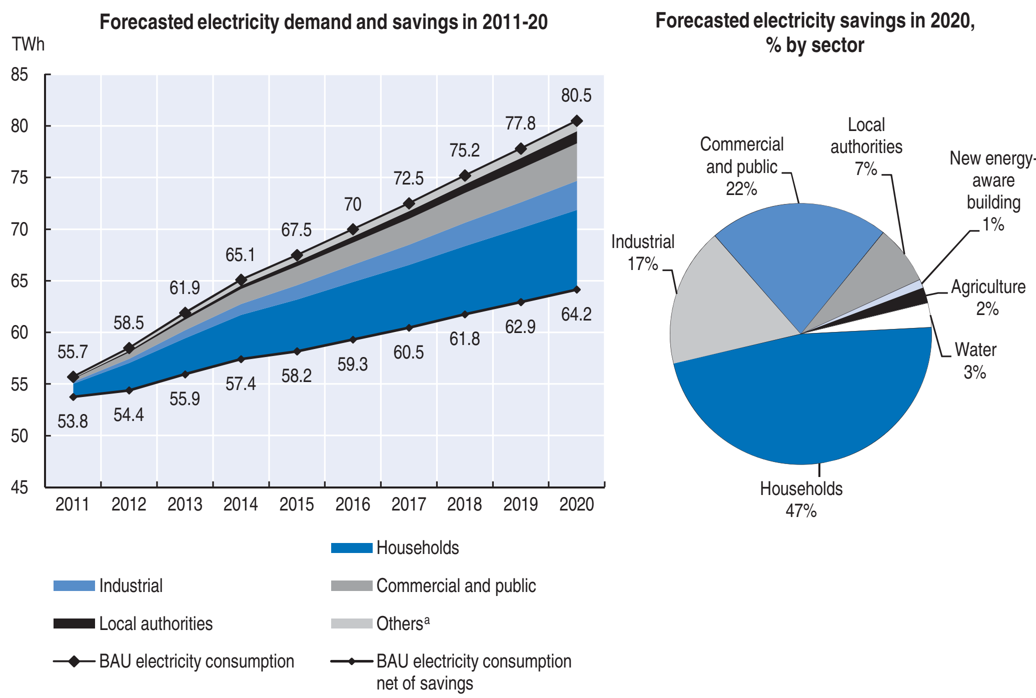
In 2008-09, several regulations and standards were published on energy efficiency and the energy labelling of electrical appliances (including refrigerators, air conditioners, dishwashers, washing machines, baking ovens and clothes dryers), in addition to regulations and standards published in previous years. An energy conservation campaign was also inaugurated by the MoNI, the MoEP and the IEC to raise awareness of energy efficiency among the general public. In 2009 and 2010, the MoNI published several tenders related to energy efficiency, including pilot projects for the distribution of energy efficient light bulbs, energy efficiency in hotels, energy efficiency in government buildings, and small-scale energy efficiency projects.

A new government target of achieving a 20% savings in anticipated electricity consumption by 2020 was adopted in September 2008. The 2010 National Energy Efficiency Programme (NEEP), prepared by the MoNI, is expected to achieve about 16 TWh of savings in electricity demand by 2020 (Figure 6.7). This would imply reducing average growth in electricity demand from 3.9% per year under a business-as-usual scenario (comparable to the estimated GDP growth) to 1.6% per year. This rate is comparable to estimated population growth and implies stabilising electricity consumption per capita during the next decade (OECD, 2011). The NEEP will then contribute to reducing GHG emissions by 12 Mt CO_2 eq by 2020.

The NEEP establishes savings targets by sector. Most of the savings are intended to be achieved in the household, commercial and public sectors (including local authorities) (Figure 6.7). The programme sets out several measures and an implementation schedule between 2011 and 2020 for each sector. Among these measures are: introducing regulatory changes, such as higher energy efficiency standards for electrical appliances, light bulbs and industrial equipment; subsidising the replacement of appliances for low-income households; a light bulb replacement programme; investments in the public sector;[25] tax incentives (*e.g.* an accelerated depreciation rate and tax benefits for investment in energy-efficient devices) for the business sector; and public information campaigns. The NEEP is expected to cost about NIS 200 million per year, mostly to cover the various subsidies and investment schemes, compared to overall estimated cost savings for the economy of USD 4.35 billion by 2020 (due to avoided additional electricity generation capacity). About 75% of the funds are allocated proportionally to the expected savings from implementation of each measure. The remainder is reserved for so-called “systemic” measures such as regulation, awareness campaigns and enforcement.

The market failures which prevent these negative-cost investments from being made have been well-documented (IEA, 2007).[26] To overcome these market failures, the action plan proposes the establishment of an energy efficiency fund financed by a surcharge on the unit price of electricity. This is expected to provide an additional incentive to reduce electricity consumption. The surcharge has been determined so that it is comparable to the

Figure 6.7. **National Energy Efficiency Programme**



a) Includes savings to be achieved in the building (new energy-aware buildings), agriculture and water sectors.
Source: MoNI (2010).

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electricity price increase that would be required to fund additional electricity generation if the energy savings were not made. It is estimated to yield about NIS 200-250 million per year, covering the programme's expected implementation costs. The establishment of an energy efficiency fund could be a positive development if interventions targeted measures with a positive net present value when environmental benefits are included. It is also important that market failures which prevent private sector investment are identified and targeted. On the other hand, a fund can lock in a spending commitment and therefore reduce government flexibility in responding to changing fiscal circumstances.

There is currently little data available on energy efficiency in the Israeli economy, and great uncertainty exists about the impact of the National Energy Efficiency Programme. For the programme to be effectively implemented, a clear standard for measuring savings will be required, as well as benchmarking of progress towards achieving objectives. For these reasons, any proposed fund should be subject to periodic performance reviews together with the planned annual evaluation of the programme.

Regulatory instruments are also important in the energy efficiency field, particularly for buildings and appliances. Buildings account for some 60% of total electric power consumption in Israel. Israeli buildings suffer from poor standards of thermal energy efficiency, the energy performance of buildings is poorly understood, and no tools are available with which homeowners can make informed rental and purchase choices in the absence of a building energy rating standard. The current voluntary green building standard is under revision, although it is unclear whether the revised standards will include a mandatory component. Requiring high standards of energy efficiency in new buildings is more cost-effective than attempting to retrofit at a later date.

6. Policies and measures in the transport sector

As in many other OECD countries, transport is a major source of emissions of GHGs and air pollutants (Section 2). Energy consumption from transport continued to increase during the 2000s, although at a lower rate than in the previous decade (Figure 6.8). It currently accounts for 27% of Israel's final energy consumption. Rapid population and economic growth has led to increased transport demand. Road transport is by far the dominant transport mode. The total number of vehicles in Israel (including passenger and heavy goods vehicles) grew by 34% between 2000 and 2009. Private car ownership also increased, although it remains well below the OECD average (Figure 6.8). The average distance travelled per car journey also increased significantly during the past decade, with the use of roads by cars, trucks and buses all recording increases. Increased vehicle usage was facilitated by a multi-billion dollar investment in national road infrastructure, which significantly outstripped investment in rail during the review period (Figure 6.8).

While there has been a major increase in the number of railway passengers, which reached 35 million in 2008, the share of bus journeys has decreased, mainly in favour of those by private car. Overall, public transport use declined during the review period (Figure 6.8). Private cars accounted for a relatively lower share of travel (in passenger km) than in the EU15, whereas buses accounted for over 20% of travel compared to less than 9% in the EU15 (where, however, railway transport is more developed and more widely used).

A government decision on the reduction of air pollution from transport sources was approved in September 2007. This decision resulted in the implementation of a number of measures, including the review of vehicle and fuel quality standards on the basis of the most recent European standards and the introduction of tax incentives (Section 6.2). Leaded petrol was phased out in 2004. The 2008 Clean Air Law mandates the MoEP to revise existing regulations. The 2007 government decision did not include GHG emissions from transport, and the contribution of the transport sector to Israel's climate mitigation strategy has not yet been clarified.

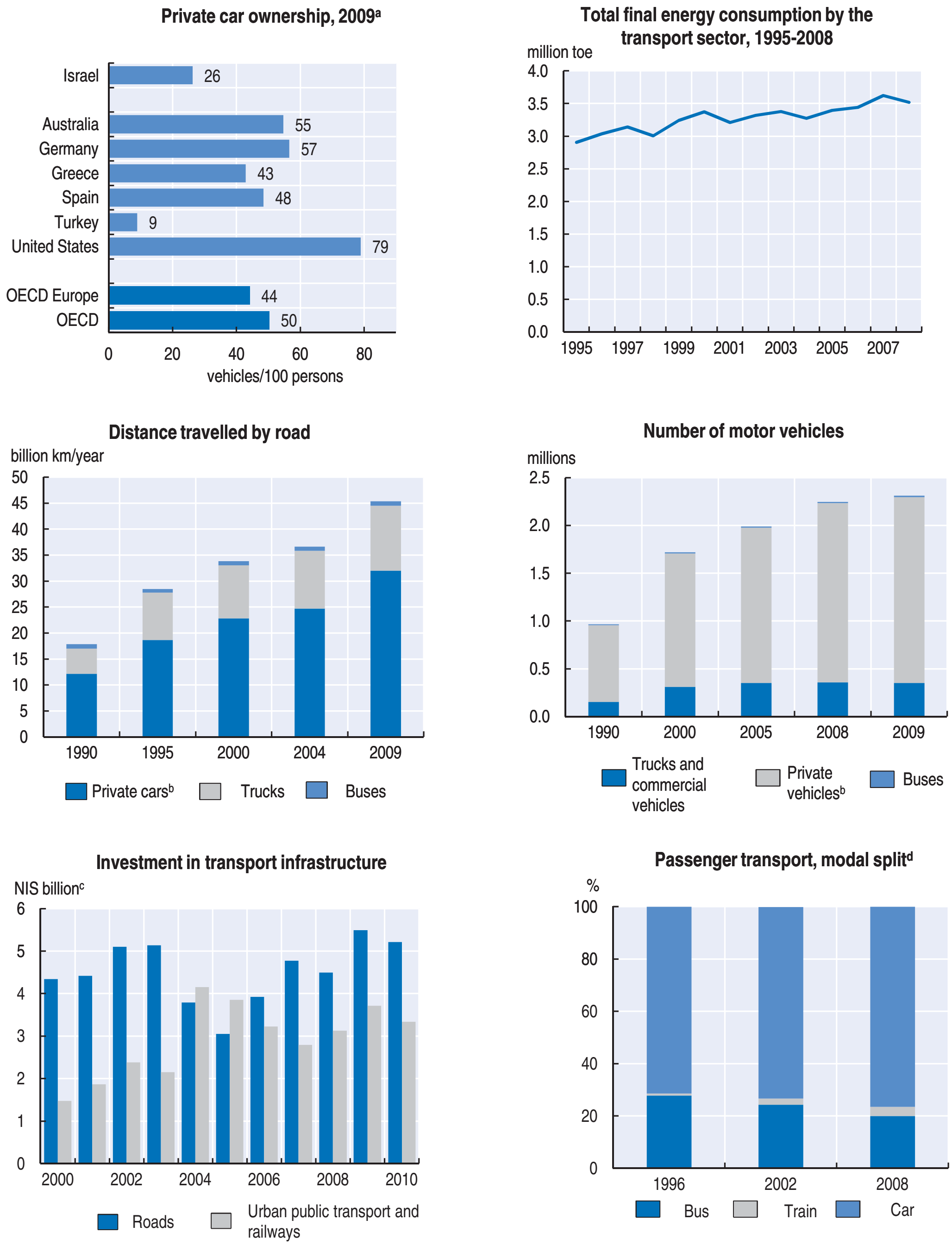
6.1. Investing in public transport

Public transport mostly consists of state-subsidised bus services. However, efforts are being directed towards encouraging a modal shift in the direction of more rail transport, although with slow progress. A development plan for railways for the period to 2017 has been published, calling for the prioritisation of investment in public transport over roads in the coming period. It envisages an investment of NIS 15 billion in the years 2010-17,[27] with a focus on connecting outlying regions with the centre. The most significant project is the fast train between Tel Aviv and Jerusalem, which is planned for completion in 2017. Light rail projects are well-advanced in Jerusalem, with full commercial operation of the light rail beginning in August 2011. These projects are still at an early stage in Tel Aviv.

To enhance the service offered by public transport, in 2008 the Ministry of Transport and Road Safety published a report calling for the establishment of a National Public Transport Authority. It would regulate the quality of services, improve the integration of routes, and provide better information to commuters on services provided. The report also proposed a Tel Aviv Regional Public Transport Authority to integrate services offered in the region, which are currently poorly co-ordinated.

An increasing emphasis was also placed during the review period on the link between land use and transport planning in policy making. Both the Green Taxation Committee and

Figure 6.8. **Key trends in the transport sector**



a) Or latest year available.
b) Excluding taxis and minibuses.
c) At 2009 constant prices.
d) Based on values expressed in passenger-km.
Source: CBS; MoEP (2010); Ministry of National Infrastructures; OECD, Environment Directorate; OECD-IEA (2010), *Energy Balances of Non-OE Countries Database*.

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the MoEP have identified the role played by poor planning in locking in car-dependent lifestyles and have recommended that planning policy be used to counteract this trend.

The Comprehensive National Master Plan for Land Transport Infrastructure (Plan 42) is being developed to respond to these challenges. Plan 42 sets ten objectives, including integrating land use and transport infrastructure planning, reversing the trend in the modal shift to private cars, and establishing a national plan for transport infrastructure.

6.2. Market-based incentives

Following the 2007 government decision on the reduction of air pollution from road transport, the government introduced a vehicle scrapping scheme, which provided a subsidy for scrapping vehicles more than 20 years old whether or not a new vehicle had been purchased. The vehicle purchase tax was also adjusted according to a "green index" as from August 2009. The new tax varies according to the level of emissions of air pollutants (NO_X, CO, PM_{10} and hydrocarbons) and CO_2.[28] Car buyers are thus given less incentive to favour diesel vehicles, which tend to emit less CO_2 and more local pollutants per kilometre driven than petrol vehicles, than in the case of a tax differentiation based exclusively on CO_2 emissions. This avoids over-incentivising diesel vehicles, a desirable outcome in view of the relatively high air pollution in Israel's urban areas. Particularly low taxes are imposed on hybrid and fully electric vehicles. However, the overall level of taxation on car purchases remains very high and potentially highly distortive (Chapter 1).

In the first year of implementation, the impact on the CO_2 emissions performance of vehicles has been relatively modest, falling by 2.6% compared to a much larger decrease in emissions of NO_X and PM (Table 6.7). Average GHG emissions per kilometre travelled by a new car sold in Israel are 177 g CO_2/km, still very high compared to the EU average of approximately 140 g CO_2/km in 2010 (EC, 2010). Diesel cars continue to account for a very low share of the fleet (less than 3%) compared to other OECD countries. However, the number of diesel cars has continued to increase, including after the change in the purchase tax, and despite diesel prices being higher than those of petrol in 2008 and 2009 (Figure 1.5).

Table 6.7. **Impact of green motor tax reform on vehicle emission performance**

	June 2008-July 2009 g/km	August 2009-June 2010 g/km	% change
CO_2	181.8000	177.1000	–2.6
NO_X	0.0360	0.0290	–17.8
CO	0.3520	0.3410	–3.4
PM	0.0012	0.0009	–24.2

Source: Israeli Taxation Authority, 2010.

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As explained in more detail in Chapter 1, distortionary incentives for car ownership persist, leading to higher emissions from the transport sector than would otherwise be the case. In the banking and civil service sectors, for example, allowances are available for car ownership. Company cars, which account for a relatively large share of this overall car fleet, benefit from a favourable tax treatment that allows unlimited travel and creates a zero marginal cost for car users (OECD, 2011). Free parking is also provided by many employers, and no tax is paid on this benefit.

Israel should consider correcting these perverse incentives for car ownership and use, and using taxes and charges to target car use (*i.e.* the activity generating the environmental costs, rather than ownership). The Bank of Israel (2010) compared the impact on distance travelled of similar tax revenue increases generated by raising the vehicle purchase tax and the petrol tax. It found that an increase in the petrol excise duty would reduce distance travelled more than three times as much as an increase in the purchase tax.

Transport fuel prices in Israel are already among the highest in the OECD, especially for diesel and when purchasing power parities are taken into account. This is partly due to relatively high pre-tax prices, as the share of taxes (including VAT) in fuel prices is lower than in a number of other OECD countries. While lower than that on petrol, the excise duty on diesel is among the highest in the OECD. However, there is some scope to further increase fuel taxation, and the government should continue with its plan to equalise tax rates on transport fuels. As in all OECD countries, excise duty rates on transport fuels are very much above those on fuels for stationary installations and those that would be implied by a carbon price around the rate at which CO_2 emissions allowances are traded in the EU (EUR 15 CO_2/tonne) (Table 6.4). Therefore, accounting for excise duties in terms of environmental externalities requires either the assumption of a higher carbon price and/or consideration of other externalities such as air pollution (OECD, 2011).

The use of road pricing or charging schemes has been limited in Israel. The introduction of an electronic toll system on the main highway to Tel Aviv from the eastern part of the country in early 2011 was a positive step forward. One lane is reserved for paying customers; tolls are paid through the internet and vary on a real-time basis, depending on traffic conditions. The impact of this system should be carefully monitored. If it is successful in reducing congestion and/or emissions, it could be extended to other congested motorway stretches. Moreover, congestion or pollution charges could be considered for the metropolitan areas of Jerusalem and Tel Aviv, which suffer from high levels of congestion. The possibility of introducing such schemes is currently limited by co-ordination difficulties between the municipalities and the central government. However, to be effective in encouraging a modal shift away from private cars, implementation of road charging schemes and an increase in fuel taxation would also require the development of a more widespread and integrated public transport network.

7. Policy and measures in other sectors

7.1. Waste

At the end of the 1990s, the MoEP initiated the collection of methane from landfills for the purpose of reducing environmental hazards and GHG emissions. This was one of the biggest successes in Israeli climate policy during the review period. Most of Israel's operational landfills collect methane, with a 40% collection rate compared with total methane emissions from this source. Some facilities use the collected methane to produce energy at three installations, with a total capacity of 5.1 MW, while others transfer it to a thermal treatment plant for burning. An additional 12 wastewater treatment plants (representing 28% of the wastewater treated in Israel) collect methane from sludge. The economic potential of methane collection and use is being examined for the remaining 52 closed landfills whose restoration is planned.

To reduce the amount of waste disposed in landfills, and associated emissions, efforts have been made to increase the waste recovery rate through legislation, economic incentives and education. A landfill levy was introduced in 2007. Its objective is to reflect the true cost of landfilling; one of the main components of the cost is the emission of methane from decomposition of organic matter in landfills (Chapter 7).

7.2. Agriculture and land use

The Israeli agricultural sector is highly efficient in its use of resources. Agricultural policies have indirectly contributed to meeting national climate change policy goals during the review period.

From 1999 to 2007, the MoEP provided NIS 493 million in investment grants to facilitate enhanced environmental standards on dairy farms. The reform programmes on livestock farms have led to an increase in manure recycling and advanced waste treatment methods, and to the establishment of regional manure collection and recycling sites. These reforms have probably also led to a lower rate of ammonia emissions (OECD, 2010), although emissions were not monitored during the review period. Furthermore, the installation of cooling systems on dairy farms has led to an increase in milk production and a net reduction of methane emissions.

The improvement of fertilisation practices has helped reduce the contribution of agriculture to GHG and ammonia emissions.[29] Since the late 1990s, a decline in inorganic fertiliser use has also been observed in Israel, mainly because of the increased use of reclaimed wastewater (with its high nutritional value) for irrigation. Almost all the waste from livestock manure and about half of sewage sludge are currently recovered for use in the agricultural sector, according to stringent regulations set by the MoEP and the Ministry of Health.

Israel is a leader in resource and nutrient management in agriculture. No reliable data are available, however, for the GHG emissions efficiency of Israeli produce measured on a life cycle basis. International comparisons would therefore be impossible. This may be an avenue by which Israel could gain a competitive advantage in the marketplace for the produce, technologies and farming systems it has developed.

Afforestation programmes have been pursued for several decades, resulting in a net removal of CO_2 from the atmosphere. In 2007, Israel's forest area included 83 200 ha of plantations[30] and about 99 400 ha of natural woodlands. Although most forests are composed of conifers and broad-leaved species, the relatively small area planted in eucalyptus contributes about 12% of CO_2 removals.

Notes

1. "F gases" are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). For the purposes of all GHG comparisons during the review period, "F gases" will not be included since data on them became available for the first time in 2008.
2. "F gases" not included.
3. No breakdown is available for emissions from private transport, public transport and freight, although emissions from "international bunkers" (aviation and shipping) not included in Israel's official inventories were 3.5 Mt in 2007, a 26% increase on 2000 levels.
4. It is unclear whether the decline in CO_2 emissions is attributable to policies and measures implemented during the review period, structural changes in the Israeli economy, or changes in the manner in which inventories are calculated.
5. The Haifa Bay area, in the north of the country, hosts the petrochemical industry, which is characterised by heavy oil consumption. Israel's largest coal-fired power plant is located in Hadera, a short distance to the south. In the southern coastal area, two major industrial zones in Ashdod

and Ashkelon include an oil refinery, recycling of sulphur and metals, fertiliser manufacturing, a natural gas power plant and a coal-fired power plant. The Ramat Hovav industrial zone in the Negev is home to the chemical industry, characterised by large quantities of hazardous materials, and to the national site for the disposal and treatment of hazardous waste.

6. For example, adult mortality due to long-term exposure to $PM_{2.5}$ and to ozone in Greater Tel Aviv in 1995-99 was estimated to be 8 and 1% of the yearly baseline mortality, respectively. In Greater Tel Aviv in the period 1997-99, an estimated 20% and 14% of yearly recorded respiratory diseases in children were related to PM_{10} and to $PM_{2.5}$.
7. United Nations Framework Convention on Climate Change, 1992, Article 4.
8. The business-as-usual scenario includes prevailing emissions trends and existing government policies as of 2009.
9. The accord recognised that deep cuts in global emissions would be required "so as to hold the increase in global temperature below 2 degrees Celsius" and that action should be taken "consistent with science and on the basis of equity". Developed countries' pledges to cut GHG emissions were subsequently formally recognised at the 16th Conference of the Parties, although they remain non-binding.
10. The UK Climate Bill (2008) sets out a robust climate policy framework which: makes GHG reductions targets for 2020 and 2050 legally binding; introduces a system of "carbon budgeting" that caps emissions over five-year periods; establishes an independent body to advise on the setting of carbon budgets and to report on progress; and introduces a system of government reporting to Parliament, including on climate change adaptation policies.
11. Under the Abatement of Nuisances Law, the Minister of Environmental Protection can address administrative orders (personal decrees) to operators of existing industrial and energy facilities indicating specific requirements to prevent and reduce their emissions.
12. There will be an air permit fee, consisting of a substantial one-time fee and an annual fee, depending on the economic sector's environmental impact. The revenue will go to the general budget.
13. Business licensing conditions also include stack sampling and monitoring and reporting obligations.
14. While the rewarding mechanism would provide incentives to abate emissions at the installation level, it can have the perverse effect of increasing aggregate emissions by attracting more firms into the market. Insofar as there is some level of discretion in setting the permitted emission level, installations also have an information advantage over the regulator.
15. Under the Clean Air Law, a pollutant is defined as a material whose presence in the air causes or is liable to cause changes in climate, weather or visibility.
16. In the transport sector, for example, sub-sectoral data are unavailable on emissions from freight, private transport and public transport. In the agricultural sector a rapid decline in CO_2 emissions is evident, for which no explanation is available.
17. Examples of international best practices include Annual Progress Reports from the UK Climate Change Committee and the Irish Environmental Protection Agency's annual emissions inventory report.
18. There can be cases in which a fee is required to cover the cost of handling a large information set.
19. This is a financial instrument that allows international trade in GHG permits. Under the mechanism, Annex I parties to the Kyoto Protocol may acquire emissions reduction permits from non-Annex I parties instead of reducing their own emissions. Permits are generated by projects in non-Annex I countries which reduce emissions and are certified by the UNFCCC.
20. CO_2 emissions are valued at USD 22 per tonne of CO_2 (or USD 0.0164/kWh). The shadow prices for emissions of air pollutants from electricity generation are USD 7 420/tonne, USD 4 297/tonne and USD 10 590/tonne (or USD 0.012/kWh, USD 0.007/kWh and USD 0.0006/kWh) for SO_2, NO_X and particulate matter, respectively.
21. Almost 200 bcm of natural gas was discovered at the Tamar field in 2008. An additional discovery at the Leviathan field in 2009 may contain 400 to 500 bcm of natural gas, according to the Israel Electric Corporation (IEC).
22. Quotas are allocated on a first-come, first-served basis. The feed-in tariffs for the current quotas vary between NIS 1.51/kWh for small facilities (up to 50 kW) and NIS 1.02/kWh for large installations (above 50 MW).
23. The flagship large-scale project, the Ashalim tender in the Western Negev region for an estimated 250 MW of solar energy, has not been delivered and has suffered a series of delays. The MoNI officially

called for tenders from energy companies in 2007 with the understanding that the power plant would be build-operate-transfer (BOT). The tenders committee hoped to complete the entire tendering process by the fourth quarter of 2008, but the financial aid criteria for the winner have yet to be formulated.

24. Israel Standard 5281 for "green" buildings 2005; Israel Standard 5282 Part 1 for energy rating of buildings (2005); and Israel Standard 5282 Part 2 (2007) for energy rating of office buildings.
25. While ministries that invest in energy efficiency will be able to withhold any resulting budget savings, those that fail to achieve energy efficiency objectives will experience budget cuts.
26. In the building sector, principle-agent difficulties create barriers to investment in high-energy standards by developers, which will not be paying energy bills. In cases of investment in building retrofit and high efficiency lighting, lack of information, lack of access to private capital and high discount rates may prevent homeowners and businesses from making investments with reasonable returns.
27. There may be additional investment in rail.
28. The green index is to be revised on the basis of updated estimates of the social, environmental and health costs of pollution from transport, to be produced by the MoEP in 2011.
29. Nitrogen fertiliser is applied through pressurised irrigation systems, which can reach 85-95% efficiency.
30. Including 50 300 hectares of conifers, 8 000 hectares of eucalyptus and 24 900 hectares of broad-leaved species.

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