Ministry of Environmental Protection

State of Israel

ISRAEL'S THIRD NATIONAL COMMUNICATION ON CLIMATE CHANGE

Submitted to the United Nations Framework Convention on Climate Change

2018

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Cover photos: Avi Ohayon/Government Press Office, Pini Hamou, Riki Shlomo Edri, Fred Arzoine, Ministry of Environmental Protection

Prepared on behalf of the Ministry of Environmental Protection by EcoTraders Ltd.

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Photo: Government Press Office

Executive Summary

National circumstances

The State of Israel is located on the southwest tip of the Asian continent, in the eastern Mediterranean basin. Approximately 45% of Israel is comprised of arid zones. The rest of the country contains plains and valleys (25%), mountain ranges (16%), the Jordan Rift Valley (9%) and the coastal strip (5%).

Water sources

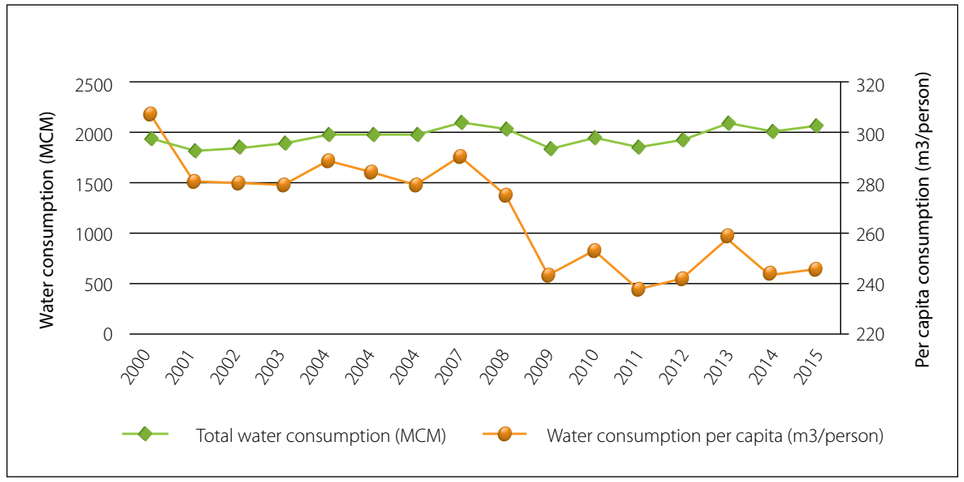
Israel is located in a region characterized by scarcity of natural water resources and faces various challenges regarding water resource management. Total water consumption in Israel has remained relatively constant, increasing by only 3% over the period 2000-2015, reaching 2,047 million cubic meters (MCM) in 2015. Water management policy has focused on improving efficiency in usage. In 2015, water use per capita was 244 m^3, an improvement of 20% relative to per capita consumption of 306 m^3 in 2000.

Water scarcity in Israel has led to the development of advanced technologies for seawater and saline water desalination and wastewater treatment and recovery. Desalination of seawater increased by 91% between 2010 and 2015, from 277 MCM to 503 MCM, as desalination capacity increased.

The amount of treated wastewater has also risen, from 380 MCM in 2000 to 525 MCM in 2016, an increase of 38%.

Israel is a global leader in water recycling, primarily for agricultural use. In 2016, 85% of domestic

***Figure 1**: Total and per capita water consumption.*



wastewater was recycled and used for agriculture.

Climate profile

Average annual rainfall volume during 2000-2009 was 5.78 Billion Cubic Meters (BCM). Average annual rainfall during the following decade, 2010-2016, was slightly higher at 6.02 BCM.

The mean annual temperatures recorded in Israel have increased steadily since the 1990s, although these are slightly lower than averages from the 1950s and 1960s due to relatively high temperatures during those years. Mean temperatures are calculated for periods of several years and the most recent data pertains to 1995-2009, which is the data reported in Israel's first Biennial Report submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2016. In all but one year, the mean temperature was higher during 1995-2009 than during 1981-2000.

Population profile

Israel has experienced steady population growth since 2000 and reached 8.55 million residents at the conclusion of 2016.

***Figure 2:** Annual rainfall volume in Israel (BCM), red bars show data since 2010.*

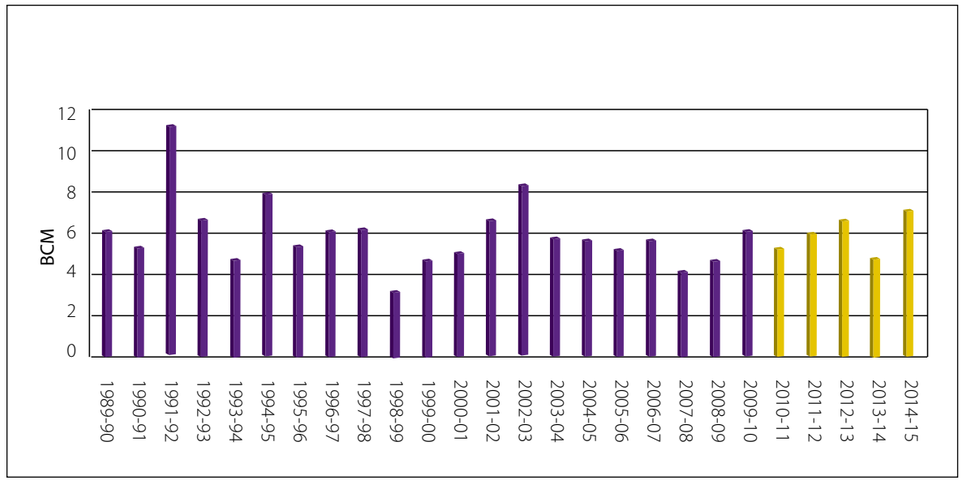
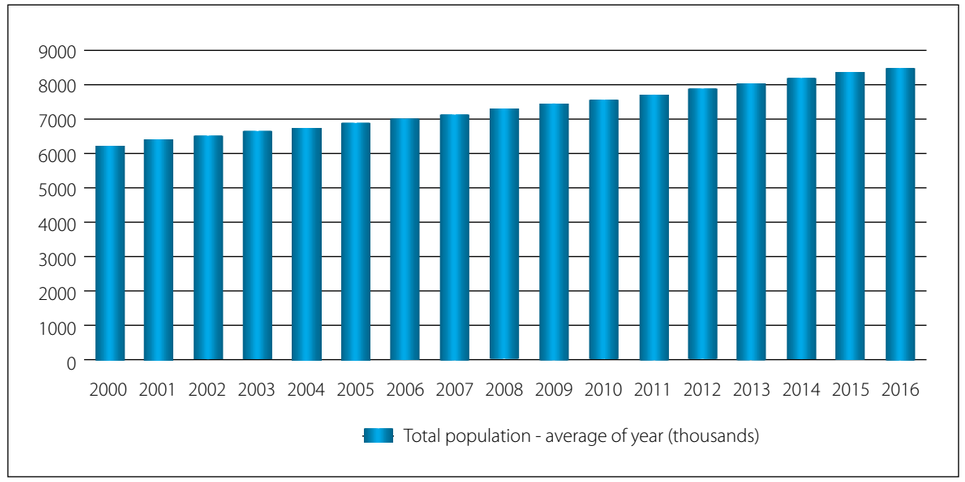


***Figure 3:** Population of Israel (thousands) (2000-2016)*



The annual growth rate during the period was 1.94%, of which 14.9% was from immigration. Israel's annual growth rate is one of the highest among OECD countries, which averaged an annual population growth rate of 0.63% over the same period.

Israel's population density has increased steadily, from 278.7 people per square kilometers (km^2) in 2000 to 380.2 people per km^2 in 2016.

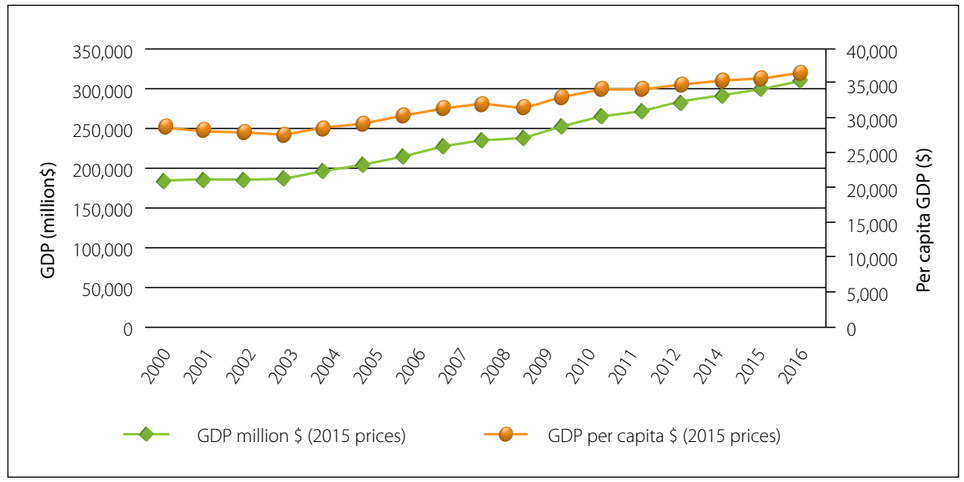
Economic profile

Despite the economic crisis of 2008-2009 when Gross domestic product (GDP) growth fell to just 1.3% in 2009, Israel has continued to experience strong economic growth, with an average annual growth rate of approximately 4% over 2010-2016. Israel's growth remains well above the 1.90% average annual growth rate in the OECD during the same period.

Energy profile

The total primary energy supply in Israel in 2015 was 22,607.6 thousand tonne of oil equivalent (TOE), an increase of 16% from 19,499.2

***Figure 4:** Trends in per capita and real GDP (2015 prices)*



thousand TOE in 2000.

Israel's energy intensity improved significantly during 2000-2015 period, both in per capita use and in energy consumption per unit of GDP:

1. Final total energy consumption per capita decreased by 13%, from 2.037 TOE per capita in 2000 to 1.77 TOE per capita in 2015.
2. Energy consumption per unit of GDP improved by 29%, from 30.6 TOE per million NIS GDP in 2000 to 21.8 TOE per million NIS GDP in 2015.

The primary trend in the total fossil fuel mix continues to be increased use of natural gas, both in power generation and manufacturing/large-scale commercial sectors.

In 2016, approximately 36% of total power generated was from coal, down from 59% in 2010. Natural gas accounted for 61% of total power generated, up from 39% in 2010. Renewables accounted for 2.6% of power generation.[1]

Between 2010 and 2016, electricity consumption increased from approximately 52 TWh to approximately 62.5 TWh, representing an annual growth rate of 3%.

Transportation

The total number of vehicles in Israel grew from 1,832,000 in 2000 to 2,566,191 by 2010 and 3,239,305 by 2016. Of the total 84% are private cars.

In 2016, the rate of motorization was 382.7 cars per 1,000 residents, up from 333.5 in 2010 and 287.6 in 2000.

Total vehicle kilometers travelled in 2016 amounted 57,220 million km, of which 43,953 million km were by private cars, an increase of 32% relative to 2010 and 93% relative to 2000. In 2010, total vehicle kilometers travelled were 49,870 million km and in 2000, 36,482 million km.

Greenhouse Gas (GHG) Inventory

In 2015, Israel's total GHG emissions were 80.18 million tons CO_2 equivalent ($MtCO_2e$), representing an absolute increase of around 40% relative to 1996 GHG emissions, 20% relative to 2000 emissions, and an increase of 4% relative to 2010 emissions.

Emission intensity has shown an overall declining trend since 1996, in both GHG emissions per capita and GHG emissions per unit of GDP. The 2015 values, 9.38 tCO_2e/capita and 0.28 tCO_2e/$1000 GDP are the lowest levels since the inventory was first published in 1996.

Emissions have decreased in recent years largely due to a reduction of GHG emissions from the power sector. GHG emissions from power generation peaked in 2012 due to a natural gas shortage that led to increased use of more GHG-intensive fossil fuels. Once the natural gas supply resumed in 2013, emissions from the power sector declined from 47.9 $MtCO_2e$ in 2012 to 41.3 $MtCO_2e$ in 2015.

Figure 5: *GHG emission trends*

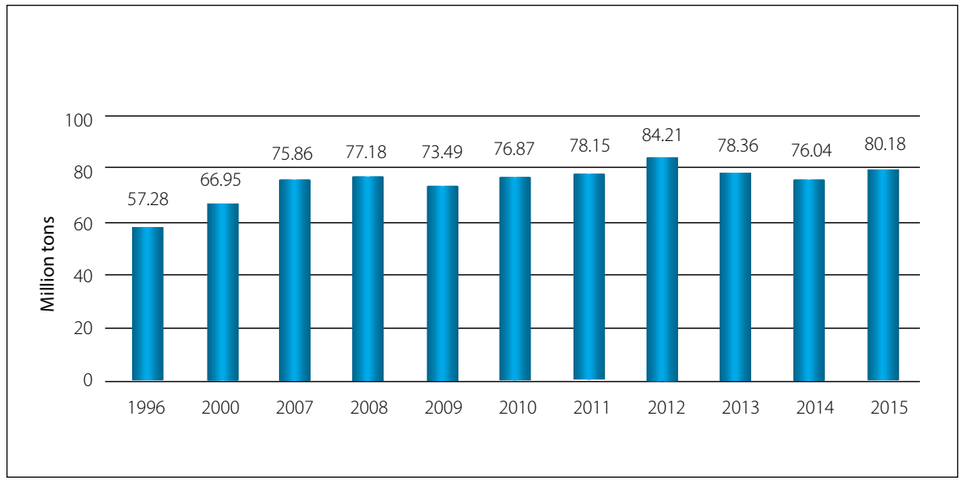
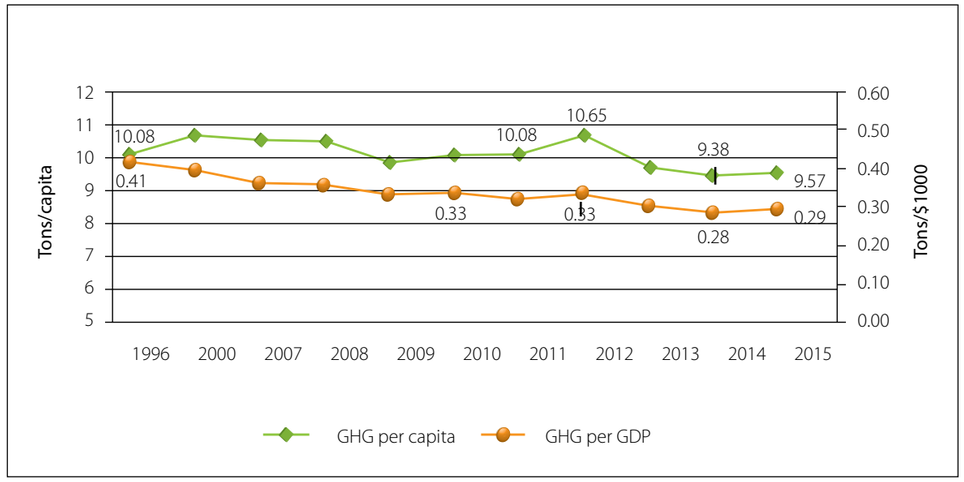


Figure 6: *GHG emission intensity*



Mitigation

On April 22, 2016, Israel signed the Paris Agreement and the government ratified it on November 22, 2016.

In September 2015, in preparation for the Paris convention, the Israeli government approved an economy-wide unconditional target to reduce per capita GHG emissions to 7.7 tCO_2e by 2030, constituting a 26% reduction relative to 2005 emissions of 10.4 tCO_2e per capita, and amounting to an expected total of 81.65 $MtCO_2e$. Additionally, the government approved an interim target of 8.8 tCO_2e per capita by 2025, amounting to an expected 86.6 $MtCO_2e$. The government further approved the following sector-specific targets for 2030:

- 17% reduction in electricity consumption.
- 13% of electricity consumption in 2025 will be from renewables, increasing to 17% in 2030.
- 20% reduction in kilometers travelled by private vehicles.

The following tables summarize national progress

Table 1: *National progress on 2020, 2025 and 2030 primary GHG targets*

National target	Latest reported value (2015)	Target value (2020)	Target value (2025)	Target value (2030)
National GHG emission reduction target value	80.1 $MtCO_2e$ (9.6 tCO_2e per capita)	87.2 $MtCO_2e$ (9.60 tCO_2e per capita)	8.8 tCO_2e per capita (86.6 $MtCO_2e$)	7.7 tCO_2e per capita (81 $MtCO_2e$)

Table 2: *National progress on 2020, 2025 and 2030 supporting targets*

National target	Latest reported value (2016)	Target value (2020)	Target value (2025)	Target value (2030)
National energy efficiency target	62.5 TWh	64.2 TWh	-	80 TWh
National renewable energy target	2.6%	10%	13%	17%
National target for private car mileage reduction	43.9 million vehicle-km	-	-	44.4 million vehicle-km

1 (Electricity Authority, 2016)

in meeting the key 2020, 2025 and 2030 targets described above:

In April 2016, the government approved the National Plan to Reduce GHG Emissions and Increase Energy Efficiency to achieve its 2020, 2025 and 2030 targets. In September 2016, the National Plan for the Implementation of the Paris Agreement was published.

Within the framework of these national plans, the following key abatement measures are in various stages of implementation:

1. **Reducing electricity generation from coal-fired power plants**

   The Ministry of Energy, in conjunction with the Ministry of Environmental Protection, has approved two key measures aimed at significantly reducing the use of coal for power generation:

   a. **Reducing generation in existing coal-fired power plants:** The two ministries have agreed and implemented policy guidelines to reduce generation in existing coal-fired power plants. According to these guidelines, preference is given to the generation of electricity by natural gas over coal, and coal units are operated at the minimum possible load that still enables flexibility of the generation system and reliability of electricity supply.

   b. **Decommissioning 30% of Israel's coal-fired units:** The ministries signed a Memorandum of Understanding declaring that the four most polluting coal units, with a total capacity of 1440 MW, will be decommissioned by 2022, subject to the following conditions:

      i. Increasing the availability of natural gas by connecting at least three natural gas reserves to the national natural gas transmission network.

      ii. Establishing alternative generation capacity based on natural gas at the site of the decommissioned coal-fired units or the surrounding area.

2. **Promoting the use of renewable electricity generation**

   The following steps have been taken to promote construction of renewable energy power plants, with a strong emphasis on solar photovoltaic (PV):

   a. **Tax exemptions** including exemptions from municipal tax, VAT, income tax, betterment levies, and fuel excise taxes (for bio-gas);

   b. **Expansion of approved tariff quotas** including an additional quota for 1,300 MW of PV power plants, bringing the total approved quotas to 1,690 MW for PV and 3,760 MW in general.

   In 2016, total renewable energy generation reached 1,745 GWh, approximately 2.7% of electricity generation.

3. **Government grants and loan guarantees**

   To meet the national reduction targets, the government has approved a combination of grants and government loan guarantees to be used for emissions abatement and energy efficiency finance.

   In particular, the government has resumed the National Support Mechanism for Energy Efficiency and Emission Reduction projects, which was successfully offered during 2011-2013, with a renewed budget of NIS 300 million (approximately $78 million).

   Additionally, the government will allocate NIS 500 million (approximately $130 million) in government loan guarantees over a ten-year period to leverage investment in the fields of energy efficiency and GHG emissions reduction.

   Over the 2015-2016 period, a total of NIS 157.6 million (approximately $41 million) were allocated within the context of government grant schemes for energy efficiency and GHG reduction projects, leveraging an estimated NIS 600 million (approximately $156 million) in private investment.

4. **Prevent landfilling of municipal solid waste**

   The Ministry of Environmental Protection has set a national target to recycle 35% of the municipal solid waste (MSW) collected by local authorities by 2020. The policies implemented by the Ministry to meet this target include:

   1. Increasing the efficacy of waste separation at the source and expanding the requisite infrastructure to additional local authorities to increase the total number of local authorities with separation-at-source infrastructure.
   2. Construction of waste treatment facilities, as follows:
      a. Anaerobic digestion facilities with an annual treatment capacity;
      b. Composting facilities;
      c. Refuse-derived fuel production facility;
      d. Incineration facilities

   In 2016, 20% of MSW collected by local authorities was recycled.

   In addition to the abatement measures described above, the following sectorial plans have either been approved or are in the final development stages. Successful implementation of these plans in their respective sectors will contribute significantly to Israel meeting its reduction targets:

   1. **National energy efficiency plan:** Approved by the government in December 2017, this plan addresses the policies and measures to be implemented to reach the national goal of reducing electricity consumption by 17% in 2030. The plan focuses on the implementation of short-term measures and will be updated periodically.
   2. **National transport sector plan:** This comprehensive plan for the transport sector addresses the required measures, including the establishment and expansion of public transport systems, to meet the national target to reduce private car mileage by 20% by 2030, relative to the BAU scenario (as projected in 2015).
   3. **A plan for the implementation of the Kigali Amendment to the Montreal Protocol:** Approved in 2016, the Kigali Amendment to the Montreal Protocol sets a timetable to significantly phase down the production and use of hydrofluorocarbons (HFCs).
   4. **A plan to reduce GHG emissions from buildings**: This plan addresses policy measures to be implemented in both new and existing buildings, with an emphasis on energy efficiency measures and green building standards.

Achieved emission reductions

Israel is currently developing a national monitoring, reporting and verification (MRV) system to facilitate the following:

- Measurement of national progress towards achieving its mitigation goals.
- Measurement of the effectiveness of specific government GHG-reduction policies and actions.
- Revision and expansion of policy actions to maximize the achieved economic and environmental benefits.
- Fulfillment of national reporting obligations to the United Nations on mitigation actions and their implications.
- Ensuring that the information on Israel's progress towards its reduction goals is publicly available.

The current methodologies under approval within the MRV system framework are:

- Monitoring fuel consumption and emission reductions in power generation.
- Monitoring energy efficiency and electricity consumption.
- Monitoring fuel consumption and emission reductions in the transportation sector.
- Monitoring fuel consumption and emission reductions in industry and construction sectors.
- Monitoring emissions reduction from the avoidance of landfilling MSW and emissions from the waste sector.
- Monitoring national targets and measures for reduction of GHG emissions from fluorinated gases.
- Updating emission forecasts from agriculture, land use, wastewater and industrial process emissions.

The MRV system is in the final stages of development, and the first monitoring report should be submitted to government by the end of June 2018. At this stage, emission reduction estimates (using a simplified approach) have been prepared, where possible, for key policy measures:

Table 3: *Key policy measures*

Policy measure	Estimated reductions (ton CO_2e) in the last reporting year (2016)	Estimated reductions (ton CO_2e) in 2030
Reducing coal-fired electricity generation	3.9 $MtCO_2e$	6.6 tCO_2e
Renewable electricity	206,000 tCO_2e Emission reduction is relative to 2015 generation (reference scenario). Total emissions reduced by all renewable generation is 768,166 tCO_2e.	5.4 $MtCO_2e$
Energy efficiency (central measure)	Data not available, monitoring methodology under development	7.3 $MtCO_2e$

Adaptation

In May 2009, the government approved Decision No. 250 to appoint an inter-ministerial committee to address issues related to environmental protection and climate change adaptation. In June 2009, the government approved Decision No. 474 instructing the committee to recommend a National Adaptation to Climate Change Plan for government approval, focusing on the following of Israel's most vulnerable sectors:

- Energy
- Water resources
- Agriculture
- Infrastructure, green building and urban planning
- Public health
- Geo-strategical aspects
- Biodiversity and natural habitats.

Proposed recommendations for a National Adaptation Plan include the following five targets:

1. Minimize casualties, property loss and ensure of economic robustness.
2. Improve resilience of natural systems.
3. Build and improve scientific knowledge.
4. Boost education, awareness and accessibility of information.
5. Encourage technologies for climate change adaptation.

The proposed National Adaptation Plan includes:

- Addressing knowledge gaps on the climate change impacts faced by Israel, based on different possible scenarios until 2030.
- Addressing knowledge gaps on the impact of climate change – observed and predicted.
- Review of measures available to minimize the climate change and maximize any climate change benefits in Israel.
- Guidelines relevant to government ministries to implement the tools and measures necessary to minimize damage and maximize benefits.
- Schedules and milestones.
- Economic and budgetary aspects of the implementation of preparation and adaptation measures.
- Identification of Israeli knowledge and technology that can be proposed to other countries to cope with the effects of climate change.
- Determination of output and outcome indicators to track progress towards meeting the National Action Plan objectives.

Climate forecasts by 2100

During the 21th century, drastic climactic changes are expected on global scale and Israel will be significantly affected. The Israel Meteorological Service (IMS) predicts that climate change will increase the number of extreme weather events such as floods, droughts and heatwaves. **Models for 2100 predict that in moderate scenarios winter temperatures will increase by 1.5°C-3°C and summer temperatures by 1.5°C-4°C.**

The Mediterranean Sea appears to have a mitigating effect on temperature increases, and models predict that temperature will rise moderately along the coastline and increase more in inland regions.

Water sources

In the last few decades, a reduction in rainfall has been measured in Israel's north where the tributaries that feed the Jordan River are located. Lower rainfall has led to reduced water flow in the large springs and into the Sea of Galilee, causing changes in the salinity of the water. Drier conditions have also been measured in southern Israel, but no significant trends in the amount of precipitation has been found in central Israel.

Desalination is currently Israel's primary strategy to combat fluctuations and reduced natural water resources. Desalination output is expected to reach 1500 MCM by 2050, and a full 12% of this amount is the preparedness of the economy to a climate change-induced reduction in the water supply.[2]

The Israel Water Authority manages the national water supply based on data that is collected regularly. This data is used to set measures designed to increase restricted freshwater availability in the future.

Biodiversity

Despite Israel's relatively small size of 22,000 km^2, it is home to 2,388 plant species, approximately 100 mammal species[3], and some 450 bird species.[3] This biodiversity is the result of the unique geographic position of the country. Designated protected areas cover 27% of the area of the country. A rise of 1.5°C will move the desert line northward and Mediterranean ecosystems, which are situated currently on the edge of the desert, will be transformed into desert. This is expected to lead to a spatial shift northward of 300-500 km in the distribution of Mediterranean organisms and a shift of desert ecosystems up from the Negev.

In October 2010, Israel joined other Parties to the Convention on Biological Diversity in adopting an updated Strategic Plan for Biodiversity for 2011-2020. This strategic plan, developed by the Ministry of Environmental Protection and called the Aichi Biodiversity Targets, includes 20 biodiversity targets covering public awareness, formulation of guidelines, incorporation of biodiversity into sectorial policies, and growing the knowledge base on biodiversity and ecosystem services.

Human health

A research study published by the Ministry of Health in 2014 reported a 3.7% increase in mortality in Tel Aviv due to heart, vascular, and respiratory diseases for every one unit increase in the Thermal Discomfort Indicator (a scale that factors in temperature and relative humidity) above the threshold that is considered comfortable. The study also when a heat wave surpasses this threshold for even one day the mortality rate rises. The same report indicated a rise of 1.47% in the number of emergency hospital visits for every rise of 1°C during a heat wave.[4]

Infrastructure

Major components of the infrastructure in Israel are situated on the populated Mediterranean coastline, which is particularly vulnerable to climate change. Roads, railroad tracks, ports and bridges, industrial centers, and power stations are located in possible flooding areas due to sea level rise and extreme weather events. Damage to these facilities could cause enormous economic and lifestyle consequences.

The rapidly growing population results in a continuous boom of urban development. Constructing these commercial and residential buildings in a sustainable manner is a primary focus; in Israel, the construction sector is responsible for 60% of electricity consumption and 40% of water use.[5]

A well-designed building can help mitigate climate change by reducing the need for activities that produce carbon emissions. Green buildings can help Israel adapt to climate change through maintaining a cooler interiors, relieving

2 (Proposed National Adaptation Plan, 2017)
3 (Ministry of Environmental Protection, 2010)
4 (Environmental and Health Fund; The Israeli Ministry of Health, 2014)
5 (Ministry of Environmental Protection, 2012)

some of the urban heat island effect, and utilizing less water.

Energy

Climate change has a significant impact on energy consumption and production. Heat waves are expected to affect peak energy demand levels and duration, especially in crowded cities where the heat island effect is pronounced. Of total electricity consumption in Israel, a full 45% is from air conditioning. Electricity consumption patterns change during heat waves because air conditioners are less efficient in extreme heat and electricity demand increases at night. The increased use of desalination technology to boost the water will also increase energy consumption. Measures must be taken to equip the energy sector to cope with climate change. These measures may include, but are not limited to promoting high efficiency air conditioning technologies, increasing domestic electricity production to meet increased demand, research on energy and electricity supply, and demand management based on simulations.[6]

Agriculture

Agriculture is the primary consumer of water in Israel (55% of total water consumption in 2016) and fluctuations in rain and water availability can deeply affect agricultural productivity. Overall, efficiency in water use has significantly increased in the past decade, up 28% between 2007 and 2012. At the same time, total agricultural output has risen 19% since 2008. Despite the predominance of arid landscapes in Israel, agricultural products total nearly NIS 30 billion (approximately $ 7.8 billion).

By 2020, Israel plans to increase annual capacity of wastewater treatment, which is suitable to be used in agriculture, to 600 MCM. In 2016, Israel recycled about 85% of its sewage to levels appropriate for agricultural grey water use; the goal is to reach 95% by 2020.

6 (Proposed National Adaptation Plan, 2017)

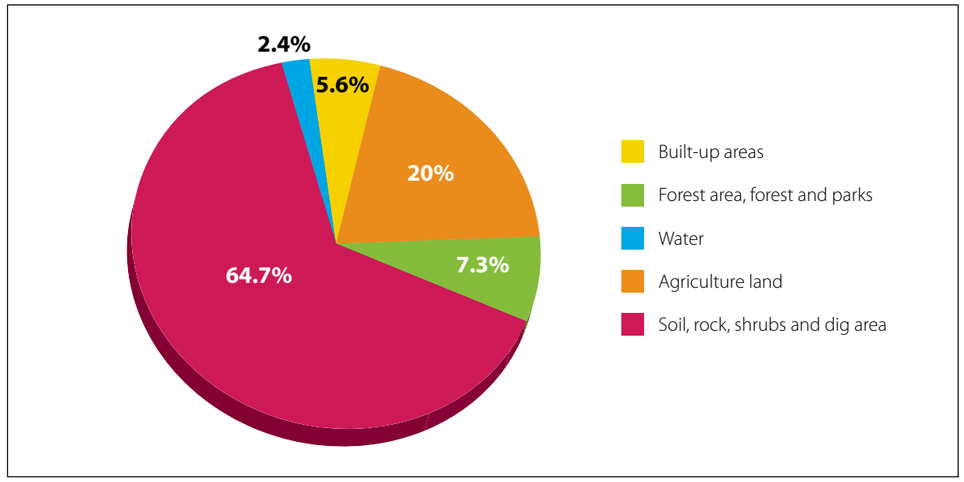
Photo: Government Press Office

1. National circumstances

Key developments since the last National Communication

- The population of Israel has been rising steadily since 2000. At the end of 2016, the population reached 8.62 million, with a population density of 380.2 people per km^2. During 2000-2016, the annual growth rate between was 1.92%, of which 14.9% was from net immigration.
- Israel's economic growth has continued to be strong, with an average annual growth of approximately 4% over 2010-2016.
- Water consumption per capita in 2015 was 244 m^3, an improvement of 20% relative to per capita consumption of 306 m^3 in 2000.
- The share of natural gas in the total energy fuel mix rose from approximately 23% in 2010 to approximately 30% in 2016; the share of coal decreased from approximately 35% in 2010 to 30% in 2015; and the share of petroleum fuels fell from approximately 42% in 2010 to 38% in 2015.
- In 2016, approximately 36% of total power generated came from coal, down from 59% in 2010. Around 61% came from natural gas, up from 39% in 2010. An additional 2.6% came from renewables.
- Between 2010 and 2016, electricity consumption increased from approximately 52 TWh to approximately 62.5 TWh.
- In 2016, 85% of domestic wastewater was recycled and used for agriculture.

Figure 7: *Area by category, 2015*



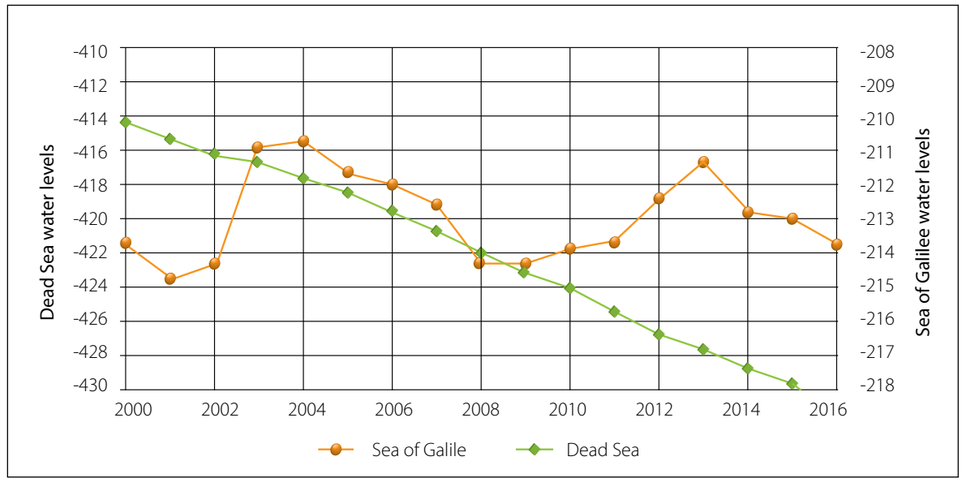
Geographic profile

The State of Israel is located on the southwest tip of the Asian continent, in the eastern basin of the Mediterranean Sea. The country lies at a latitude between 29° and 33° north of the Equator, with a total area of 22,072 km^2 (Israel includes East Jerusalem (1967) and the Golan Heights (1982) in its territory), 97.6% of which is land and 2.4% of which is marine (Sea of Galilee and the Dead Sea).[7]

Land resources

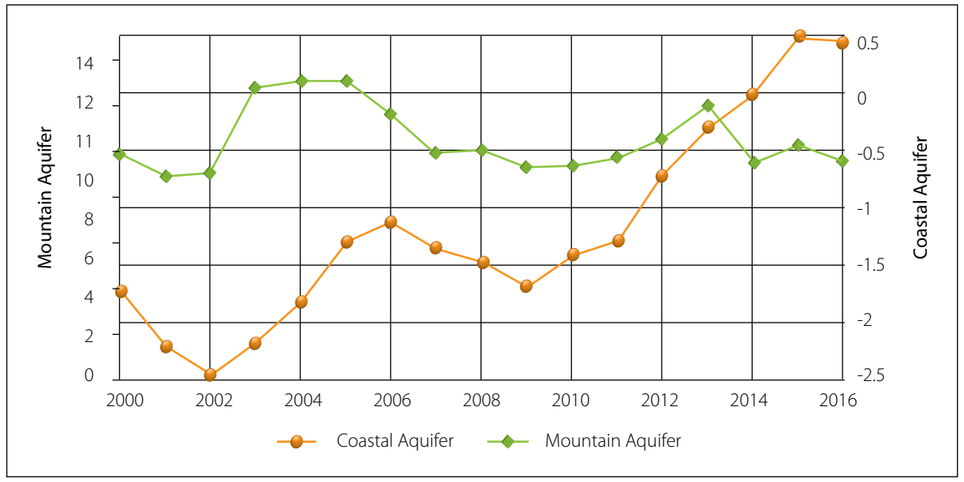
Land resources in Israel include fertile plains and arid zones, coastline and desert, mountain ranges and the lowest point on earth - the Dead Sea - all in close proximity. Arid zones comprise approximately 45% of the area of the country. The remainder includes plains and valleys (25%), mountain ranges (16%), the Jordan Rift Valley (9%) and the coastal strip (5%). [8]

Figure 8: *Sea of Galilee and Dead Sea levels (meters below mean sea level, MSL)*



7 (The Central Bureau of Statistics , 2015)
8 (Ministry of Environmental Protection, 2010)

Figure 9: *Mountain and Coastal Aquifers water levels (meters below mean sea level, MSL)*



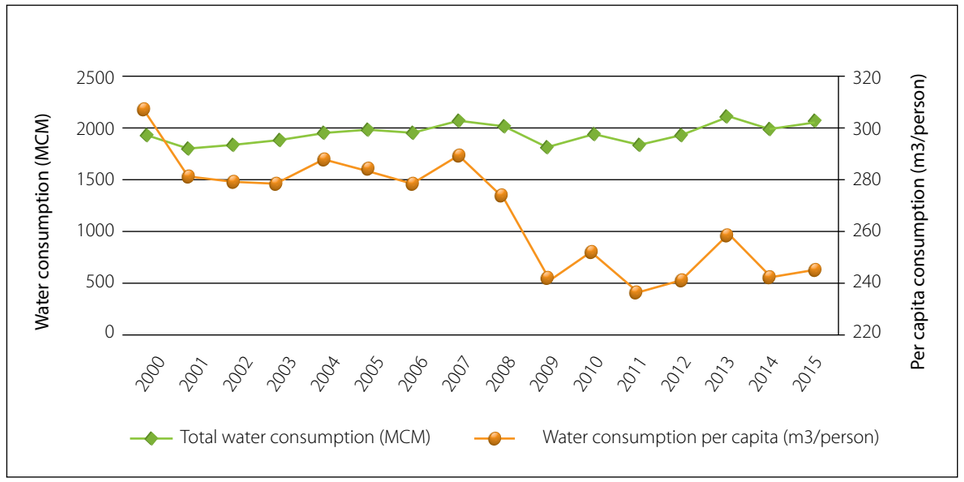
The majority of the area (64.7%) consists of soil, rock, shrubs and dig areas. Of the remaining area, 20% is agricultural land, and developed areas account for only 5.6% of the total area.

The Tel Aviv District has the highest proportion of built-up areas in Israel and accounts for 64.2% of the district's total area. The Jerusalem District has the highest proportion of forest, grove, and parks, which account for 49.1% of the district's total area. The most agricultural district is the Central District at 47.2%, followed by the Northern District at 32.9% of total area. The Southern District is primarily soil, rock, shrubs and dig areas (81.6%).[9]

Water resources

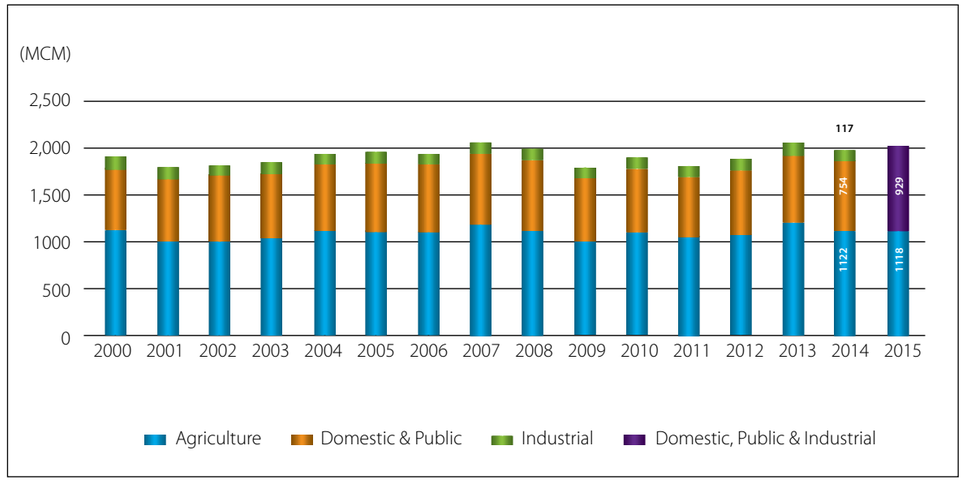
Israel is located in an area characterized by scarcity of natural water resources, and faces various challenges regarding water resource management.

Figure 10: *Total and per capita water consumption.*



9 (The Central Bureau of Statistics , 2015)

Figure 11: *Total water consumption by usage (MCM)*



** A sectoral breakdown for 2015 is only partially available due to lack of data regarding the breakdown between domestic & public and industrial.*

Israel's natural freshwater resources can be divided into aboveground reservoirs (the Sea of Galilee) and subterranean groundwater reservoirs (aquifers).

As can be seen in the following graph, the Dead Sea water level continues to decline at a rate of approximately one meter per year. Meanwhile water levels in the Sea of Galilee have started to stabilize, due to reduced pumping activities resulting from increased use of desalination (see below).[10]

Groundwater (aquifers) serves as Israel's primary water source and is important for maintaining both the water inventory and a variety of sources.

Water levels, which are directly affected by consumption activities and the extent to which precipitation infiltrates into the aquifers, have improved in recent years. This too can be attributed to the growing use of desalinated seawater that is reducing pressure on these water resources.

Water consumption

Total water consumption in Israel has remained relatively constant, increasing by only 3% over the period 2000-2015, reaching 2,047 MCM in 2015.

This stability is due to consistent improvement in water consumption per capita: in 2015, water consumption was 244 m^3 per capita, an improvement of 20% over per capita consumption of 306 m^3 in 2000.

In 2015, agriculture accounted for approximately 55% of the total water consumption; these proportions have remained relatively stable since 2000, as illustrated by the following chart.

Water scarcity in Israel has led to the development of advanced technologies for seawater and saline water desalination and wastewater treatment and recovery.

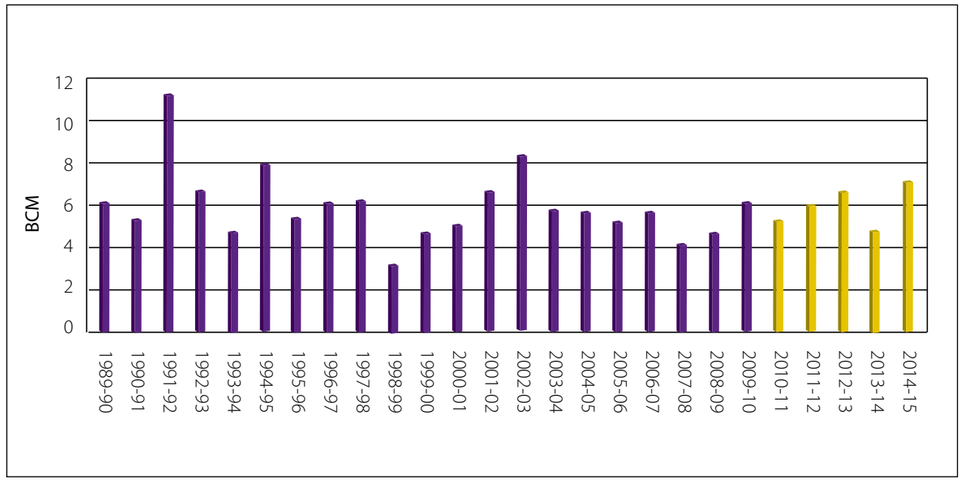
Water desalination

Seawater desalination increased by 91% between 2010 and 2015, from 277 MCM to 503 MCM.[11]

There are currently five seawater desalination facilities in Israel, with a total annual desalination capacity of 582 MCM: Sorek (150 MCM), Hadera (127 MCM), Ashkelon (115 MCM), Ashdod (100 MCM) and Palmachim (90 MCM). A few small facilities with a total annual capacity of 78 MCM desalinate brackish water from the aquifer for use in agriculture and industry.[12]

10 (The Central Bureau of Statistics , 2015)
11 (Water Authority, 2013)
12 (The Central Bureau of Statistics , 2015)

Figure 12: *Annual rainfall volume in Israel (BCM), red bars show data since 2010.*



Wastewater recycling

Israel is a global leader in water recycling, primarily for agricultural use. In 2016, 85% of domestic wastewater was recycled and used for agriculture.[13]

In 2015, 525 MCM wastewater was treated, an increase of 38% over the 380 MCM treated in 2000.

Climate profile

Israel lies in a transition zone between the hot and arid southern part of West Asia and the relatively cooler and wetter northern Mediterranean region. The northern part of Israel is characterized by a Mediterranean climate, while the southern part is arid, with a narrow, semi-arid strip in between.

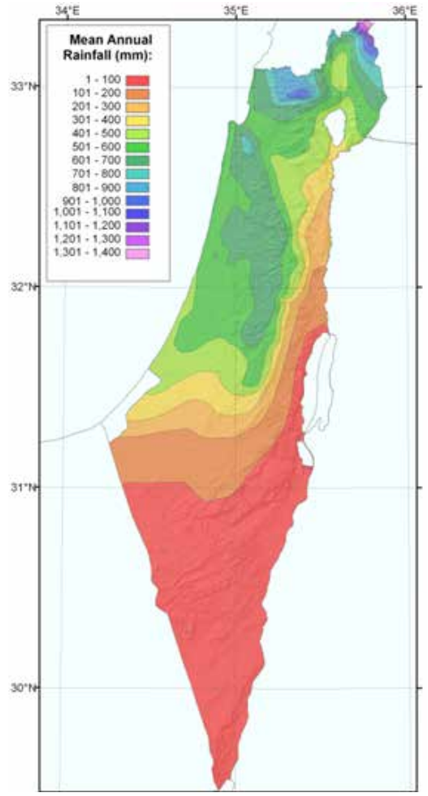
Israel's climate is characterized by hot summers and mild winters. Rainfall varies significantly across the country and from year to year.

Rainfall

The most crucial component of Israel's climate is the rainfall regime. Changes in the rainfall regime, including annual quantity, number of rain spells, seasonal distribution, intensity and timing, all have major impacts on the country's water resources.[14]

The average annual rainfall volume during 2000-

Figure 13: *Precipitation map, average multi annual rainfall, 1981-2010*



Source: Israel Meteorological Service

13 (Ministry of Foreign Afairs , 2016)
14 (Israeli Climate Change Information Center (ICCIC), 2014)

***Table 4**: Average number of days with temperatures above 30°C and below 10°C in major cities*

Station	Monthly average min/max daily temperature (°C)							
	January				July			
	Min (1981-2000)	Min (1995-2009)	Max (1981-2000)	Max (1995-2009)	Min (1981-2000)	Min -1995) 2009)	Max (1981-2000)	Max (1995-2009)
Jerusalem	6.4	6.9	11.8	12.8	19.4	20.2	29.0	30.0
Tel Aviv	9.6	10.2	17.5	17.6	23.0	24.2	29.4	29.9
Haifa	8.9	10.0	17.0	17.8	23.0	24.4	31.1	31.6
Zefat	4.5	5.1	9.4	10.2	18.8	19.9	29.8	30.7
Beer-Sheva	7.5	7.1	16.7	17.7	20.5	21.3	32.7	34.7
Eilat	9.6	10.4	20.8	21.3	25.9	27.3	39.9	40.4

Source: IMS

2009 was 5.78 BCM. Average annual rainfall during 2010-2016 was slightly higher, at 6.02 BCM (as shown in Figure 12).

Mean annual rainfall by locality is calculated for 30-year periods, to adequately characterize the rainfall regime at each monitoring station and its surroundings in accordance with the World Meteorological Organization (WMO) guidelines. The map shown in Figure 13 illustrates the geographic variation in mean annual rainfall.[15]

Over the period of 1981-2000, the mean annual rainfall varied across the six major cities, from 22 mm in Eilat (south) to 671 mm in Zefat (north). Similarly, the number of mean annual rainy days is lowest in Eilat (10) and highest in Zefat (74). Haifa, Tel Aviv, and Jerusalem are located in the middle of the country above the desert and therefore have relatively high annual rainfall (537-583 mm) and mean annual rainy days (56-61). Beer Sheva is further south in the desert and experiences an annual rainfall of 195 mm and 41 mean annual rainy days.[16]

Temperature

Although slightly lower than in the 1950s and 1960s (due to relatively high temperatures in those decades), the mean annual temperature has increased steadily since 1990.

Like precipitation, mean temperatures are also measured over long-term periods. The most recent data is for 1995-2009, which was used in the recent Israel Biennial Update Report submitted to the UNFCCC in 2016.

The data shows that mean temperatures have increased in nearly all cities relative to the previous measurement period (1981-2000). The daily minimum and daily maximum temperatures for January and July, measured

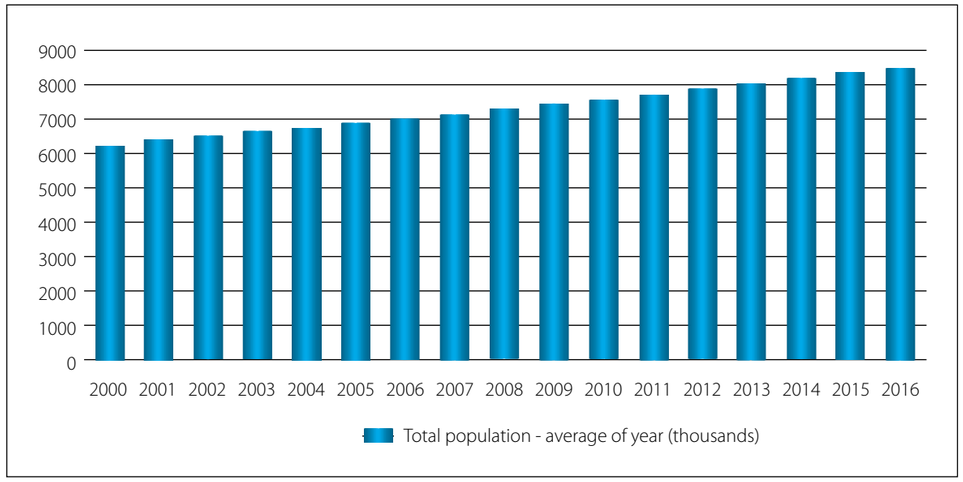
***Table 5:** Mean temperatures (°C) in major cities*

Station	No. of days per year with temperature (1981-2000)		No. of days per year with temperature 1)995-2009)	
	Above 30°C	Below 10°C	Above 30°C	Below 10°C
Jerusalem	44	116	59	109
Tel Aviv	41	52	55	32
Haifa	87	67	95	47
Zefat	51	146	61	142
Beer-Sheva	126	102	155	101
Eilat	202	44	207	29

Source: IMS

15 (Israel Meterological Service, 2015)
16 (The Central Bureau of Statistics , 2015)

***Figure 14:** Population of Israel (thousands) (2000-2016)*



for six geographically distributed cities, can be seen in the tables below. In all but one case, the average temperature was higher for 1995-2009 than for 1981-2000. The average changes in temperature for January were +0.5°C (daily lows) and +0.7°C (daily highs). The average changes in temperature for July were +1.1°C (daily lows) and +0.9°C (daily highs).[17]

Extreme weather events

There have been several specific extreme weather events in Israel over the past few years.

In December 2013, winter storm Alexa hit the Middle East. It was the worst storm to hit the region 60 years, with significant precipitation in the form of both rain and snow.[18] Some areas in Israel experienced snowfall up to 70 cm, while in Jerusalem, snow accumulated to a height of 40 to 60 centimeters, breaking the previous snowfall record set in 1879.[19]

Only three months later, in March 2014, there was an unprecedented low volume of rainfall and rainy days. In most areas in Israel, the volume of rainfall was less than 20% of the mean annual rainfall, accounting for a negative peak period in most parts of the country.[20]

In August 2015, a heat wave struck the Middle East, causing extremely high temperatures in Israel. Temperatures in the Jordan Valley were reported to reach 49°C.[21] According to the Israel Meteorological Service, August 2010 and August 2015 were the two hottest months in the past 75 years.

Population Profile

Population changes and growth

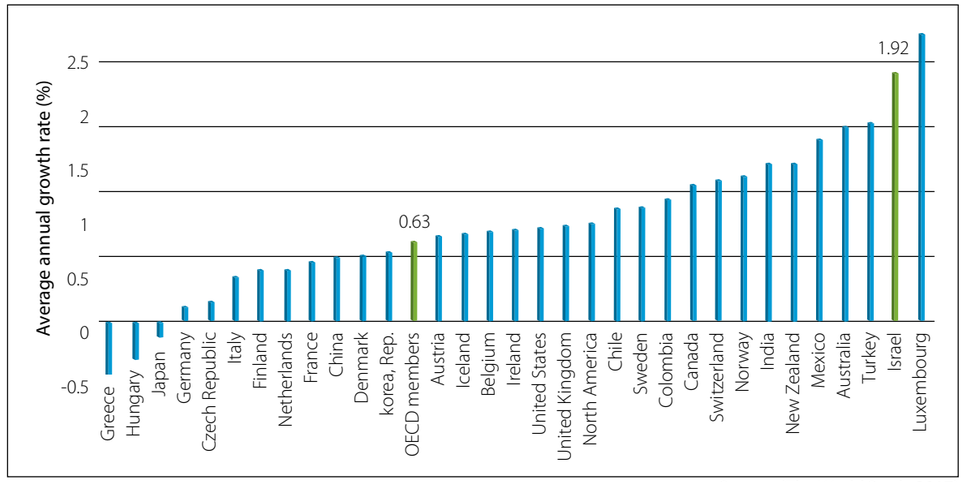
Population changes and growth patterns are fundamental drivers of trends in energy consumption, land use, housing density, and transportation, all of which have a significant impact on GHG emissions.

Rising steadily since 2000, Israel's population at the end of 2016 reached an average of 8.55 million residents, as seen in Figure 14.

The annual growth rate during 2000-2016 was 1.94%, of which 14.9% originated from net immigration. This annual growth rate is one of the highest among the OECD countries, which averaged an annual population growth rate of

17 (Ministry of Environmental Protection, 2015)
18 (The Guardian , 2013)
19 (Jewish National Fund- KKL, 2013)
20 (The Central Bureau of Statistics , 2015)
21 (Israel Meterological Service, 2015)

Figure 15: *Annual growth rate- comparison to OECD countries (2010-2016)*



Source: (The World Bank, 2017)

0.63% over the same period.

In 2016, approximately 91% of the Israeli population lived in urban localities; this figure has remained stable at around 91-92% over the past decade.

Density

Israel's population density has increased steadily, from 278.7 people per km² in 2000 to 380.2 people per km² in 2016.

The population density varies greatly from region to region, from approximately 87.7 people per km² in the Southern District to more than 8,072.1 people per km² in the Tel Aviv District; approximately 40% of Israel's population lives in the Tel Aviv District and the adjacent Central District, which together comprise less than 7% of the country's land area.[22]

Immigration

Immigration to Israel fell from approximately 200,000 immigrants in 1990 to just 13,701 immigrants in 2008; thereafter, immigration remained relatively constant before increasing slightly, totaling 25,977 immigrants in 2016. Average annual immigration over the 2010-2016 period was 20,716.

Economic profile

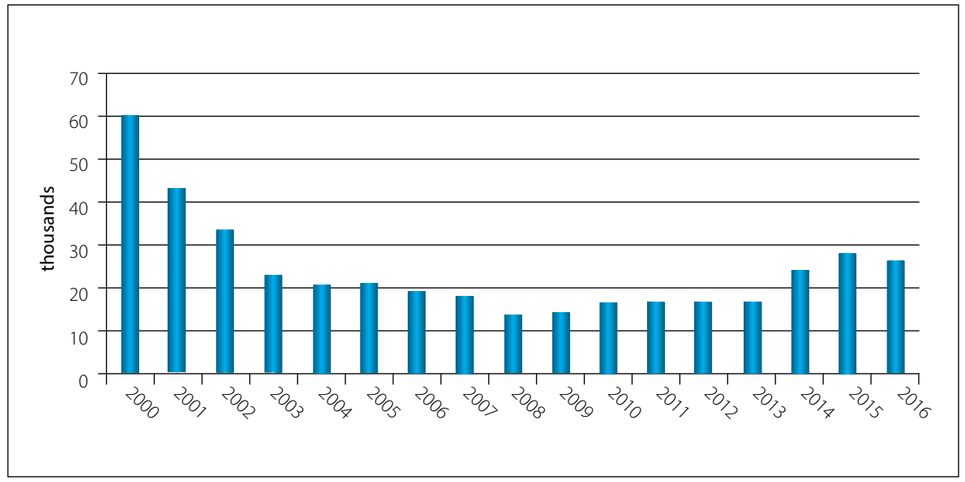
Thanks to cautious monetary, financial and fiscal policies, economic growth has exceeded that

Table 6: *Density per km²*

Districts	2000			2016		
	% of total population	total area (km²)	density per km²	% of total population	total area (km²)	density per km²
Central District	23%	1276	1,142.4	25%	1294	1,635.1
Tel Aviv District	18%	171	6,747.2	16%	172	8,072.1
Jerusalem District	12%	652	1,163.0	13%	653	1,659.0
Haifa District	13%	863	948.4	12%	866	1,150.5
Northern District	17%	4,478	241.9	16%	4473	313.3
Southern District	14%	14,233	63.2	14%	14185	87.7

22 (The Central Bureau of Statistics , 2015)

Figure 16: *Immigration to Israel (thousands) (2000-2016)*



of most other OECD countries for more than a decade. Employment is rising, inflation is low, the external surplus is comfortable, and the public finances are in relatively good shape.[23]

Economic growth and changes in the overall GDP

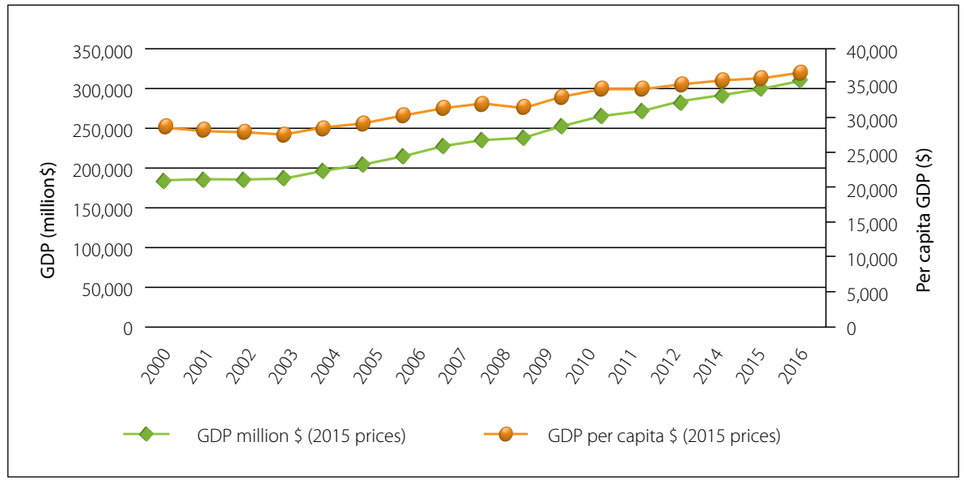
Despite the economic crisis of 2008-2009, when GDP growth fell to just 1.3% in 2009, Israel's economic growth has continued to be strong. Israel experienced an average annual growth of approximately 4% over the 2010-2016 period. Economic growth in Israel remains well above the average annual growth rate of 1.9% in the OECD over the same period.

Development of economic sectors

The share of domestic product (DP) of most sectors remained largely unchanged during 2010-2016. Changes to key sectors in terms of climate change included:

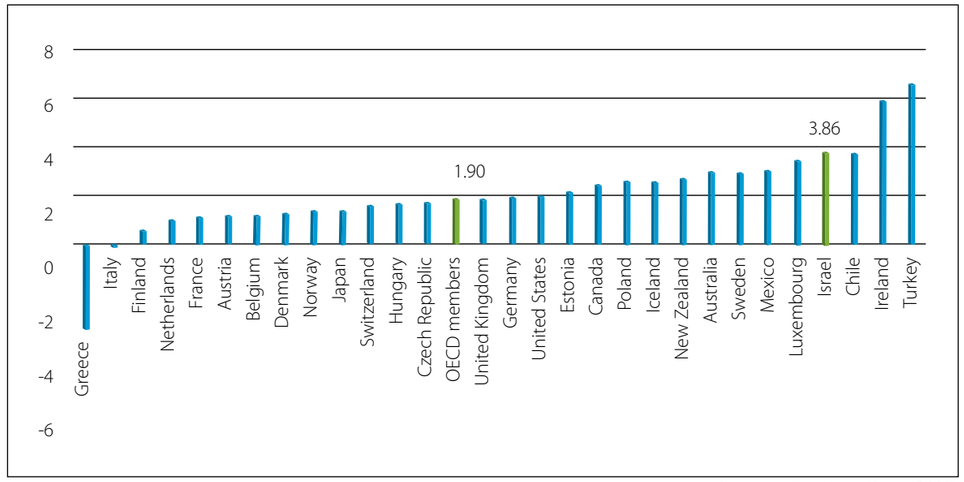
- Manufacturing, mining, quarrying and

Figure 17: *Trends in per capita and real GDP (2015 prices)*



23 (OECD, 2016)

Figure 18: *GDP average growth rate, OECD (2010-2016)*



Source: (The World Bank, 2017)

construction declined from 19.4% of DP in 2010 to 17.8% in 2015.

- Electricity and water supply, sewage, and waste management remained steady at around 1.7% from 2010-2015.
- Transportation, storage, postal and courier activities declined from 3.0% of DP in 2010 to 1.9% in 2015.
- Agriculture, forestry and fishing declined from 1.6% of DP in 2010 to 1.1% in 2015.

Industry

During the first decade of the state, the country's industrial base consisted of textile manufacturing, diamonds and food processing. In subsequent decades, the development of chemical, metallurgical and electronics industries resulted in a major increase in industrial production.

Israel has few raw natural resources and its industry has concentrated on manufacturing products with a high added value. Major industries include pharmaceuticals, electronics, agro-technology, telecommunications, fine chemicals and computers. Other industries include cement manufacturing, nitric acid production, lime manufacturing, and industries that consume soda ash such as glass and paper production industries.

The manufacturing industry

The manufacturing industry (including high-tech) is key to Israel's economy. In 2016, 11% of total employees in Israel worked in the manufacturing industry. Its share of the net DP was around 10.8% (at 2015 prices). While the high-tech sector has seen gains, both the sectoral share of DP and the share of employees working declined during 2010-2016, from 12.3% to 11% and from 10% to 8%, respectively.[24]

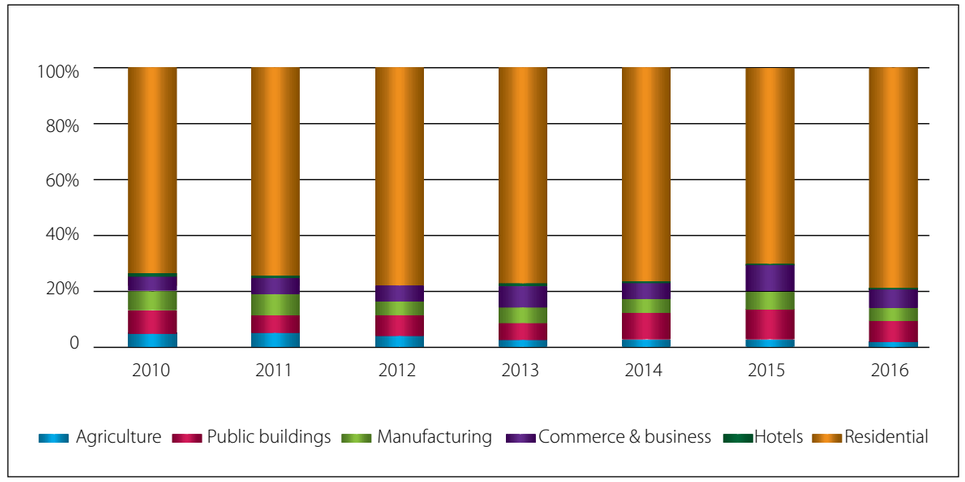
The highest growth rates are in the high-tech sectors, which are skill and capital intensive and require sophisticated production techniques, as well as considerable investment in research and development. The high-tech sector accounted for 26% of industrial jobs in 2016, remaining steady since 2010.

Building stock and urban construction

The contribution of construction to Israel's net DP was 6.3% in 2016, compared to 5.9% in 2011; the number of jobs in the construction sector grew 4% from 2010 to 2016. Additionally, the average construction wages rose nearly 13% (in current prices) between 2010 and 2014.[25]

24 (Central Bureau of Statistics, 2013)
25 (Ministry of Environmental Protection, 2015)

Figure 19: *Share of completed construction*



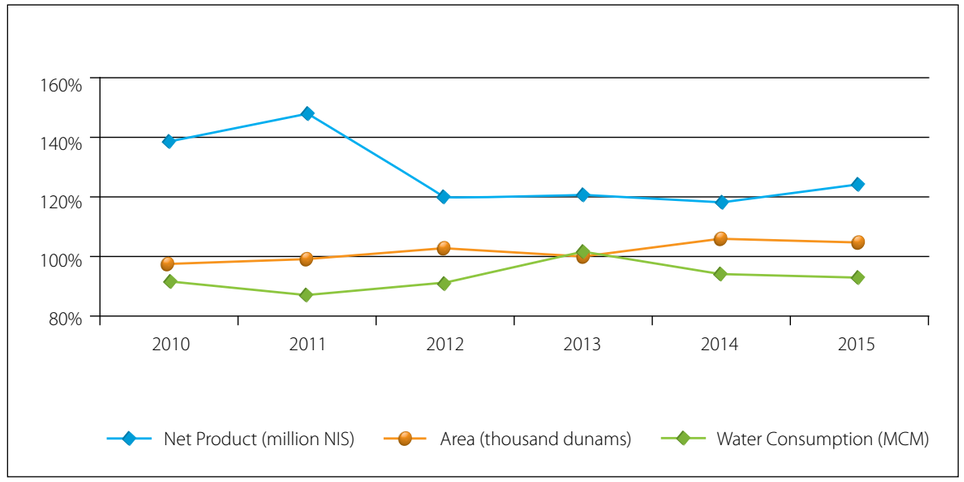
The residential sector accounted for 79% of total construction completed in 2016 followed by public buildings at 7%, and commerce and business at 6%. The relative share of residential, public, business and commercial buildings has increased slightly, as the proportion of manufacturing and agriculture buildings slightly declined relative to 2010.

Table 7: *Share of domestic product (current prices) 2010-2015*

Classification	Year					
	2010	2011	2012	2013	2014	2015
Total DP (NIS million)	660,881	710,141	756,950	809,848	840,176	888,727
Total DP ($ million)	172,104	184,933	197,122	210,898	218,796	231,439
Agriculture, forestry and fishing	2%	2%	1%	1%	1%	1%
Manufacturing; mining and quarrying	14%	13%	13%	12%	12%	11%
Electricity and water supply, sewage and waste management	2%	1%	1%	2%	2%	2%
Construction	6%	6%	6%	6%	6%	6%
Wholesale & retail trade & repair of motor vehicles; accommodation & food service activities	12%	12%	13%	13%	12%	12%
Transportation, storage, postal and courier activities	3%	2%	2%	2%	2%	2%
Information and communications	10%	9%	10%	10%	10%	11%
Financial & insurance; real estate; professional, activities scientific & technical; administrative & support service	19%	21%	20%	21%	20%	20%
Housing services	10%	11%	11%	10%	11%	11%
Local, public and defense administration and social security	6%	6%	6%	6%	6%	6%
Education	7%	7%	7%	7%	7%	7%
Human health and social work activities	7%	7%	7%	7%	7%	7%
Arts, entertainment and recreation; other service activities	4%	4%	3%	3%	3%	3%

**Monthly average exchange rate for 2015 was 3.840 NIS/$ according to the Bank of Israel*

Figure 20: *Major indices in agriculture*



In recent years, Israel has experienced a sharp increase in real apartment prices and rental prices: the apartment price index rose by 55% and the average rent rose by 30% over the 2008-2014 period. This is due in part to a housing shortage, resulting from a decrease in construction and an increasing number of households.[26] To address the high prices and housing shortfall, increased residential construction is expected over the coming decades.

Agriculture

In 2016, agriculture accounted for 1.0% of the workforce and less than 2% of net DP, a decrease from 1.6% and 1.7% in 2010, respectively. Total land under agricultural cultivation increased by 7.1% from 2,832 thousand dunams in 2010 to 3,045 thousand dunams in 2016.

In 2015, agriculture accounted for approximately 55% of total water consumption, totaling 1,118 MCM, an increase of 1.6% from 1,100 MCM in 2010.

Energy profile

Israel's total primary energy supply in 2015 was 22,607.6 thousand TOE, an increase of 16% from 19,499.2 thousand TOE in 2000.

Israel's energy intensity improved significantly during 2000-2015, both per capita consumption and energy consumption per unit of GDP:

3. Final total energy consumption per capita decreased by 13%, from 2.037 TOE per capita in 2000 to 1.77 TOE per capita in 2015.
4. Energy consumption per economic output improved by 29%, from 30.6 TOE per million NIS GDP in 2000 to 21.8 TOE per million NIS GDP in 2015.

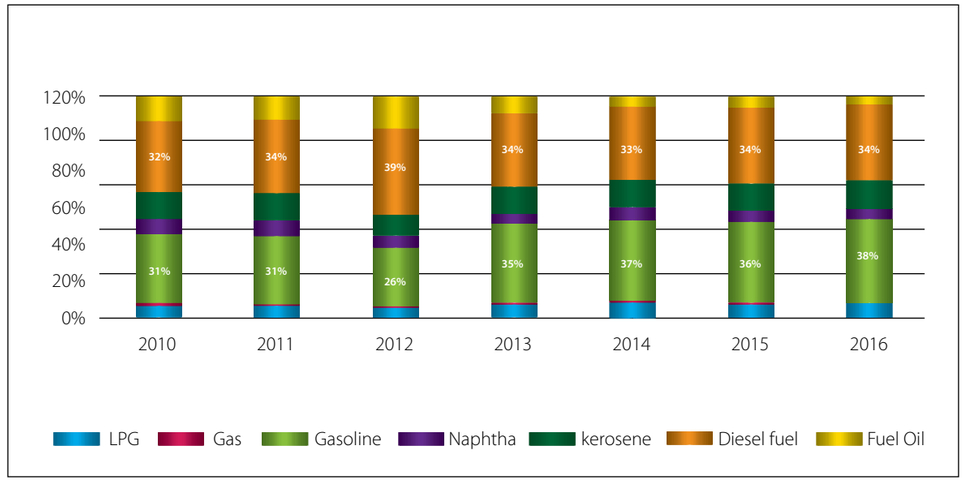
Table 8: *Fuel mix (thousand TOE)*

	2008	2009	2010	2011	2012	2013	2014	2015
Coal	7,520.4	7,357.2	7,464.9	7,448.6	8,487.4	7,221.5	6,637.2	6,578.0
Natural gas	4,038.6	4,478.0	5,000.1	4,678.28*	2,410.02*	5,840.0	6,380.0	7,059.3
Total petroleum products	8,677.2	8,629.3	9,022.5	9,075.0	8,931.0	8,346.6	8,195.5	8,450.5

** Estimated based on data from Natural Gas Authority*

26 (State Comptroller, 2014)

Figure 21: *Petroleum products consumption (thousand tons), 2010-2016*



The Israeli energy production sector continues to undergo two major changes:

1. Independent Power Producers (IPPs) continue to enter the market, with a total generating capacity of cogeneration and conventional power plants (not including renewable energy) reaching 4,048 MW at the end of 2016.[27]
2. The discovery of natural gas reserves has significantly changed the energy generation fuel mix.

Energy supply (production and reserves)

Fuel mix

An increased uptake of natural gas is the main trend in the country's total fossil fuel mix, both in the power generation and manufacturing/large-scale commercial sectors.

The share of natural gas in the total fuel mix rose from approximately 23% in 2010 to approximately 30% in 2016. The share of coal and petroleum fuels has decreased from approximately 35% in 2010 to 30% in 2015 and from approximately 42% in 2010 to 38% in 2015, respectively.

Coal

Coal was introduced during the early 1980s to diversify energy resources and became a major fuel in electricity production; it is used solely for electricity generation purposes by the state-owned Israel Electric Corporation (IEC). Israel has no domestic coal supply and relies on coal that is imported solely by the National Coal Supply Company.

Petroleum-based fuels

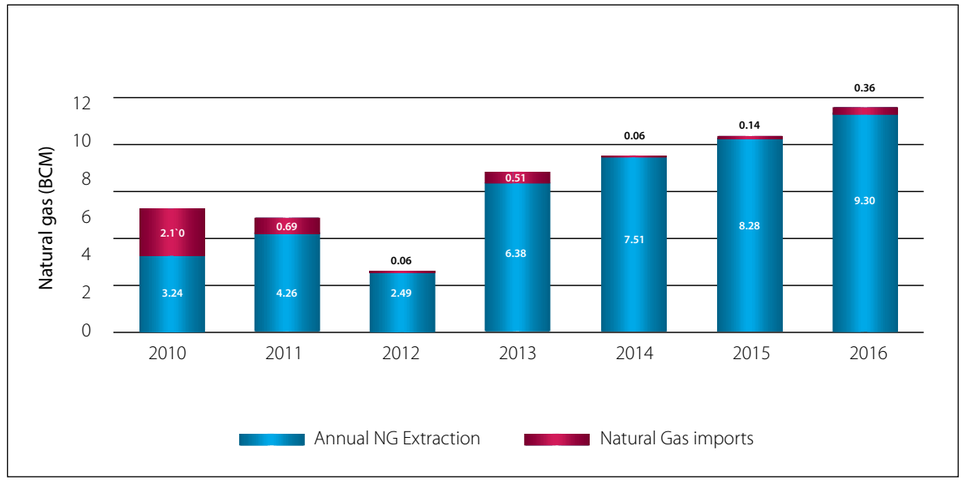
Israel has negligible domestic crude oil extraction and either imports raw petroleum to refine most of the fuel products it requires, or imports ready-made fuel products.

Oil exploration in Israel began in 1953. In 1955, petroleum was first discovered in the "Heletz" field at the southern coastal plain area. In 1957, petroleum was also discovered in the adjacent "Brur" and Kokhav" fields in that same area. Since extraction began, the combined Heletz-Brur-Kokhav field, which is near depletion, produced 17.2 million barrels.

Israel has two major oil refineries with a total refining capacity of about 15 million tons per year: Oil Refineries Ltd (ORL) in Haifa with a maximum crude oil refining capacity of approximately 9.8 million tons of crude oil per year, and the Paz

27 (The Electricity Authority, 2017)

Figure 22: *Natural gas supply from extraction and imports*



Refinery in Ashdod.

Petrol is the bulk of the petroleum consumption, accounting for 38% of total consumption in 2016, up from 31% in 2010. Diesel fuel follows, with 34% of total consumption in 2016, up from 32% in 2010. The use of fuel oil decreased from 11% in 2010 to 4% in 2016.

Natural gas

In recent years, offshore natural gas reserves totaling an estimated 900 BCM (proven and contingent) have been discovered. These are expected to have major ramifications for the Israeli market.[28]

These reserves, specifically the Tamar and Leviathan fields, are of very high quality (over 99% methane) and significantly large enough to supply the domestic market for the coming decades. In 2013, the Tamar field began producing gas for Israeli consumption,

28 (Natural Gas Authority, 2013)

Figure 23: *Natural gas consumption*

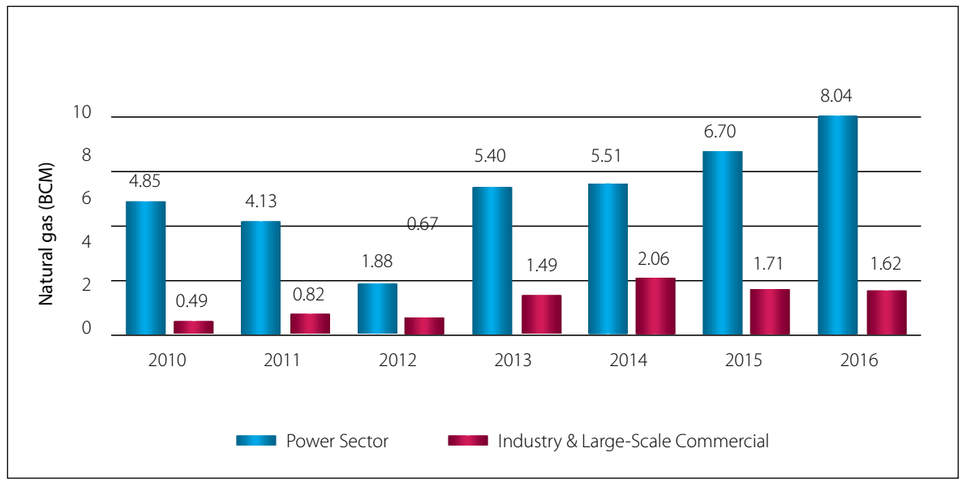


Table 9: *Installed capacity (MW), 2010-2016*

	IEC coal capacity	IEC other capacity (including natural gas)	IPP conventional capacity	IPP co-generation capacity	IPP renewables capacity
2010	4,840	7,929	0	0	0
2011	4,840	7,919	0	0	0
2012	4,840	8,408	542	401	309
2013	4,840	8,643	542	461	346
2014	4,840	8,777	1476	461	491
2015	4,840	8,777	2388	677	679
2016	4,840	8,777	2400	677	971

and natural gas consumption increased. Continued development of the natural gas sector is a strategic energy sector goal for Israel. The development of the Leviathan field has experienced delays and Government Decision Number 476, the "Natural Gas Framework Pact" of August 2015, was intended to accelerate development of the Leviathan field and increase the production from the Tamar field. The Leviathan field is now expected to begin supplying the Israeli market by late 2019.

Natural gas supply to the Israeli market totaled 9.66 BCM in 2016, an increase of approximately 80% relative to the approximately 5.4 BCM in 2010. Further, domestic natural gas accounted for approximately 96% of the total supply in 2016, a drastic increase from the 60% in 2010, now that natural gas imports from Egypt have ceased, and natural gas imports are limited to small amounts of LNG for the power sector.

The power sector accounted for approximately 90% of natural gas consumption in 2010. Although power sector consumption grew by 66% over the 2010-2016 period, this period is also characterized by significant uptake of natural gas in the industrial and large-scale commercial sectors, which grew by 231% to approximately 20% of total consumption.

Renewable energy

In Israel, renewable energy policy is focused on increasing renewable electricity generation. In 2016, renewable generation accounted for 2.6% of electricity consumption. For more information, see power sector below.

Furthermore, solar energy is a major source of power for residential water heating, as per a long-standing regulation that mandates installation of solar water heaters on all new residential buildings up to nine stories.

Power sector

Market structure

Historically, the state-owned IEC has had a full monopoly on the power sector, including the generation, transmission and distribution, and grid management segments.

In recent years, however, the Israeli electricity market has undergone extensive reform for privatization of the generation component. By the end of 2016, the established electricity generation capacity owned by private producers and connected to the national electricity grid accounted for about 20% of total electric generation capacity in the country.[29]

The Israel Electricity Authority (EA) has estimated that by 2025 around 40% of the installed capacity will be private. The transmission and distribution segments, as well as grid management, continue to be managed by the IEC and are expected to remain so in the future.[30]

Generation capacity

Installed generating capacity at the end of 2016 was 16,694 MW, an increase of 31% relative to the

29 (The Electricity Authority, 2017)
30 (The Electricity Authority, 2015)

	2010	2011	2012	2013	2014	2015	2016
Coal	59%	59%	61%	52%	49%	45%	36%
Fuel oil	1%	1.9%	7%	0.6%	0%	0.1%	0.1%
Natural gas	39%	35%	17%	44%	50%	53%	61%
Diesel oil	1%	4%	14.7%	2.4%	0.1%	0.7%	0.4
Renewables	0%	0.1%	0.3%	0.7%	1.4%	2%	2.6%

generation capacity of 12,769 MW in 2010.

Generation fuel mix

In 2016, approximately 36% of total power generated was from coal, down from 59% in 2010. Sixty-one percent was from natural gas, up from 39% in 2010 and an additional 2.6% was generated from renewables.[31]

Between 2010 and 2016, electricity consumption increased from approximately 52 TWh to approximately 62.5 TWh, representing an annual growth rate of 3%. Over the same period peak demand increased from 10,950 MWh to 13,360 MWh amounting to annual growth of 3.4%.

The residential and public and commercial sectors are the highest consuming sectors in Israel, which account for approximately 29% and 28% of total consumption, respectively. This has remained steady over the period of 2010-2016. Consumption per sector between 2010 and 2016, as provided by the IEC, is presented in table 10.

Transportation

The dominant fuel for private vehicles remains petrol, with 96% of private vehicles powered by petrol in 2015, a rate that has remained constant since 2010. For other vehicles (taxis, buses and trucks), the share of vehicles powered by diesel fuel has increased from 34% in 2010 to 67% in 2015, replacing petrol.

In 2015, the share of vehicles powered by alternative fuels (gas and electric) remained very low, only 0.8% of total vehicles, a small increase from 0.3% in 2010.

The total number of vehicles in Israel grew from 1,832,000 in 2000 to 2,566,191 by 2010, and then to 3,239,305 by 2016. Of this amount, 84% are private cars.

In 2016, the rate of motorization was 382.7 cars per 1,000 residents, an increase from 333.5 in 2010, and 287.6 in 2000.

The increase in car ownership has not resulted in a proportionate increase in road surface; total road length increased only 18% over the same period, from 16,450 km in 2000 to 19,362 km in 2016.[32]

The disproportionate increase in vehicular traffic compared to the road surface area has increased traffic and congestion.

Of the 57,220 million km vehicle mileage in 2016, 43,953 million km were by private cars. This constitutes an increase of 32% relative to 2010 levels (49,870 million km) and 93% relative to 2000 (36,482 million km).

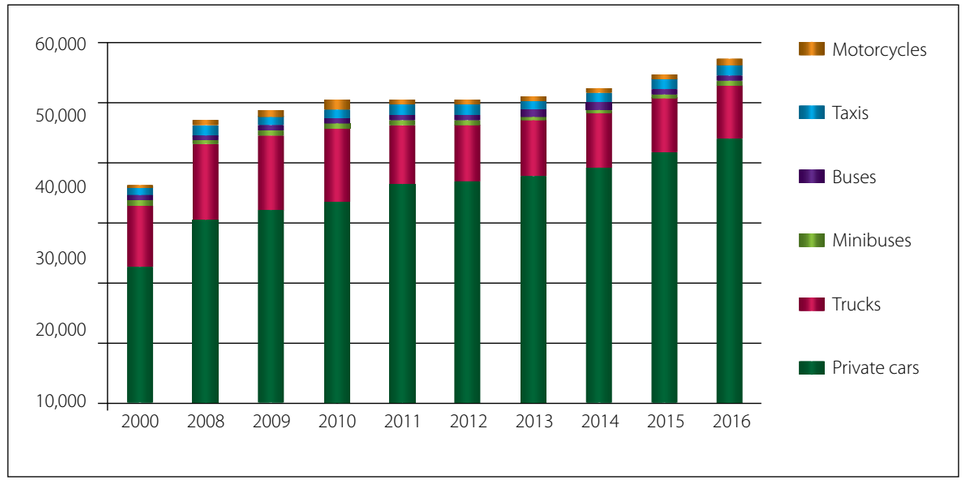
Table 10: *Electricity consumption by sector (GWh)*

Year	Residential	Public & Commercial	Industrial	Other	Total
2010	15,591	17,132	10,647	8,243	51,977
2011	15,909	17,202	10,987	7,876	53,067
2012	17,245	18,433	11,849	8,607	57,085
2013	15,662	17,753	13,182	8,969	56,794
2014	15,981	15,953	15,211	9,558	56,162
2015	17,606	17,381	14,210	10,197	60,340
2016	18,154	17,370	15,689	9,017	62,518

31 (The Electricity Authority, 2016)

32 (Ministry of Environmental Protection, 2015)

Figure 24: *Kilometers travelled, by type of vehicle*



Public transportation

Use of public transport increased during 2010-2016:

- An increase of 30% in bus service – travel by buses rose from 458 million kilometers in 2010 to 597 kilometers in 2016; the number of buses rose from 6,479 in 2010 to 9,024 in 2016.
- An increase of 66% in rail ridership, from approximately 36 million passengers in 2010 to approximately 60 million passengers in 2016.

To manage the congestion problems, Israel is expanding and adapting public transportation:

- **Public transport in metropolitan areas:** All four main metropolitan areas (Tel Aviv, Jerusalem, Haifa and Beer Sheva), home to 43.5% of Israel's population, are pursuing public transportation development plans, including dedicated public transport "fast lanes", light rail trains, and bus rapid transit (BRT).
- **Intercity public transport:** Israel is establishing new rail lines, including rail transport from Beit Shean to Haifa in the Galilee region and construction of a high-speed rail link between Tel Aviv and Jerusalem. In addition, Israel has expanded intercity highway lanes dedicated to public transport.

Other sectors

Waste

Waste and recycling trends

Israel generated approximately 5.3 million tons of MSW in 2016, compared to 4.6 million tons in 2010. The average Israeli generates 1.7 kg of waste per day and total waste produced is growing at a rate of average 2.5% per year, in line with population growth.[33]

In 2010, the Ministry of Environmental Protection introduced a plan to reduce landfill waste by recycling and recovering useful material. To increase the recycling rate, local authorities are switching to waste separation at the source (at homes).

The number of households that are separating waste at the source reached 470,606 by the end of 2015; according to a Ministry of Environmental Protection assessment, about 2.5 million Israelis

33 (Ministry of Environmental Protection, 2015)

will separate waste in their homes by 2019.[34] In addition, the Ministry has invested in the construction of waste treatment facilities, including composting and anaerobic digestion facilities for treatment of organic waste, and facilities for production of refuse derived fuel (RDF).

In 2015, 4,098,500 tons of municipal solid waste were sent to landfills. The recycling rate in 2015 was 20%, a rise of 2% from 2014. It continues the trend towards meeting the target to reach 50% recycling of solid waste by 2020.

Government structure

Israel is a parliamentary democracy. As such, there is a joint responsibility for the nation's economic development, energy, natural resources, and many other issues affecting the welfare of Israelis. The government consists of three distinct branches: executive, legislative, and judicial. Each branch possesses distinct powers, but is not independent of the others. This creates a system of checks and balances and separates the powers to create, implement and adjudicate laws.

Executive branch

The executive branch in Israel is its government (cabinet of ministers). The executive branch is charged with implementing and enforcing the laws of Israel. The Prime Minister is the head of the executive branch, and the ministers are responsible for implementing policies in their respective fields. The ministries are as follows:

- Prime Minister's Office
- Agriculture and Rural Development
- Aliyah and Integration
- Communications
- Construction and Housing
- Culture and Sports
- Defense
- Development of the Negev and the Galilee
- Economy and Industry
- Education
- Energy
- Environmental Protection
- Finance
- Foreign Affairs
- Health
- Interior
- Jerusalem And Heritage
- Justice
- Public Security
- Religious Services
- Science and Technology
- Social Equality
- Social Affairs and Social Services
- Tourism
- Ministry of Transport and Road Safety

Legislative branch

The legislative branch in Israel is its parliament, the 'Knesset'. The Knesset passes all laws, elects the President and Prime Minister (although the President ceremonially appoints the latter), approves the cabinet, and supervises the work of the government. In addition, the Knesset elects the State Comptroller.

Judicial branch

The judicial branch of Israel consists of both secular courts and religious courts. The courts constitute a separate and independent unit of the Ministry of Justice. The President of the Supreme Court and the Minister of Justice head the judicial branch. In its capacity as the High Court of Justice, the Supreme Court also acts as a court of first instance in matters concerning the legality of state decisions and actions.

Institutional arrangements

The Ministry of Environmental Protection is responsible for the formulation of a nationwide, integrated, and inclusive policy for the protection of the environment, and is Israel's key institution for climate change issues. The Ministry operates on three levels: national, regional, and local.

The ministries of Energy, Transport, Agriculture and Rural Development, Economy and Industry, and Finance also play important roles in areas concerning climate change and the environment.

An Inter-ministerial Steering Committee for GHG Reductions includes representatives from the Ministry of Energy, the Electricity Authority, the National Economic Council in the Prime Minister's Office, the Ministry of Finance, the Ministry of Economy, the Ministry of Transport, the Ministry of Interior, the Ministry of Construction and Housing, the Ministry of Foreign Affairs, the Ministry of Health, and the Ministry of Agriculture and Rural Development.

The primary role of the Steering Committee is to evaluate the effectiveness of government measures to reduce emissions, including cost-benefit analyses, evaluating the progress towards meeting the GHG emission reduction targets and supporting targets, and recommending additional measures as needed. The Steering Committee reports annually to government.

The Ministry of Environmental Protection is responsible for the preparation of national communications and biennial update reports, including compiling the requisite data from various government ministries and agencies, and other relevant stakeholders, and submitting these to the Steering Committee for approval.

The Israel Central Bureau of Statistics (CBS) prepares the National GHG Inventory annually and has a legal mandate to collect data from all stakeholders in the country.

To facilitate both the work of the Steering Committee and report in accordance with its international obligations, Israel is in the process of establishing a national Monitoring, Reporting and Verification (MRV) system, in accordance with the GHG Protocol Policy and Action Standard and the Mitigation Goal Standard. The MRV system will be operational by mid-2018. The Ministry of Environmental Protection, as head of the Steering Committee, oversees the process.

The institutional arrangements require the ministries on the Steering Committee to provide the Ministry of Environmental Protection with the requisite data to prepare an annual report to government, as well as national reports in accordance with the country's international obligations. These arrangements are formalized within the context of government decision 1403 - National Plan for Implementation of the Greenhouse Gas Emissions Reduction Targets and for Energy Efficiency.

34 (Ministry of Environmental Protection, 2015)

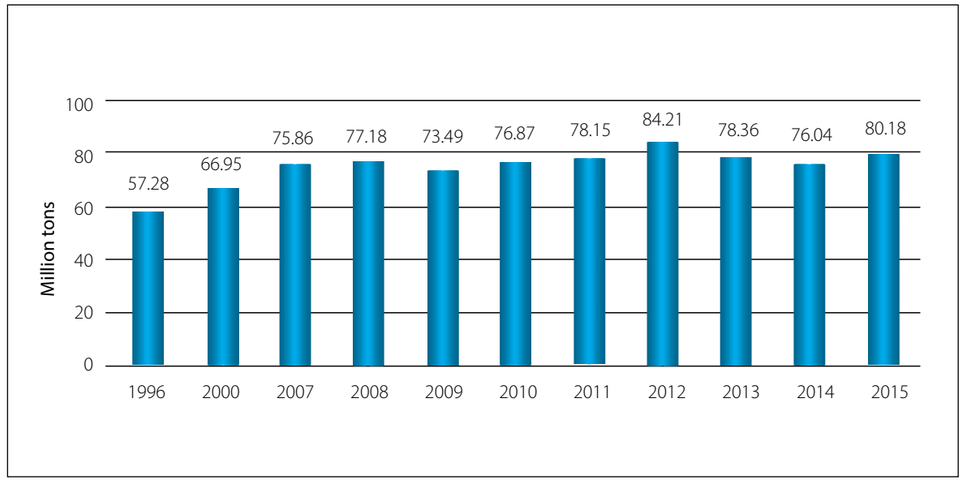
Photo: Pini Hamou

2. GHG Inventory

Key developments since the last National Communication

- In 2015, Israel's total GHG emissions were 80.18 $MtCO_2e$, representing an absolute increase of around 40% relative to 1996 GHG emissions, 20% relative to emissions in 2000, and an increase of 4% relative to 2010 emissions.
- Emission intensity has shown an overall declining trend since 1996, both in terms of GHG emissions per capita and GHG emissions per GDP, with 2014 values reaching their lowest levels since the inventory was first published in 1996, at 9.38 tCO_2e/capita and 0.28 tCO_2e/$1000 GDP.
- The share of CO_2 in total emissions has declined steadily in recent years, from 91% in 1996 to 83% in 2015.
- Fuel combustion remains the predominant source of CO_2 emissions and accounted for 97% of total CO_2 emissions in 2015; 64% of fuel combustion CO_2 emissions resulted from energy industries.
- Energy industries remain the largest source of CO_2e emissions, accounting for 52% of total GHG emissions in 2015.
- Transport is the second largest source, accounting for 22% of total emissions in 2015, an 8% increase since 2010, due primarily to increases in both the number of private vehicles and kilometers travelled per private vehicle.
- Emissions from the agricultural sector, which are mostly of methane emissions from enteric fermentation and manure management, amounted to 2.1 tCO_2e in 2015, a decrease of 10% from 2010 levels.

Figure 25: *GHG emission trends*



In accordance with the guidelines for National GHG Inventories, Israel's national inventory includes the following sectors: Energy Industries, Industrial Processes, Agriculture, Waste and Wastewater, and Forestry. The inventory includes emissions and removals of the three main GHGs – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) as well as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6), which have been included in the inventory since 2008. The inventory also includes emissions of indirect GHGs, which are precursors of tropospheric ozone – carbon monoxide (CO) and nitrogen oxides (NO_x) – as well as sulfur dioxide (SO_2), an aerosol precursor that has a cooling effect on climate. While not included in the national inventory, the CBS also publishes data on emissions from international bunker fuels (aviation and marine).

Methodologies

IPCC Guidelines

The revised 1996 IPCC Guidelines for National GHG Inventories were applied for the calculation of GHGs in all sectors, with the exception of agriculture and waste. For these sectors, the 2006 IPCC Guidelines for National GHG Inventories have been applied since 2011, as these guidelines are more detailed and useful to the level for calculations used in those sectors.

Additional Guidance

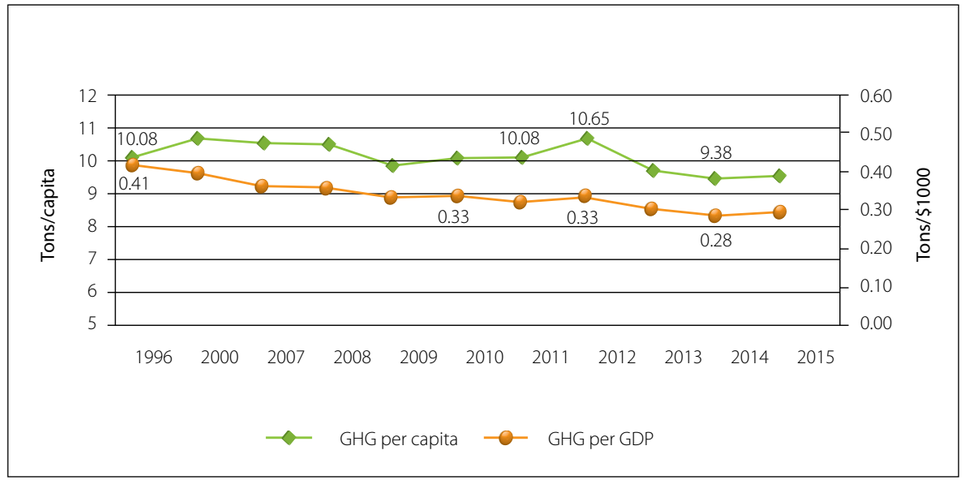
In addition to the IPCC Guidelines for National GHG Inventories, the 'Good Practice Guidance and Uncertainty Management in National GHG Inventories' guidelines were used for preparation of the inventory.

Tier Levels

The tier level applied in the national GHG inventory varies from sector to sector due to the varying availability of data and information:

- **Module 1-Energy:** In principle, Tier 1 was applied, with notable exceptions being the application of Tier 2 using information that is unique to Israel such as calorific values of primary energy sources (coal, natural gas, oil shale). Tier 3 was applied for emissions of SO_x, NO_x, and CO from vehicles, as well as emissions of SO_x and NO_x from electricity generation.
- **Module 2-Industrial Processes:** In principle, Tier 1 was applied. For some sources emission factors specific to Israeli industry were used and therefore Tier 3 was applied. Regarding emissions of fluorinated gases, a methodology was adapted specifically to Israel and therefore Tier 3 was applied.
- **Module 3-Solvent and Other Product Use:** There are no emissions from sources as such and therefore no tier level was applied.
- **Module 4- Agriculture:** In principle, Tier 2 was applied, taking into account the specific processes in Israel's agriculture sector and appropriate emission factors.
- **Module 5- Land Use Change and Forestry:** Israel uses the Tier 1 approach for estimating removals in forest land areas. There is no forest inventory in place as the forest land in Israel is negligible. However, data on forest land and on the mass of trees harvested do exist and are periodically updated.
- **Module 6- Waste:** Tier 2 is applied to waste and Tier 1 to wastewater.

Figure 26: *GHG emission intensity*



Areas where data may be further improved

Israel has encountered challenges in conducting the uncertainty analysis as well as estimation of emissions using the reference approach and comparison to the sectoral approach due to a combination of a lack of resources and knowledge gaps. The key category analysis has been partially conducted but not published. Israel would be interested in improving its capabilities in those matters through capacity- building.

In addition, data gaps regarding agricultural residues continue to pose a challenge, and no calculations were conducted for lime and urea application due to uncertainty as to the relevance of this emission source to Israel.

Emissions Profile

In 2015, Israel's total GHG emissions were 80.18 million tons (Mt) CO_2 equivalent (CO_2e), representing an absolute increase of around 40% relative to 1996 GHG emissions, 20% relative to emissions in 2000, and an increase of 4% relative to 2010 emissions. Emissions have decreased in recent years, largely due to a reduction of GHG emissions from the power sector, which peaked in 2012 (see Figure 25) due to a natural gas shortage, and resulted in increased use of more GHG-intensive fossil fuels. Once supply resumed in 2013, emissions from the power sector declined from 48.7 $MtCO_2e$ in 2012 to 41.3 $MtCO_2e$ in 2015. Emission intensity has shown an overall declining trend since 1996 both in terms of GHG emissions per capita and in terms of GHG emissions per GDP, with 2014 values reaching their lowest levels since the inventory was first published in 1996, at 9.38 tCO_2e/capita and 0.28 tCO_2e/$1000 GDP.

Key emission trends by sector

Israel's inventory is based on the breakdown of CO_2e emissions by the source categories defined by IPCC, as follows: energy industries, manufacturing industries and construction,

Table 11: *GHG emissions (1000 tCO_2e) by sector in Israel, 1996, 2010 and 2015*

Sector	1996	2000	2010	2015
Energy sector	50,598	59,052	64,698	64,943
Fuel combustion	50,598	59,052	64,698	64,943
Energy industries	28,590	36,571	42,342	41,476
Manufacturing industries and construction	6,746	6,788	5,255	4,934
Transport	11,112	14,109	16,293	17,667
Other sectors	4,150	1,584	808	866
Fugitive emissions from fuels	-	-	-	-
Industrial processes	2,426	2,812	4,493	6,859
Agriculture	2,072	2,222	2,357	2,129
Waste	2,558	3,076	5,904	6,437
Total net emission (excluding LULUCF)	57,653	67,163	77,452	80,367
Land use, land-use change and forestry	- 370	- 213	- 411	- 190
Total net emissions (including LULUCF)	57,283	66,950	77,041	80,177

**The full GHG Inventory table can be found at the end of this chapter.*

transport, residential/commercial/institutional sector and agriculture.

Key emissions trends by sector are shown in table 11.

Energy sector

Emissions from the energy sector were 64.9 $MtCO_2e$ in 2015, up by 28% from the approximately 50.6 $MtCO_2e$ in 1996, and up by less than 1% from the approximately 64.5 $MtCO_2e$ in 2010.

Table 12: *Sectoral GHG emissions*

Year – 2015	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x
Total Energy	64,664.71		4.07	0.62	136.17	155.63	214.72	111.61
A. Fuel combustion (sectoral approach)	64,664.71		4.07	0.62	136.17	155.63	214.72	111.61
1. Energy industries	41,333.27		0.62	0.42	10.97	108.18	2.78	101.13
2. Manufacturing industries and construction	4,918.89		0.24	0.03	1.61	12.84	0.39	8.48
3. Transport	17,552.20		3.07	0.16	123.33	33.25	211.47	1.60
4. Other sectors								
5. Commercial, institutional	393.66		0.06	0.00	0.12	0.62	0.03	0.19
6. Residential sectors	366.19		0.06	0.00	0.12	0.58	0.03	0.05
7. Agriculture, forestry and fishing	100.50		0.02	0.00	0.03	0.15	0.01	0.15
8. Other (please specify)	393.66		0.06	0.00	0.12	0.62	0.03	0.19
B. Fugitive emissions from fuels								
1. Solid fuels								
2. Oil and natural gas								

Energy Industries (Power Sector)

Energy industries remain the largest source of CO_2e emissions, accounting for 52% of total GHG emissions in 2015. Over the 2010-2016 period, emissions from power production declined by 2% due to an increase in natural gas-based electricity generation and, to a lesser extent, renewables. This is despite a peak in emissions in 2012, which resulted from increased use of diesel oil and fuel oil to compensate for a shortage in natural gas.

Table 13: *Sectoral GHG emissions from industrial processes*

Year - 2015	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	SF_6	HFCs	PFCs
2. Industrial processes	2,376.61		0.21	2.53		1.11	82.12	5.21	84.07	3,495.02	113.07
A. Mineral products											
Cement production	2,233.28							0.10			
Production of lime	112.98										
Soda ash use	30.36										
Road paving with asphalt							76.17				
Container Glass							0.90				
B. Chemical industry											
Nitric acid production				2.53		1.11					
Ethylene			0.21								
Production of other chemicals							5.05				
Sulphuric acid								5.11			
C. Metal production											
D. Other production											
E. Production of halocarbons and sulphur hexafluoride											
F. Consumption of halocarbons and sulphur hexafluoride									84.07	3,495.02	113.07
G. Other (please specify)											

Transport

Transport is the second largest source, accounting for 22% of total emissions in 2015. Emissions increased by 8% over the 2010-2016 period, due primarily to increases in both the number of private vehicles and kilometers travelled by private vehicles, which grew by 26% and 32%, respectively.

Manufacturing Industries and Construction

Manufacturing Industries and Construction accounted for 6% of the total emissions in 2015, a decrease of 6% from 2010 levels. This is due to the decline of use in diesel fuel and fuel oil, which has been supplanted by natural gas.

Industrial processes

GHGs are emitted from a large variety of industrial processes not related to energy. The main emission sources are industrial production processes which chemically or physically transform materials.

The sources included in the Israel National GHG Inventory are:

1. Cement production
2. Nitric acid production
3. Lime production
4. Soda ash use

Industrial process emissions amounted to 6.9 tCO_2e in 2015, an increase of 53% from 2010.

Agriculture

Emissions from the agricultural sector, which

Table 14: *Sectoral emissions from Agriculture*

year – 2015	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	SF_6	HFCs	PFCs
4. Agriculture			**40.32**	**4.14**							
A. Enteric fermentation			37.29								
B. Manure management			3.04	0.64							
C. Rice cultivation			-	-							
D. Agricultural soils			-	3.50							
E. Prescribed burning of savannahs			-	-							
F. Field burning of agricultural residues			-	-							
G. Other (please specify)			-	-							

are mostly methane emissions from enteric fermentation and manure management, amounted to 2.1 tCO_2e in 2015, a decrease of 10% from 2010 levels.

Waste

In 2015, emissions from waste and wastewater amounted to 6.4 tCO_2e, an increase of 9% since 2010.

It should be noted that in 2013, the CBS altered the methodology for calculating methane emissions from waste, with emissions now calculated using the IPCC first order decay (FOD) model instead of the IPPC mass balance method used in previous reports.

Forestry

In 2015, Israel's forest area included 115,400 hectares of plantations (including 48,700 hectares of conifers, 8,300 hectares of eucalyptus and 15,100 hectares of broad-leaved trees) and 22,000 hectares of natural woodlands. Although only a relatively small area is planted with eucalyptuses, it contributes all of the CO_2 removals and sinks.

Total CO_2 removal by forests in 2015 was 297 thousand tons, a decrease of 43% from 2010.

It should be noted that emissions and removals from Soil Organic Carbon (SOC) pools or deadwood are not calculated; furthermore, grasslands, croplands, settlements, wetlands and other lands are not included in the calculation as they are considered to have a relatively insignificant impact.

International Bunkers

Emissions from international bunkers are also calculated by the CBS, although they are not included in the national inventory.

Emissions of direct and indirect GHGs from international bunkers peaked in 2008, before generally declining until 2016. During that period, CO_2e emissions decreased 4% as can be seen in Table 15.

KEY EMISSIONS TRENDS BY GAS

Table 16 summarizes GHG emissions by gas, as calculated for the years 1996, 2000 and 2007-2015. Methane and nitrous oxide emissions are expressed as CO_2e.

Sector	1996	2000	2005	2010	2015
Waste total emissions (1000 tCO_2e)	2,558	3,076	4,755	5,904	6,437
Solid waste disposal on land (1000 tCO_2e)	2,348	2,682	3,964	4,947	5,445
Waste-water handling (1000 tCO_2e)	210	395	791	957	991

Table 15: *Table of Emissions from International Bunkers*

Thousand tons	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
Direct (CO_2e):	**2,225**	**2,803**	**3,485**	**3,659**	**3,534**	**3,617**	**3,570**	**3,450**	**3,289**	**2,918**	**3,498**
CO_2	**2,207**	**2,781**	**3,460**	**3,633**	**3,509**	**3,590**	**3,544**	**3,425**	**3,263**	**2,894**	**3,471**
Aviation	1,924	2,298	2,400	2,434	2,413	2,549	2,571	2,420	2,494	2,521	2,670
Marine	283	483	1,060	1,199	1,095	1,041	973	1,005	769	374	801
CH4	**0.7**	**1**	**1.8**	**2**	**1.9**	**1.8**	**1.7**	**1.7**	**1.4**	**0.9**	**1.5**
Aviation	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Marine	0.4	0.7	1.5	1.6	1.5	1.4	1.3	1.4	1.1	0.5	1.1
N_2O	**17.4**	**21.3**	**23.6**	**24.2**	**23.8**	**24.9**	**24.9**	**23.7**	**23.7**	**23.0**	**25.3**
Aviation	16.7	20.1	21	21.3	21.1	22.3	22.5	21.2	21.8	22.1	23.4
Marine	0.6	1.2	2.6	2.9	2.7	2.5	2.4	2.5	1.9	0.9	2
Indirect: NO_x	**13.7**	**19.3**	**31**	**33.9**	**31.8**	**31.3**	**30.1**	**30.1**	**25.7**	**18.1**	**27.1**
Aviation	8.1	9.7	10.2	10.3	10.2	10.8	10.9	10.3	10.6	10.7	11.3
Marine	5.6	9.5	20.9	23.6	21.5	20.5	19.2	19.9	15.2	7.4	15.8
NMVOCs	**2.1**	**2.9**	**4.5**	**4.9**	**4.6**	**4.5**	**4.4**	**4.4**	**3.8**	**2.8**	**4.0**
Aviation	1.4	1.6	1.7	1.7	1.7	1.8	1.8	1.7	1.8	1.8	1.9
Marine	0.8	1.3	2.8	3.1	2.9	2.7	2.6	2.6	2	1.0	2.1
SO_2	6	9.3	15	14.7	13.7	13.3	12.3	11.9	10.7	7.6	11.5
Aviation	3.7	4.4	4.6	4.6	4.6	4.8	4.9	4.6	4.7	4.8	5.1
Marine	2.4	4.9	10.4	10.1	9.1	8.4	7.4	7.3	6	2.8	6.4
CO	**6.5**	**9.6**	**17.3**	**19.2**	**17.8**	**17.3**	**16.4**	**16.7**	**13.6**	**8.5**	**14.3**
Aviation	2.7	3.2	3.4	3.4	3.4	3.6	3.6	3.4	3.5	3.6	3.8
Marine	3.7	6.4	13.9	15.7	14.4	13.7	12.8	13.2	10.1	4.9	10.5

Carbon Dioxide (CO_2)

In 2015, CO_2 emissions accounted for 83% of total GHG emissions. Although CO_2 remains the predominant GHG emitted in Israel, its share of total emissions has steadily declined over recent years, from 91% in 1996, gradually decreasing to 86% in 2010, and 83% in 2015. In 2015, Israel emitted 66 million tons of CO_2, a 10% decrease from 2000.The predominant source of CO_2 emissions remains fuel combustion, which accounted for 97% of total CO_2 emissions in 2015; 64% of fuel combustion CO_2 emissions resulted from energy industriesas can be seen in Table 17.

Table 16 : *Summary of GHG inventory*

(1000 tons, unless stated otherwise)	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
Carbon Dioxide (CO_2)	57,283	60,855	66,862	66,298	63,595	65,912	67,096	72,535	66,147	65,101	66,851
Methane (CH_4)	8,945*	3,888	6,043	6,268	6,413	6,790	6,800	6,958	7,043	7,097	7,114
Nitrous Oxides (N_2O)	1,897	2,206	2,950	2,797	2,566	2,619	2,142	2,476	2,434	2,575	2,520
Sulfur hexafluoride (SF_6)	NC	NC	NC	1,107	166	87	122	73	73	100	84
Hydro-fluorocarbons (HFCs)	NC	NC	NC	660	720	1,352	1,889	2,093	2,557	2,128	3,495
Perfluorocarbons (PFCs)	NC	NC	NC	51	31	109	104	78	106	103	113

**This figure reflects the previous calculation method (IPPC mass balance method)*

Table 17: *CO_2 emissions by sector*

	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total emissions and removals	57,283	60,855	66,862	66,298	63,595	65,912	67,096	72,535	66,147	65,101	66,851
From fuel combustion	50,344	58,765	64,807	64,297	61,999	64,146	65,092	70,409	64,091	62,824	64,665
1. Energy industries	28,466	36,412	42,654	42,255	40,226	41,917	42,648	47,906	41,722	40,060	41,333
2. Manufacturing industries and construction	6,720	6,759	5,858	5,716	5,278	5,240	5,437	5,208	4,975	5,218	4,919
3. Transport	11,031	14,018	15,198	15,346	15,550	16,186	16,079	16,379	16,554	16,695	17,552
4.Other sectors	4,127	1,575	1,097	980	945	803	929	916	840	851	860
From Industrial processes	1,888	2,303	2,440	2,348	1,963	2,176	2,418	2,423	2,329	2,451	2,377
Land-use change and forestry	-370	-213	-385	-347	-367	-411	-414	-297	-273	-166	-190
1. CO_2 emissions and removals from soil	-	183	107	107	107	107	107	107	107	107	107
2. Changes in forest and other woody biomass stocks	-370	-396	-491	-453	-474	-518	-521	-404	-380	-273	-297

Methane (CH_4)

In 2015, methane emissions amounted to 7,114 tCO_2e (8.8% of total GHG emissions), an increase of 83% relative 2000 and 5% relative to 2010. Solid waste disposal remains the dominant source of CH_4 emissions, accounting for 77% of total CH_4 emissions in 2015.

Nitrous Oxide (N_2O)

In 2015, nitrous oxide emissions amounted to 2,520 tCO_2e (3% of total GHG emissions), an increase of 14% relative 2000 and a decrease of 4% relative to 2010. Agriculture is the main source of N_2O emissions, accounting for 51% of total N_2O emissions in 2015 as can be seen in Table 19.

Table 18: *CH_4 emissions by sector*

	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total emissions	3,523	3,888	6,043	6,268	6,413	6,790	6,800	6,958	7,043	7,097	7,114
From fuel combustion	75	73	74	75	74	77	79	84	79	81	85
From Industrial processes	-	4	4	4	5	4	5	5	4	4	4
From Agriculture	891	920	932	963	936	961	787	796	819	825	847
From solid waste disposal on land	2,558	2,682	4,440	4,641	4,831	5,031	5,187	5,334	5,438	5,474	5,445
From waste-water treatment	210	210	593	585	567	717	743	739	702	713	732

Fluorinated Gases (SF_6, HFCs, and PFCs)

In 2015, fluorinated gas emissions amounted to 3,692 tCO_2e (5% of total GHG emissions), an increase of 103% relative to 2008 and 139% relative to 2010. HFCs are the primary F-gas relevant to Israel, accounting for 95% of total F-gas emissions in 2015.

Indirect GHG emissions

The inventory includes the emissions of the following GHG precursors:

- **Nitrogen oxides (NO_x)** - Fuel combustion activities, especially energy production and mobile sources, are the most significant anthropogenic source of NOx. Two different mechanisms contribute to their formation: conversion of chemically bound nitrogen in fuel and fixation of atmospheric nitrogen in the combustion process. The first mechanism contributes most of the NOx emitted from coal, whereas the second mechanism is dominant in oil combustion and is the sole mechanism for gaseous fuels.
- **Carbon monoxide (CO)** - Most CO emissions from fuel combustion come from motor vehicles and small combustion equipment in the residential sector. CO emissions from mobile sources are a function of the efficiency of combustion and post combustion controls.
- **Sulfur dioxide (SO_2)** - SO_2 emissions are directly related to the sulfur content in fuels.

During 1996-2015, emissions of NO_x, CO and SO_2 decreased by 29%, 72% and 43%, respectively.

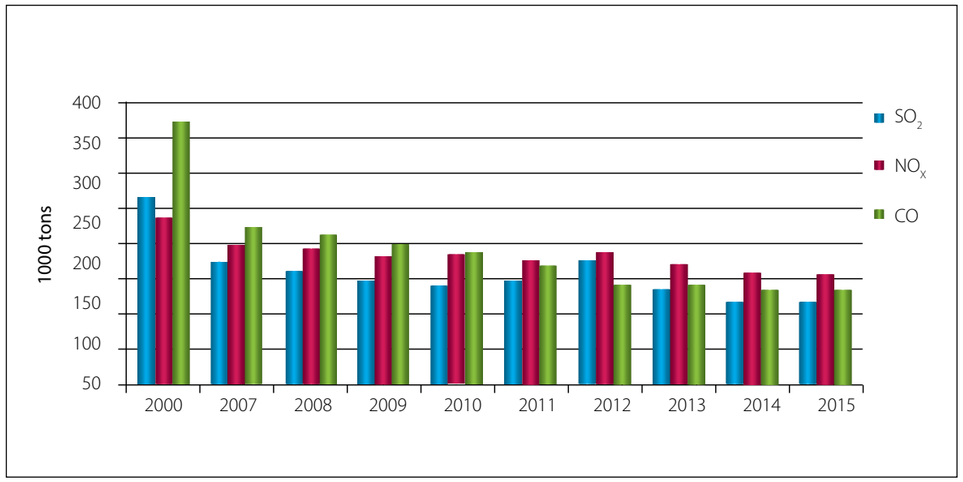
Table 19: *N_2O emissions by sector*

	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total emissions	1,897	2,206	2,950	2,797	2,566	2,619	2,142	2,476	2,434	2,575	2,520
From fuel combustion	180	215	226	218	208	209	215	245	201	192	193
From agriculture	1,180	1,300	1,599	1,496	1,423	1,396	1,147	1,147	1,178	1,272	1,282

Table 20: *Indirect GHG emissions by sector*

	1996	2000	2007	2008	2009	2010	2011	2012	2013	2014	2015
NO_x total	220	237	201	196	184	186	177	189	170	160	157
1. From fuel combustion	215	232	200	195	183	185	177	188	169	159	156
CO total	478	376	226	214	199	187	169	143	140	136	136
1. From fuel combustion	478	376	226	214	199	187	169	143	140	136	136
2. From transport	469	367	215	203	189	176	157	131	128	123	124
SO_2 total	281	284	210	196	179	175	183	210	174	160	117
1. From fuel combustion	262	264	174	162	150	142	149	178	137	123	112
2. From Industrial processes	19	19	36	33	30	33	34	32	37	5	5

Figure 27: *Indirect GHG emissions from fuel combustion*



Full Inventory Tables

Table 21: *Full inventory tables*

Year 1996	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
GHG SOURCE AND SINK CATEGORIES	CO_2	CO_2	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x
Total national emissions and removals	52,232.30	-370.00	167.76	6.12	478.18	219.90	247.42	281.13
1. Energy	50,344.00		3.55	0.58	477.70	214.74	157.98	262.00
A. Fuel combustion (sectoral approach)	50,344.00		3.55	0.58	477.7	214.74	157.98	262.00
1. Energy industries	28,466.00		0.57	0.36	5.96	86.38	1.64	190.71
2. Manufacturing industries and construction	6,720.00		0.23	0.07	1.15	22.68	0.57	45.57
3. Transport	11,031.00		2.18	0.12	469.44	99.92	155.48	12.61
4. Other sectors								
Commercial, institutional residential sectors	3,520.00		0.49	0.03	0.98	4.90	0.25	10.52
Agriculture, forestry and fishing	607.00		0.09	0.01	0.17	0.85	0.04	2.60
5. Other (please specify)								
B. Fugitive emissions from fuels								
1. Solid fuels								
2. Oil and natural gas								
2. Industrial processes								
A. Mineral products	1,888.30		-	1.73	0.48	5.16	89.44	19.14
CEMENT PRODUCTION								
PRODUCTION OF LIME	1,673.00							1.01
SODA ASH USE	106.70							
ROAD PAVING WITH ASPHALT							85.77	
Container Glass								
B. Chemical industry								
NITRIC ACID PRODUCTION				1.73	0.48	5.16		
Ethylene								
PRODUCTION OF OTHER CHEMICALS	92.00						3.67	0.00
Sulphuric Acid								18.13
C. Metal production								
D. Other production								
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)								
3. Solvent and other product use								
4. Agriculture			42.42	3.810				
A. Enteric fermentation			32.42					
B. Manure management			10.00	0.80				
C. Rice cultivation			-	-				
D. Agricultural soils			-	3.01				
E. Prescribed burning of savannahs			-	-				
F. Field burning of agricultural residues			-	-				
G. Other (please specify)			-	-				
5. Land-use change and forestry	-	-370.00						
A. Changes in forest and other woody biomass stocks	-	-370.00						
B. Forest and grassland conversion	-	-						
C. Abandonment of managed lands	-	-						
D. CO_2 emissions and removals from soil		-						
E. Other (please specify)								
6. Waste			121.79	-	-	-	-	
A. Solid waste disposal on land			111.79					
B. Waste-water handling			10.00					
C. Waste incineration	-							
D. Other (please specify)								
7. Other (please specify)								
Memo items								
International bunkers	**2,207.00**		0.03	0.06	**6.46**	**13.70**	**2.11**	**6.01**
Aviation	1,924.00		0.01	0.05	2.72	8.10	1.36	3.66
Marine	283.00		0.02	0.00	3.74	5.60	0.75	2.35
CO_2 emissions from biomass	2,207.00		0.03	0.06	6.46	13.70	2.11	6.01

Year 2000	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
GHG SOURCE AND SINK CATEGORIES	CO_2	CO_2	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x
Total national emissions and removals	61,251	-396.00	185.16	7.11	375.90	237.18	239.20	283.94
1. Energy	58,764.79		3.47	0.69	375.90	232.31	155.69	264.44
A. Fuel combustion (sectoral approach)	58,764.79		3.47	0.69	375.90	232.31	155.69	264.44
1. Energy industries	36,411.76		0.73	0.47	7.64	110.72	2.10	209.14
2. Manufacturing industries and construction	6,759.39		0.25	0.08	1.27	25.19	0.63	46.39
3. Transport	14,018.35		2.25	0.14	366.54	94.10	152.85	4.76
4. Other sectors								
Commercial, institutional	378.80		0.05	0.00	0.11	0.55	0.03	1.83
residential sectors	838.01		0.12	0.01	0.25	1.25	0.06	0.33
Agriculture, forestry and fishing	358.47		0.05	0.00	0.10	0.50	0.02	2.00
5. Other (please specify)								
B. Fugitive emissions from fuels								
1. Solid fuels								
2. Oil and natural gas								

2. Industrial processes	2,303.03		0.20	1.63		4.87	83.51	19.50
A. Mineral products								
CEMENT PRODUCTION	2,152.13							1.30
PRODUCTION OF LIME	134.30							
SODA ASH USE	16.60							
ROAD PAVING WITH ASPHALT							78.40	
Container Glass							0.77	
B. Chemical industry								
NITRIC ACID PRODUCTION				1.63		4.87		
Ethylene			0.20					
PRODUCTION OF OTHER CHEMICALS							4.34	
Sulphuric Acid								
C. Metal production								
D. Other production								
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)								
3. Solvent and other product use			43.81	4.195				
4. Agriculture			33.42					
A. Enteric fermentation			10.39	0.83				
B. Manure management			-	-				
C. Rice cultivation			-	3.37				
D. Agricultural soils			-	-				
E. Prescribed burning of savannahs			-	-				
F. Field burning of agricultural residues			-	-				
G. Other (please specify)	183.33	-396.00						183.33
5. Land-use change and forestry	-	-396.00						-
A. Changes in forest and other woody biomass stocks	-	-						-
B. Forest and grassland conversion	-	-						-
C. Abandonment of managed lands	183.33	-						183.33
D. CO_2 emissions and removals from soil			43.81	4.195				
E. Other (please specify)								
6. Waste			137.68	0.60	-	-	-	
A. Solid waste disposal on land			127.69					
B. Waste-water handling			9.99	0.60				
C. Waste incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo items								
International bunkers	2,780.97		0.05	0.07	9.61	19.28	2.90	9.27
Aviation	2,297.79		0.02	0.06	3.25	9.74	1.62	4.37
Marine	483.18		0.03	0.00	6.36	9.55	1.27	4.90
CO_2 emissions from biomass	2,780.97		0.05	0.07	9.61	19.28	2.90	9.27

Year 2010	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
GHG SOURCE AND SINK CATEGORIES	CO_2	CO_2	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x
Total national emissions and removals	66,429.31	-517.70	323.34	8.45	187.43	185.72	267.84	174.93
1. Energy	64,146.24		3.69	0.67	187.43	184.63	193.53	141.83
A. Fuel combustion (sectoral approach)	64,146.24		3.69	0.67	187.43	184.63	193.53	141.83
1. Energy industries	41,917.16		0.61	0.47	10.43	119.45	2.66	124.04
2. Manufacturing industries and construction	5,239.84		0.17	0.04	0.91	13.42	0.35	15.56
3. Transport	16,186.12		2.77	0.16	175.83	50.50	190.46	1.96
4. Other sectors								
Commercial, institutional	394.90		0.06	0.00	0.12	0.62	0.03	0.17
residential sectors	369.25		0.06	0.00	0.12	0.58	0.03	0.05
Agriculture, forestry and fishing	38.97		0.01	0.00	0.01	0.06	0.00	0.04
5. Other (please specify)								
B. Fugitive emissions from fuels								
1. Solid fuels								
2. Oil and natural gas								
2. Industrial processes	2,176.44		0.20	2.50		1.09	74.31	33.10
A. Mineral products								
CEMENT PRODUCTION	2,023.46							1.22
PRODUCTION OF LIME	121.74							
SODA ASH USE	31.24							
ROAD PAVING WITH ASPHALT							68.39	
Container Glass							0.86	
B. Chemical industry								
NITRIC ACID PRODUCTION				2.50		1.09		
Ethylene			0.20					
PRODUCTION OF OTHER CHEMICALS							5.06	
Sulphuric Acid								31.89
C. Metal production								
D. Other production								
E. Production of halocarbons and Sulphur hexafluoride								
F. Consumption of halocarbons and Sulphur hexafluoride								
G. Other (please specify)								
3. Solvent and other product use								
4. Agriculture			45.74	4.50				
A. Enteric fermentation			34.62					
B. Manure management			11.12	0.92				
C. Rice cultivation			-	-				
D. Agricultural soils			-	3.58				
E. Prescribed burning of savannahs								

F. Field burning of agricultural residues								
G. Other (please specify)								
5. Land-use change and forestry	106.63	-517.70						
A. Changes in forest and other woody biomass stocks	-	-517.70						
B. Forest and grassland conversion	-	-						
C. Abandonment of managed lands	-	-						
D. CO_2 emissions and removals from soil	106.63	-						
E. Other (please specify)								
6. Waste			273.71	0.78				
A. Solid waste disposal on land			239.59					
B. Waste-water handling			34.12	0.78				
C. Waste incineration			273.71	0.78				
D. Other (please specify)								
7. Other (please specify)								
Memo items								
International bunkers	3,590		0.09	0.08	17.26	31.29	4.53	13.28
Aviation	2,549		0.02	0.07	3.60	10.80	1.80	4.85
Marine	1,041		0.07	0.01	13.66	20.49	2.73	8.43
CO_2 emissions from biomass	3,590		0.09	0.08	17.26	31.29	4.53	13.28

year 2015	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
GHG SOURCE AND SINK CATEGORIES	CO_2	CO_2	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x
Total national emissions and removals	67,147.95	-296.80	338.76	8.13	136.17	156.74	296.83	116.82
1. Energy	64,664.71		4.07	0.62	136.17	155.63	214.72	111.61
A. Fuel combustion (sectoral approach)	64,664.71		4.07	0.62	136.17	155.63	214.72	111.61
1. Energy industries	41,333.27		0.62	0.42	10.97	108.18	2.78	101.13
2. Manufacturing industries and construction	4,918.89		0.24	0.03	1.61	12.84	0.39	8.48
3. Transport	17,552.20		3.07	0.16	123.33	33.25	211.47	1.60
4. Other sectors								
Commercial, institutional	393.66		0.06	0.00	0.12	0.62	0.03	0.19
residential sectors	366.19		0.06	0.00	0.12	0.58	0.03	0.05
Agriculture, forestry and fishing	100.50		0.02	0.00	0.03	0.15	0.01	0.15
5. Other (please specify)								
B. Fugitive emissions from fuels								
1. Solid fuels								
2. Oil and natural gas								
2. Industrial processes	2,377		0.21	2.53		1.11	82.12	5.21
A. Mineral products								
CEMENT PRODUCTION	2,233.28							0.10
PRODUCTION OF LIME	112.98							
SODA ASH USE	30.36							
ROAD PAVING WITH ASPHALT							76.17	
Container Glass							0.90	
B. Chemical industry								
NITRIC ACID PRODUCTION				2.53		1.11		
Ethylene			0.21					
PRODUCTION OF OTHER CHEMICALS							5.05	
Sulphuric Acid								5.11
C. Metal production								
D. Other production								
E. Production of halocarbons and Sulphur hexafluoride								
F. Consumption of halocarbons and Sulphur hexafluoride								
G. Other (please specify)								
3. Solvent and other product use								
4. Agriculture			40.32	4.14				
A. Enteric fermentation			37.29					
B. Manure management			3.04	0.64				
C. Rice cultivation			-	-				
D. Agricultural soils			-	3.50				
E. Prescribed burning of savannahs			-	-				
F. Field burning of agricultural residues			-	-				
G. Other (please specify)			-	-				
5. Land-use change and forestry	106.63	-296.80						
A. Changes in forest and other woody biomass stocks	-	-296.80						
B. Forest and grassland conversion	-	-						
C. Abandonment of managed lands	-	-						
D. CO_2 emissions and removals from soil	106.63	-						
E. Other (please specify)	-	-						
6. Waste			294.16	0.84				
A. Solid waste disposal on land			259.30					
B. Waste-water handling			34.85	0.84				
C. Waste incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo items								
International bunkers	3,471		0.07	0.08	14.29	27.09	3.99	11.49
Aviation	2,670		0.02	0.08	3.77	11.32	1.89	5.08
Marine	801		0.05	0.01	10.52	15.77	2.10	6.41
CO_2 emissions from biomass								

Photo: Riki Shlomo Edri

3. Mitigation policies and measures

Key developments since the last National Communication

- In December 2017, the government approved a National Plan for Energy Efficiency-Electricity Consumption Reduction
- On April 22, 2016, Israel signed the Paris Agreement, and ratified the Agreement on November 22, 2016.
- In September 2015, the government approved an economy-wide unconditional target to reduce per capita GHG emissions to 8.8 tCO_2e by 2025 and 7.7 tCO_2e by 2030.
- The same government decision included the following sector-specific targets:
  - An energy efficiency target to achieve a 17% reduction in electricity consumption by 2030 relative to business as usual.
  - Renewable electricity generation will amount to 13% of electricity consumption in 2025 and 17% of electricity consumption in 2030.
  - Achieve a 20% reduction of private car kilometers travelled by 2030 relative to business as usual.
- In April 2016, the government approved a National Plan to Reduce GHG Emissions and Increase Energy Efficiency
- In 2016, the government reactivated a National Support Mechanism for Energy Efficiency and Emission Reduction projects.
- Significant steps have been taken to reduce the use of coal -fired power plants for power generation.

Paris Agreement

On April 22, 2016, Israel signed the Paris Agreement and ratified the Agreement on November 22, 2016.

Israel's INDC and National GHG Reduction Target for 2030

In September 2015, prior to the UNFCCC Conference of the Parties (COP 21) the Israeli government approved an economy-wide unconditional target to reduce per capita GHG emissions to 7.7 tCO_2e by 2030. Such a reduction would constitute a 26% reduction relative to 2005 emissions of 10.4 tCO2e per capita; given current population forecasts, total emissions in the target scenario are expected to be 81.65 MtCO2e compared to 100 MtCO2e in the business-as-usual scenario (BAU). Additionally, the government approved an interim target of 8.8 tCO_2e per capita by 2025, amounting to an expected 86.6 $MtCO_2e$. The government decision further approved the following sector-specific targets:

1. **Energy Efficiency in Electricity Consumption:** Achieve a 17% reduction in electricity consumption by 2030, relative to the business-as-usual (BAU) consumption as projected in 2015. This amounts to an absolute target of 80 TWh in 2030.
2. **Renewable Electricity Generation:** Renewable electricity generation will amount to 13% of electricity consumption in 2025 and 17% of electricity consumption in 2030.
3. **Public Transport:** Achieve a 20% reduction of private car kilometers travelled by 2030, relative to BAU kilometers travelled as projected in 2015. This amounts to a target of limiting private car mileage to 44.4 million vehicle kilometers in 2030.

These targets are in addition to the following previously approved targets for 2020:

1. **GHG Reduction:** Reduce GHG emissions by 20% relative to a business as usual (BAU) scenario. This amounts to an absolute target of 87.2 $MtCO_2e$, and was included in the 2009 Copenhagen Accord.
2. **Energy Efficiency in Electricity Consumption:** Achieve a 20% reduction in electricity consumption by 2020, relative to the business-as-usual (BAU) consumption. This amounts to an absolute target of 64.2 TWh.
3. **Renewable Electricity Generation:** Renewable electricity generation will amount to 10% of electricity consumption.

Target status

The following tables summarize Israel's progress towards meeting its key 2020, 2025 and 2030 targets described above.

Implementation of Targets and Paris Agreement

In April 2016, the government approved a National Plan to Reduce GHG Emissions and Increase Energy Efficiency, to achieve its 2020, 2025 and 2030 targets, and in September 2016, the National Plan for the Implementation of the Paris Agreement was published.

The national plan is set for the period of 2016-2017, and will be updated periodically, as required. It focuses on the following subjects:

- GHG emissions reduction, with a focus on:
  - Increasing energy efficiency in electricity consumption
  - Increasing electricity generation from renewable sources
  - Reducing the use of coal for electricity generation
  - Government loan guarantees and grants for energy efficiency and GHG emission reduction projects
  - Reducing the use of private transport
  - Reducing emissions from buildings
- Measurement, Reporting and Verification
- Participation in international climate financing
- Participation in international negotiations
- Capacity building and training.

Table 22: *Israel's progress in meeting its 2020, 2025 and 2030 primary GHG targets*

National Target	Latest Reported Value (2015)	Target Value (2020)	Target Value (2025)	Target Value (2030)
National GHG Emission Reduction Target value	80.1 $MtCO_2e$ (9.6 tCO_2e per capita)	87.2 $MtCO_2e$ (9.60 tCO_2e per capita)	8.8 tCO_2e per capita (86.6 $MtCO_2e$)	7.7 tCO_2e per capita (81 $MtCO_2e$)

Table 23: *Israel's progress in meeting its 2020, 2025 and 2030 supporting targets*

National Target	Latest Reported Value (2016)	Target Value (2020)	Target Value (2025)	Target Value (2030)
National Energy Efficiency Target	62.5 TWh	64.2 TWh	-	80 TWh
National Renewable Energy Target	2.6%	10%	13%	17%
National target for private car mileage reduction	43.9 million vehicle-km	-	-	44.4 million vehicle-km

Decision making process

The formulation of the national reduction target involved a planning process directed by an Inter-ministerial Steering Committee that examined the potential for reducing GHG emissions in 2030. The committee was chaired by the Director-General of the Ministry of Environmental Protection, with representatives from all relevant government ministries, public utility companies, industry and commerce, local government, environmental and non-governmental organizations, academia and other national and international experts from various disciplines.

As explained in further detail in the Institutional Arrangements section in Chapter 1 (National Circumstances) the decision making process going forward is supported by the Inter-ministerial Steering Committee for GHG Emissions Reductions, which consists of representatives from all relevant government ministries and advisory bodies. The Steering Committee submits an annual report to the government evaluating the effectiveness of government measures to reduce emission reductions, the progress towards meeting national GHG emission reduction targets and supporting targets, and recommending additional measures as needed.

Key policies and measures

Reduction of coal use for electricity generation

Two significant decisions have been approved to reduce the use of coal for electricity generation:

1. **Reducing generation in existing coal-fired power plants:** In late 2015, the Minister of Energy directed the Israel Electric Corporation (IEC), Israel's sole operator of coal-fired power plants, to reduce annual generation by coal plants by at least 15% relative to 2015 (amounting to an annual cap of 24,800 GWh), effective immediately. This will remain in place until scrubbers and other emission reduction technologies are installed on all generating units. Further to this decision, the Ministry instructed the IEC to reduce generation to 24,300 GWh in 2016 and 2017.
   Subsequent to this decision, the Ministries of Energy and of Environmental Protection agreed on policy guidelines to reduce generation in existing coal-fired power plants. Preference would be given to the electricity generation by natural gas over coal, and coal units should be operated at the minimum possible load that would still enable flexibility of the generation system and reliability of the electricity supply. This agreement was implemented in the emissions permit given by the Ministry of Environmental Protection to the IEC coal-fired power plants at the end

of 2016, which sets the terms of operation for the coal-fired power plants until 2022.

In late 2017, the Ministry of Energy decided to extend the reduced generation in existing coal-fired power plants beyond 2022, subject to the connection of a minimum of three natural gas fields to the national natural gas transmission network.

2. **Decommissioning 30% of Israel's coal-fired units:** In August 2016, the Minister of Energy declared his intention to decommission four coal units with a total capacity of 1440 MW by 2022 and replace them with NG-fired combined cycle units. These four units account for approximately 30% of Israel's coal power generation capacity. In September 2016, the Ministries of Energy and Environmental Protection signed a Memorandum of Understanding declaring that the units would be decommissioned subject to the following conditions:
   a. Increasing the availability of natural gas by connecting at least three natural gas reserves to the national natural gas transmission network
   b. Establishing alternative generation capacity based on natural gas at the site of the decommissioned coal-fired units or the surrounding area.

Electricity generation from renewable energy

As stated above, electricity generation from renewable energy amounted to 2.7% of the total electricity generation in 2016, compared to the target of at least 10% by 2020, 13% by 2025 and 17% by 2030.

In 2016, the following steps were taken to achieve the goals set:

1. **Tax exemptions:**
   a. The Knesset passed legislation granting small renewable energy installations exemptions from municipal tax, VAT, income tax, and betterment levies.
   b. The Israel Tax Authority approved a full and permanent excise tax exemption for biogas.
2. **Expansion of approved quotas:** The Electricity Authority published, for public hearing, an additional quota for 1,300 MW of PV power plants, bringing the total approved quotas to 1,690 MW for PV and 3,760 MW in general.

Grants and Loan Guarantees for Energy Efficiency and GHG Emissions Reduction

To meet the national reduction target, the government has approved a combination of grants and government loan guarantees, to be used for emissions abatement and energy efficiency finance:

1. **Emission Reduction Support Mechanism**: In 2015, the government reactivated the National Support Mechanism for Energy Efficiency and Emission Reduction projects, which was successfully offered over 2011-2013.

   The program is managed by the Ministries of Environmental Protection, of Economy and Industry, of Energy and of Finance.

   In addition to its energy efficiency and emission reduction goals, the program promotes projects implemented by local authorities with low socio-economic rankings and by small and medium-sized enterprises, as well as projects with co-benefits such as industrial air pollution reduction and enhancement of new Israeli technologies.

   The grants are awarded to energy efficiency, renewable energy and other emission reduction projects through a tendering process based on the amount of funding requested per KWh and tCO_2e reduced. The methodologies for assessing these projects, as well as their impact on GHG emissions, were developed by the Ministry of Environmental Protection based on the relevant methodologies approved by the UNFCCC CDM Executive Board.

   In 2016, the first call for proposals with a budget of NIS 75 million (about $ 20 million) was published in support of GHG emission reduction and energy efficiency projects. A total of 131 requests were submitted by different authorities; NIS 73.85 million (approximately $ 19 million) was allocated to 90 projects in 75 authorities.

2. **Energy Efficiency Grants for Local Authorities:** In 2016, the Ministry of Environmental Protection allocated grants totaling NIS 77.7 million (approximately $ 22.3 million) to 37 energy efficiency and renewable energy projects in 30 local authorities with a low socio-economic ranking. These grants leveraged further investments totaling NIS 147 million (approximately $38.3 million). The projects are expected to generate savings of approximately NIS 47 million (approximately $ 12 million) per year in the electricity expenditures of these local authorities.
3. **Energy Efficiency Grants:** In 2016, the Ministry of Energy allocated grants totaling NIS 5.6 million (approximately $1.5 million) to 16 energy efficiency projects. These grants leveraged further investments totaling NIS 12.1 million (approximately $3.2 million), and are expected to reduce electricity consumption by 5.2 million KWh per year.
4. **Government Loan Guarantees:** The government will allocate NIS 500 million (approximately $130 million) in government loan guarantees over a ten-year period to leverage investment loans in the fields of energy efficiency and GHG emissions reduction. The mechanism is currently under development, and will include prioritization of innovative Israeli technologies.

Emissions reductions in buildings

1. **Project 'Good Neighborhood':** The Ministry of Environment Protection, in cooperation with the Ministry of Housing, is leading an innovative project within the framework of Israel's neighborhood renewal project, which includes energy efficiency measures and rooftop solar panel installation as part of the renovation of old buildings. Within the framework of the project, 65 residential public housing buildings were chosen, which include 1200 households in Beer Sheva, Sderot and other cities in Israel's northern and southern periphery. As part of the project, measures will be taken to insulate walls and seal roofs, significantly improving the thermal comfort of residents and reducing their air conditioning and heating expenses. The installation of PV panels on the rooftop of each building, at an installed capacity of 16 kilowatts per building, will lead to an annual reduction of more than 2.3 million kWh in the electricity consumption of the residents and to NIS 1.2 million (approximately $300,000) savings in their annual electricity expenses.

Prevention of Landfilling

The Ministry of Environmental Protection has set a national target to recycle 35% of the MSW collected by local authorities by 2020. The policies implemented by the Ministry to meet this target include:

1. Increasing the efficacy of waste separation at the source and expanding the requisite infrastructure to additional local authorities, thus increasing the total number of local authorities that have separation-at-source infrastructure.
2. Construction of waste treatment facilities, as follows:
   a. Anaerobic digestion facilities with an annual treatment capacity;
   a. Composting;
   a. Refuse-Derived Fuel production;
   a. Incineration.

In 2016, the share of MSW collected by local authorities that was recycled was 20%.

Sectorial National Plans

In addition to the abatement measures described above, the following national sectorial plans have either been approved or are in the late stages of development. Successful implementation of these plans in their respective sectors will contribute significantly to Israel meeting its reduction targets:

1. **A National Energy Efficiency Plan:** In December 2017, the Government approved a National Plan for Energy Efficiency-Electricity Consumption Reduction. This plan addresses the policies and measures to be implemented to reach Israel's goal of reducing electricity consumption by 17% in 2030. The plan is focused on the measures to be implemented in the short term, and will be updated periodically.

2. **A National Transport Sector Plan:** This comprehensive plan for the transport sector addresses required measures, including both the establishment and expansion of public transport systems, in accordance with the national target to reduce private car mileage by 20% relative to the BAU scenario (as projected in 2015) by 2030.
3. **A Plan for the Implementation of the Kigali Amendment to the Montreal Protocol:** Approved in 2016, the Kigali Amendment to the Montreal Protocol sets a timetable for significantly phasing down the consumption of HFCs.
4. **A Plan to Reduce GHG Emissions from Buildings:** This plan addresses policy measures to be implemented in both new and existing buildings, with an emphasis on energy efficiency measures and green building standards.

Monitoring of GHG emission reductions

To date, emission reductions have been monitored for key measures using a simplified approach. Going forward, Israel will monitor emission reduction on both a national and a policy level in accordance with the national Monitoring, Reporting and Verification (MRV) system.

The MRV system will be managed by the Ministry of Environmental Protection, on behalf of the Steering Committee, and will produce the following annual outcomes:

1. **Reference Scenario Emissions until 2030:** The reference scenario reflects expected GHG emissions in the absence of government reduction measures implemented after 2015 – the year in which Israel committed to its mitigation goals as part of the Paris Agreement.

   It should be noted that this scenario is different from the BAU scenario the INDC was based on, as the BAU scenario includes the emission reduction impacts of policy measures that had already been approved and were expected to be implemented after 2015. As the implementation of these measures and their GHG reduction effects are monitored as part of the MRV system, a new scenario was developed to avoid double counting of the resulting emission reductions.
2. **Policy Measure Impacts:** Within the MRV system framework, both achieved (ex post) and expected (ex ante) emission reductions are monitored for key policy measures.

   The expected reductions are calculated for each of the target years (2020, 2025 and 2030), for three different levels of implementation:
   a. The level of implementation already achieved
   b. Implementation of the policy measure to the extent that it has already approved (but not necessarily fully implemented)
   c. Implementation in accordance with approved sectorial targets.

   In addition, some non-GHG impacts are also monitored, including the economic impacts of the measures.
3. **Abatement Scenario Emissions:** Abatement scenario emissions will be forecasted for each of the target years and each of the abovementioned three levels of implementation.

The MRV system will facilitate the following:

- Measurement of national progress towards achieving mitigation goals.
- Measurement of the effectiveness of specific government GHG reduction policies and actions.
- Revision and expansion of the policy actions to maximize the achieved economic and environmental benefits.
- Fulfillment of reporting obligations to the UN on mitigation actions by Israel and their effects.
- Transparency of information on Israel's progress towards its reduction goals

The monitoring will be conducted on the basis of approved government methodologies, which define the calculation methodology, the parameters to be monitored, and the requisite QA/QC procedures. The methodologies also define the manner in which overlapping effects between different government measures are accounted for in order to avoid double counting.

The current methodologies under approval within the MRV system framework are:

- Monitoring fuel consumption and emission reductions in power generation;
- Monitoring energy efficiency and electricity consumption;
- Monitoring fuel consumption and emission reductions in the transportation sector;
- Monitoring fuel consumption and emission reductions in industry and buildings sectors;
- Monitoring emissions reduction from the prevention of solid waste landfilling and emissions from the waste sector;
- Monitoring national targets for reduction of GHG emissions from fluorinated gases;
- Updating emission forecasts from agriculture, land use, wastewater and industrial process emissions.

The MRV system is in the final stages of development, and the first monitoring report should be submitted to the government by mid-2018. All emission reductions from key policies and measures mentioned in this chapter were estimated based on a simplified approach. A more accurate assessment will be prepared once the MRV system is in place.

Key measures

Detailed information on mitigation actions monitored under Israel's MRV system is provided in the following table:

Table 24: *Mitigation actions*

Name of Mitigation action	Progress of Implementation (Start year-end year)	Steps taken/planned to achieve the action	Investment allocated to mitigation actions (government and private)		Quanti-tative goals	Progress indicator and unit	Indicator value in the last reporting year (2016)	Estimated reductions (ton CO_2e) in the last reporting year (2016)	Estimated reductions (ton CO_2e) in 2030
Reducing electricity generation in coal-fired power plants	2016 - ongoing	1. Grant preference to generation with natural gas while operating coal plants at the minimum possible load whilst still ensuring flexibility of generation and reliability of electricity supply. 2. Closure of four old coal units with a capacity of 1440 MW by 2022 and replacing them with NG combined cycle units.	Government Investment: N/A		1. 15% reduction of coal use compared to 2015 (until 2021) 2. Closure of 1440 MW coal-fired units by 2022	Actual reduction rate of electricity generation in the coal units in reporting year, compared to 2015 (%)	17%	3.9 $MtCO_2e$	6.6 tCO_2e
Renewable electricity	2016 - ongoing	1. Expansion of renewable energy feed-in tariff quotas (based both on fixed tariff and tariff tenders) 2. Expansion of net metering quotas 3. Removal of barriers via tax exemptions	Government investment: data not available Private investment: data not available		10% renewable electricity gene-ration by 2020 (of total con-sumption) 13% until 2025 and 17% until 2030.	% of electricity generation from renewables	2.7%	206,000 tCO_2e Emission reduction is relative to 2015 generation, (reference scenario). Total emissions reduced by all renewable gene-ration is 768,166 tCO_2e.	5.4 $MtCO_2e$
Energy efficiency (overarching measure)	2016-ongoing	1. Government grants and loan guarantees for energy efficiency projects 2. Legal energy survey and energy officer requirements for large energy consumers 3. Continual tightening of efficiency standards for commercial and residential energyconsuming equipment 4. Increasing the uptake of residential, commercial and public new build which adheres to recognized green building standards	Government Investment: NIS 157.6 million (approximately $41 million) Private investment: Data not available		Total electricity consumption of no more than 64.2 TWh in 2020 and 80 TWh in 2030.	Annual electricity savings (MWh/ year)	Data not available, monitoring methodology under development)	Data not available, monitoring methodology under development	7.3 $MtCO_2e$
Government Grants	2016-2019	Provide monetary grants to energy efficiency, renewable energy and GHG emissions reduction projects. The grants are awarded in a tendering process based on the amount of funding requested per KWh and tCO_2e reduced. It should be noted that some of the achieved emission reductions, and in particular the emission reductions from energy efficiency and renewable energy, are included in the reductions achieved by the above overarching measures.	Government investment: NIS 157.6 million (approximately $41 million) Private investment: Approx. NIS 600 million (approximately $156 million)		N/A	NIS / KWh saved NIS/tGHG	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development
Reduction of private transport	2018-2040	Development of national plan for promoting the use of public transport	Government investment: Data not available Private investment: Data not available		Reduce private car mileage by 20% relative to BAU levels in 2030 (Private car mileage will amount to 44.4 million vehicle-km in 2030).	Private car mileage: vehicle-km.	43,953 million km	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development
Decrease landfilling through recycling	2016-2030	1. Implementation of separation-at-the-source infrastructure in additional local authorities, by 2020. 2. Construction of waste treatment facilities	Government Investment: data not available Private investment: data not available		Recycle and treat 35% of MSW collected by local authorities, by 2020	Recycling rate of MSW collected by local authorities	20%	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development
F-gas consumption reduction	2016-ongoing	Development of national plan for implementation of Kigali amendment	Government Investment: data not available Private investment: data not available		Set by Montreal Protocol and Kigali Amendment	Ton F-gas consumed (GWP)	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development	Data not available, monitoring methodology under development

Photo: Government Press Office

4. Vulnerability and adaptation

Key developments since the last National Communication

- An inter-ministerial committee prepared recommendations for a National Climate Change Adaptation Plan for Israel at the end of 2017.
- In 2012, the Israeli Water Authority updated the Long-Term Master Plan for the National Water Sector. The plan integrates supply and demand management tools. There is a clear understanding that Israel cannot rely on natural water recharge. Moreover, Israel is already significantly relying on desalinated sea-water for domestic and industrial uses and on treated wastewater for irrigation. Reliance on water treatment technologies presents an economic burden and risk (as any technology), but it is also necessary for existence and livelihood and is expected to expand in the future.
- In 2016, Israel published its Fifth National Report to the United Nations Convention on Biological Diversity. The report covers 2010-2014.
- In June 2013, the Forum 15 of Major Cities decided that starting in 2014, the Israeli Standard for Green Building will be mandatory for all cities represented by the Covenant of Mayors. As of 2015, the standard is applied to all construction in the cities.

Israel's vast range of ecosystems, from the humid Mediterranean coast to the arid desert, hosts a range of climate vulnerabilities and challenges. As temperatures increase, conditions become drier and storms become stronger, critical resources will become more vulnerable.

Climate change also imposes an economic cost. The cost of expected climate changes, in the absence of any mitigation and/or adaptation actions, is estimated at 5% of the annual GDP, and is expected to grow by 1-5% by the end of the 21st century.[35]

Proper identification of vulnerabilities in Israel's most important sectors, combined with the planning measures to both prevent and adapt to climate change effects, can play an important role in helping meet these challenges.

In May 2009, the government approved Decision No. 250 and appointed an inter-ministerial committee to deal with matters related to environmental protection, climate change readiness and adaptation. In June 2009, the government approved Decision No. 474 instructing the committee to recommend to government a National Adaptation to Climate Change Plan for its approval, focusing on the following of Israel's most vulnerable sectors:

- Changes in energy demand for cooling and heating
- Water resources
- Agriculture
- Infrastructure, green building and urban planning
- Public health
- Coastal infrastructure
- Drainage and erosion
- Economics and insurance
- Geo-strategical aspects
- Biodiversity and natural habitats.[36]

Recommendations for a National Adaptation Plan aim to achieve the following five targets:

1. Minimize casualties, property loss and establishment of economic resilience.
2. Improve the resilience of natural systems.
3. Build and improve the scientific knowledge.
4. Enhance education, awareness, and accessibility of information.
5. Encourage technology development for climate change adaptation and international aid.

The proposed National Adaptation Plan includes:

- Addressing knowledge gaps on the climate change impacts in Israel, based on different possible scenarios until 2030.
- Addressing knowledge gaps on the observed and predicted volume of climate change.
- Review of measures available to minimize the damage of climate change and maximize the benefits of climate change in Israel.
- Schedules and milestones.
- Economic and budgetary aspects resulting from the implementation of preparation and adaptation measures.
- Identification of Israeli knowledge and technology that can be offered as means to cope with the effects of climate change to other countries.
- Determination of output and outcome indicators to track progress towards meeting the objectives of the National Action Plan.

On March 2011, the Ministry of Environmental Protection created the Israeli Climate Change Information Center (ICCIC) at the University of Haifa, to develop a national scientific knowledge base and prepare policy recommendation documents, to be integrated in the national adaptation plan.[37] The ICCIC preserves knowledge related to changes in climate in the region, identifies the risks and implications of climate change and forms recommendations at the national and local levels. The ICCIC work addressed seven areas: water, biodiversity, health,

planning, geo-strategy and economics, as well as technological knowledge with an economic benefit in Israel and abroad. For further detail on the role of the ICCIC, see Chapter 5: Research and Systematic Observations.

35 (Israel Climate Change Information Center, 2012)
36 (Ministry of Environmental Protection, 2012)
37 (Ministry of Environmental Protection, 2012)

Table 25 : *CMIP5 scenarios*[39]

Scenario	Description of the scenario
RCP2.6	GHG emissions peak between 2010- 2020 then decline
RCP4.5	GHG emissions peak between 2030- 2040 then decline
RCP6.0	GHG emissions peak between 2070- 2080 then decline
RCP8.5	GHG emissions will increase continually during the entire 21st century.

Climate forecasts by 2100

During 2013, the first part of the fifth full IPCC report addressing the physical science basis of climate change was published. The report is based on the IPCC's CMIP5 (Coupled Model Intercomparison Project Phase 5) and it estimates the extent of climate change in several different scenarios.[38] The four scenarios of GHG emissions by 2010 can be seen in table 25.

In table 26, for all four RCP (Representative Concentration Pathways) scenarios, the models predict temperature increases on a global scale by 2100. The average annual temperature is expected to range between 0.3°C- 4.8°C.

Table 27 summarizes the changes in temperature in Israel, based on CMIP5 models relevant to the Mediterranean and Sahara regions. The results of the models are divided to three periods (2016-2035, 2046-2065, 2081-2100) and the percentiles of the ensemble of worldwide models. Percentiles 25%, 50%, 75% of all models are presented to exclude models with extreme results.

The models presented above predict, according to the moderate scenario (RCP 4.5) an increase of:

- 1.5°C - 3°C during winter
- 1.5°C - 4°C during summer

The Mediterranean Sea appears to have a mitigating effect on temperature increases

Table 26: *Range of global average temperature change for 2081-2100, relative to 1986-2005, by all CMIP5 models and by different scenarios.*[40]

Scenario	Range of global average temperature change
RCP2.6	Increase of 0.3 - 1.7°C
RCP4.5	Increase of 1.1 - 2.6°C
RCP6.0	Increase of 1.4 - 3.1°C
RCP8.5	Increase of 2.6 – 4.8°C

Table 27: *Estimated changes in temperature, according to moderate scenario (RCP4.5) during winter and summer in Israel (°C), by periods and percentiles of the ensemble of worldwide models*[41]

Temperature change (°C)			RCP4.5	
75%	50%	25%	Year	Season
2	1-1.5	1-1.5	2016-2035	Winter (December-February)
2-3	1.5-2	1-1.5	2046-2065	
2-3	1.5-3	1.5-2	2081-2100	
1.5-2	0.5-1.5	0.5-1	2016-2035	Summer (June-August)
2-3	1.5-3	1-2	2046-2065	
2-4	2-3	1.5-2	2081-2100	

38 (Proposed National Adaptation Plan, 2017)
39 (The Ministry of Environmental Protetction, 2017)
40 (The Ministry of Environmental Protetction, 2017)
41 (The Ministry of Environmental Protetction, 2017)

and temperatures are expected to increase moderately within the coastline regions of Israel in comparison to inland areas.

Due to climate change, the Israel Meteorological Service predicts an increase of extreme weather events such as floods, droughts and heatwaves. These extreme events can cause damage to person and property and may impact the lifestyle and day-to-day activities of citizens in different ways and in different sectors.

Water Resources

Israel is currently the world leader of efficient water usage, reclaiming 85% of its wastewater for agricultural uses; no other country reclaims more than 19%.[42] Its arid climate has spawned innovation and a revolutionary range of techniques to grow food with treated effluents, ensure potable drinking water, and conduct large-scale seawater desalination. However, the expected impacts of climate change still pose a substantial threat to the quantity and quality of the country's water resources. In the last few decades, a reduction in rainfall has been measured in the north and tributaries that feed the Jordan River. This is evident in the water flow of the large springs and the decreased volume of water that flows into the Sea of Galilee, causing changes in the salinity of the water. The amount of rainfall is forecasted to decline by at least 10-20% compared to to current levels, by the end of the century. In addition, drier conditions have also been recorded in southern Israel, yet no significant trend was found in the precipitation regime in central Israel.[43]

Changes in precipitation patterns and the growth of extreme weather events are likely to increase flooding and surface runoff. However, it is possible that the recharge of groundwater will increase. In the last decade, Israel experienced a number of extreme droughts. The Israel Meteorological Service states that the accumulative water shortage in the past four years (2013-2017) is the largest recorded shortage in western Galilee and the Sea of Galilee in the past 100 years.[44]

In addition to changes in the precipitation regime, rising sea levels may affect the Coastal Aquifer. Rising sea levels may increase the duration of floods and enable seawater penetration to streams and rivers.[45]

As can be seen in table 28 below, according to the moderate scenario (RCP4.5, see table 25), by the end of the century precipitation is expected to decline by 10-20% in comparison to current levels of precipitation (when observing models at the center of distribution). The estimation is based on the rainy season (October-March). According to the Israel Hydrological Service and the ICCIC, any change in rainfall patterns, total annual rainfall, seasonal distribution, timing of the rainy season, periods of drought, and the number of rain spells significantly impact water availability in Israel.[46]

The difference between the amount of freshwater available and the amount required is made up by desalination of seawater. Increased treatment of wastewater and higher quality is needed in order to ensure availability for agricultural crops. In 2016, Israel treated 507 MCM of sewage, approximately 85% of which was treated for reuse in irrigation.[48] While these processes are innovative ways to increase water availability, both desalination and wastewater treatment are energy-consuming processes.

Table 28: *Summary of expected changes in winter precipitation in Israel according to scenario RCP4.5, by periods and percentiles of the ensemble of worldwide models.*[47]

RCP4.5	Precipitation		
Year	25%	50%	75%
2016-2035	0 - (-20)	0 - (-10)	0 - 10
2046-2065	-10 - (-20)	-10 - (-20)	0 - (-10)
2081-2100	-10 – (-20)	-10 - (-20)	0 - (-10)

42 (Israel Ministry of Foreign Affairs, 2016)
43 (Proposed National Adaptation Plan, 2017)
44 (Proposed National Adaptation Plan, 2017)
45 (Proposed National Adaptation Plan, 2017)
46 (Israel Climate Change Information Center, 2012)
47 (Proposed National Adaptation Plan, 2017)

Adaptation

Israel is one of the first countries to prepare for climate change impacts on water resources. The Israel Water Authority is activating tools and cooperating with academic experts to analyze trends that may have an impact on water availability. Desalination is currently the primary strategy to combat fluctuations and reduced natural water resources. By 2050, it is estimated that desalination will reach 1500 MCM, 12% of which is estimated as the preparedness of the water sector for a reduced natural water supply due to climate change.[49] However, further desalination will be carefully considered and compared to other strategies that may be cheaper and have less significant environmental impacts.[50]

The Israel Water Authority is managing water supply based on a series of hydrological data updated as of 1993. In addition, the Authority is using high resolution data collected from hydroclimate models. These models estimate a decrease of 17% on average in water basins nationwide. Additionally the Authority estimates an increase in the demand for water (private demand, agricultural sector and supply for neighboring countries).

According to data collected, the following measures are designed to decrease Israel's water usage and prepare for restricted freshwater availability due to climate change:

- Raising public awareness about lowering domestic water usage.[51]
- Reduction of water waste by extensive use of water saving devices and detecting water losses from piping systems.
- Prevention of water pollution, repair of contaminated wells and preservation of quality water resources. Due to industrial pollution, 199 water wells have had to close since 1998.[52]
- Rain harvesting from floods, urban runoff, surface areas and small drainage basins.
- Gray water reuse.
- Increasing the use of effluents for gardening, firefighting, agriculture, and street cleaning. Effluents currently provide more than 30% of the water consumption in agriculture and 17% of the total water consumption by all sectors.[53]
- Promote technologies that save or use recycled water.
- Develop drought indices for Israel so the public can be aware of the severity of water crises.

Biodiversity

Biological diversity encompasses the extent of the diversity and variety of living creatures inhabiting a natural space. Biodiversity measures the number and diversity of all biotic factors, including animal and plant species, microorganisms, the genetic variance within and between populations, and the diversity between different ecological systems. Small changes in this sensitive web of interspecies relationships can affect the entire ecosystem.

Despite Israel's relatively small size of 22,000 km^2, it is home to 2,388 plant species, approximately 100 mammal species, and some 450 bird species.[54] This diversity stems from the unique geographic position of Israel. Wedged between the Mediterranean climate of Europe, and the arid regions of Africa, Israel holds a unique range of biotic conditions. It serves not only as a land bridge between the surrounding habitats, but hosts ecosystems in its mountains, flat plain areas, coastal zones, transverse areas, and many other

48 (Israel Meteorological service, 2015)
49 (Proposed National Adaptation Plan, 2017)
50 (Israel Meterological Service, 2015)
51 (Israel Water Authority, 2015)
52 (Israel Meteorological service, 2015)
53 (Ministry of Environmental Protection, 2010)
54 (Ministry of Environmental Protection, 2010)

landscapes.

Currently, 146 species of mammals, amphibians, fish and birds are defined as in danger of extinction and about 410 plant species are defined as endangered.[55]

About 27% of the area of Israel is designated protected areas. Remote sensing analysis identified that from 2000-2013, 27% of the territory in Israel saw an increase in vegetation density, and just 7% saw a decrease.[56] However, even these areas still face threats, as northern reserves are often too small to maintain a functioning ecosystem, and southern reserves face intensive human activity. According to Israel's Fifth Report on Biodiversity, published by the Ministry of Environmental Protection in 2016 and covering the period of 2010-2014, habitat loss and fragmentation rates continued at the same rate as reported in the Fourth Report, which was published in 2009.[57]

A rise of 1.5°C may move the desert line northward and Mediterranean systems, which are situated currently on the edge of the desert, will be transformed into desert. Such increased desertification is expected to lead to a spatial shift northward of 300-500 km in the distribution of Mediterranean organisms and a shift of desert ecosystems up from the Negev desert.[58] As a result, species that are less resilient to a dry climate will be pushed to the margins. Consecutive arid years, or an extended decrease in precipitation, could adversely affect the functioning of these systems, particularly in the semi-arid region.

Climate change impacts also include the warming of seas and oceans and changes in their chemical compositions. The Mediterranean Sea, with the current invasion of tropical species from the Red Sea through the Suez Canal, is at risk of losing its unique nature and becoming more of a tropical water body. Oceans and seas are significant carbon sinks for atmospheric carbon. Seawater acidification from increased CO_2 concentrations will exacerbate the deterioration of the sea cliffs and unique abrasion platforms.

The processes described above, may have the following potential impacts on Israel's biodiversity and ecosystem services available:

- An increase in drought frequency threatens wooded vegetation. Wooded vegetation plays an important role in ecosystem functioning, including prevention of soil erosion, nutrient cycling, and habitat for an abundance of biota and microorganisms.[59]
- Increased fire risks for the Mediterranean forests that may surpass the generation capacity of the forest.
- Freshwater aquatic species sensitive to salinity, temperature, and oxygen concentration will be deeply affected.[60]
- The fisheries stock and available species in the Mediterranean will change and include more invasive species and individuals from the Red Sea ecosystem.
- In the Gulf of Eilat, coral bleaching may occur, a process connected to the breakdown of mutualistic relationships of algae and corals due to temperature increase, leading to the death of coral reefs.[61]

The importance of maintaining Israel's biodiversity cannot be underestimated. The country's ecosystems provide critical services such as drinking water, genetic resources, prevention of soil erosion, regulation of invasive species, pest and pathogen control, recreation opportunities, and cultural services.[62]

Adaptation Measures

It is important to acknowledge that with the uncertainty of the extent to which climate change will impact biodiversity, appropriate strategies should be adopted. Reducing the stress of impacts not connected to climate change is a primary concern. Israel has developed the following set of planning measures to protect its biodiversity:

- Non-fragmented ecosystems are more stable. The map of protected areas in Israel must be updated and ecological corridors conserved between open areas.
- Construction should be limited in accordance with the National Master Plan and illegal construction must be prohibited and not legitimized ex post facto.
- Public awareness and laws must be reinforced to prevent or limit negative effects on open areas. Existing legislation should be enforced.
- The importance of biodiversity conservation and its benefits will be incorporated in the policies of relevant ministries and authorities.
- Planting drought resistant tree species and avoiding over-exploitation of forests.
- Mapping and identifying pests and pathogens that may be more harmful in light of future climate conditions.
- A professional committee will be created to manage invasive species by establishing criteria for the introduction of new species, and setting priorities and recommendations to deal with the current invasive populations. Law enforcement agencies will be responsible for the application of these measures.[63]

In October 2010, Israel joined other Parties to the Convention on Biological Diversity in adopting an updated Strategic Plan for Biodiversity.

This strategic plan, developed by the Ministry of Environmental Protection and based on the Aichi Biodiversity Targets for 2011-2020, included 20 biodiversity targets such as: public awareness, formulation of guidelines, incorporation of biodiversity into sectorial policies, increasing the knowledge base on biodiversity and ecosystem services. These targets have led to the creation of the Green School program, mapping of essential ecological corridors, a new forest management department, plans for sustainable fisheries, regulations on river and marine pollution, and more.

As outlined in a 2015 Ministry of Environmental Protection report, there is a need to strengthen the existing knowledge on three main issues:

- Long-term monitoring to allow the country to examine long-term effects and to connect biological processes to abiotic changes in the environment.[64]
- Experimental studies assessing threshold values of the different climate variables (temperature, precipitation, evaporation) which could undermine the stability of various habitats.
- Applied research to better understand Interface Methods to improve resistance of habitats to a more arid climate, and to develop tools for the restoration of degraded ecosystems. Such a study will give tools to increase the system's natural ability to adapt to climate change.

The scope and depth of ecological data in Israel must be reinforced to strengthen the connection between science and management. This relationship is critical for the successful protection of natural ecosystems.

Human Health

Climate change could lead to long-term negative effects on public health. These effects manifest themselves in two ways, either physiologically (directly) effects, or through a climatic impact on chronic and contagious disease (indirectly). According to the World Health Organization, there are three possible categories of health impacts: 1) due to extreme weather, 2) due to environmental changes, and 3) due to trauma and infections of displaced populations from migration.[65] The following areas summarize the vulnerabilities to human health due to the impacts of climate change:

- An increased prevalence of diseases associated with extreme heat and cold
- Spread of diseases transmitted by vectors and water

55 (Ministry of Environmental Protection, 2010)
56 (Ministry of Foreign Afairs , 2016)
57 (Ministry of Foreign Afairs , 2016)
58 (Ministry of Environmental Protection, 2010)
59 (Nature Protection Society, 2014)
60 (Israel Climate Change Information Center, 2012)
61 (Israel Climate Change Information Center, 2012)
62 (Ministry of Foreign Afairs , 2016)
63 (Ministry of Environmental Protection, 2011)
64 (Ministry of Environmental Protection, 2015)
65 (Ministry of Environmental Protection, 2011)

- Exacerbation of cardiovascular and respiratory diseases due to air pollution
- More victims of heat stroke and dehydration
- Increased mental stress.

As Israel becomes more urbanized, the impacts of climate change on health are exacerbated by increased local air pollution. There are concerns that climate change will lead to penetration of disease vectors with potential for disease transmission, and therefore it is highly important to monitor the relevant disease vectors and associated diseases. [66]

Israel's average temperature has been on the rise since the 1970s, with high stable temperatures since 2000. Predictions put temperatures in the region rising at a rate of about 1.5-4°C by the end of the century. This long-term hike in temperature, combined with short-term heat waves, will increase the heat stress experienced by both Israel's residents and livestock.[67]

A research study published by the Ministry of Health in 2014 reported that mortality from heart, vascular and respiratory diseases in Tel Aviv has increased by 3.7% for every 1 unit increase in the Thermal Discomfort Indicator (a scale that factors in temperature and relative humidity) above the threshold that is considered comfortable. It also reported that even one day in which a heat wave is above this threshold is enough to cause an increase in the mortality rate. The same report indicated a rise of 1.47% in the number of emergency hospital visits for every rise of 1°C during a heat wave.[68]

Special attention in these areas should be paid to vulnerable populations such as children, pregnant women, the elderly, people with chronic diseases and the poorer section of the population.

Adaptation

Regardless of the severity of climate change effects, resource allocation for preparatory strategy will have a positive effect on public health. The World Health Organization calls for reinforcing the public health system and devising response plans for emergency, as well as strengthening the research undertaken globally.[70]

According to the ICCIC, adaptation in the case of public health should be carried out at the local level as well; responses should be tailored to acute events and the prevention of future ones. Strategies should be focused on both the impact of extreme weather events and gradual changes in rainfall and temperature.

The following measures are planned to help prepare and mitigate harmful health impacts due to climate change:

- Reduce use of conventional sources of energy to improve air quality, create more green neighborhoods, and support healthy lifestyles. Such processes will lower the risk factors for chronic diseases, leading to fewer cases of osteoporosis, cardiovascular diseases, respiratory disorders and depression.
- Real-time monitoring and alert system based on data collection of extreme weather incidents and casualties from these incidents (heat waves, floods and natural disasters).
- Appropriately equipping medical institutions with air conditioning for longer term heat increases and training to respond to extreme events.
- Treatment for population sectors at risk.
- Provide guidelines to the public for action during heat waves or cold snaps.
- Assessment of clean water criteria and risks of water-borne diseases. [71]

Further research is still needed in order to form the basis for informed policy making regarding management and treatment of possible health consequences of climate change.[72]

Infrastructure

Major components of the infrastructure in Israel are situated on the populated Mediterranean coastline, which is particularly vulnerable to climate change.

66 (Israel Climate Change Information Center, 2012)
67 (Israel Climate Change Information Center, 2012)
68 (Ministry of Health, 2014)
69 (Israel Climate Change Information Center,2013)
70 (Israel Climate Change Information Center, 2012)
71 (Israel Climate Change Information Center, 2012)
72 (Ministry of Environmental Protection, 2014)

Although the precipitation average is not expected to differ in upcoming years, extreme rain events are expected to increase, along with severe floods. Roads, railroad tracks, ports and bridges, industrial centers and power stations are located in possible flooding areas and extreme weather events. Damage to these facilities due to climate change impacts may result in substantial economic and lifestyle consequences.

The impact of climate change is particularly pertinent to the construction sector given the long life expectancy of buildings, both in new construction and in the existing built environment to withstand a potentially very varied and uncertain climatic impact. The vulnerability of buildings and construction is mainly influenced by the design (low resistance to storms) and location (e.g. in flood-prone areas and landslides). Infrastructure investments on vulnerable building, harbors and touristic facilities will be necessary.

The rapidly growing population brings with it continuous urban development. Construction of commercial and residential buildings in a sustainable manner is a primary focus; in Israel, the building sector is responsible for 60% of electricity consumption and 40% of water use.[73] Israel must look closely at the following factors and the degree to which they impact the country's buildings, transportation, and energy systems:

- Sun exposure (and the ensuing heat stress on the thermal comfort of the building)
- Wind exposure
- Thermal comfort of open spaces
- Position and vulnerability to sea level rise
- Resilience to withstand extreme weather events such as storms and flooding.[74]

Increasing temperatures combined with a growing population are placing heavy burdens on Israel's electricity supply. Electricity demand is expected to grow significantly in the BAU scenario on a long-term average, with large increases in peak demand during times of extreme heat stress. As the daily temperature exceeds the threshold for heat stress, the high demand for electricity consumption will increase. [75]

In addition, Israeli infrastructure remains vulnerable to extreme weather events. In 2013, the State Comptroller released a report on the state of preparedness of the local authorities for extreme weather events, storms and fires.[76] The report highlighted the local authorities that are more vulnerable to extreme weather changes and impacts and the need for a master plan in some of the local authorities for maintenance of roads, the drainage system, and other infrastructure. The most important emphasis in the report was the need to establish an authority to manage non-military emergencies, such as earthquakes, fires, flooding and snow storms. Furthermore, the report emphasized the need for directives for transportation systems during harsh weather conditions.[77]

In March 2016, a team appointed by the Ministry of Energy conducted an examination and reported on the level of preparedness of the IEC and its infrastructure to deal with extreme weather events. The examination focused on the events of a serious October 2015 storm, and recommended improvements in the maintenance of the transmission and distribution system. Furthermore, the report endorsed the recommendation of the State Comptroller that the Ministry of Energy, the Electricity Authority and the Ministry of Finance review the economic viability of replacing overhead electricity distribution lines in urban areas, which are vulnerable to extreme weather situations and emergencies, with underground grid lines.[78]

Adaptation

A well-designed building has the potential to help mitigate climate change from a carbon emissions standpoint. Green buildings are also mechanisms to help Israel adapt to climate change by keeping

73 (Ministry of Environmental Protection, 2012)
74 (Israel Climate Change Information Center, 2012)
75 (Ministry of Environmental Protection, 2010)
76 (The State Comptroller and Ombudsman of Israel, 2015)
77 (The State Comptroller and Ombudsman of Israel, 2015)
78 (Ministry of Energy, 2016)

interiors cooler, relieving some of the urban heat island effect, and utilizing less water. As average temperature rises and water availability is threatened, green infrastructure will keep buildings comfortable while alleviating some of the energy burden.

The ICCIC has recommended measures to promote green building practices, such as establishing a government agency to oversee sustainable green building in Israel, providing economic incentives for green buildings, applying mandatory regulations for energy ratings of new and rehabilitated green buildings, raising public awareness of climate change and sustainable buildings, and incorporating courses on energy-saving buildings, sustainable design and climate change adaptation in institutions of higher learning.[79]

Urban areas have the potential to exacerbate the effects of temperature change due to the urban heat island effect. Asphalt and air pollution trap and magnify heat close to the ground, making green building practices in Israel's arid and semi-arid cities particularly important. The following are identified as actions to manage the impacts of the urban heat island:

- Increase open space and vegetation, including green roofs.
- Use reflective building materials that absorb less heat.
- Plant more trees for shade and improved air quality.
- Utilize the underground space for transportation.[80]

Well-designed cities have the ability to help countries cope with climate change issues such as air pollution, extreme heat, and threats to transportation.

Agriculture

As the main consumer of water (55% of total water consumption in 2016) fluctuations in rain and water availability can deeply affect agricultural productivity. Overall, the last decade has seen huge advancements in water efficiency, up 28% between 2007 and 2012. At the same time, total agricultural output has risen 19% since 2008. Despite the largely arid landscape, Israel's agricultural products total nearly NIS 30 billion (approximately $7.8 million).[81]

Climate change necessitates a clearer understanding how long-term drier conditions and short-term extreme droughts affect crops. Plant physiology is affected by severe heat stress and the frequency of dry spells between rainstorms. The health and food sources of livestock are also vulnerable to extreme heat.

Agricultural cultivation may be affected in the following ways:

- Reduced productivity from heat stress; plants must close their stomata to avoid losing too much water, and therefore cannot undergo gas exchange for photosynthesis.
- Dust storms causing erosion and soil loss due to prolonged dry soils.
- Decreased water availability for crop irrigation.
- Heat stress in farm animals.
- Seasonal shifts in ideal crop cultivation.
- The quantity and quality of soil may be degraded due to soil erosion and human activity.
- Migration of invasive species and pathogens may decrease agricultural yield.[82]

The entire Negev desert is at a high risk of dust storms, which will become more common due to climate change induced drought. Farmers have learned to plant a variety of crops, including tomatoes, olives, dates, peppers, and cucumbers, in the dry desert soil.[83] These fruits and vegetables support the local kibbutzim and are shipped to other parts of Israel. While some of these farms are largely covered by greenhouses, the threat of increased soil erosion cannot be ignored.[84]

79 (Ministry of Environmental Protection, 2014)
80 (Ministry of Environmental Protection, 2014)
81 (Ministry of Environmental Protection, 2015)
82 (Ministry of Environmental Protection, 2010)
83 (Negev Foundation, n.d.)
84 (Water Authority, 2012)

Adaptation

The following measures are designed to protect and adapt Israel's agricultural sector to the aforementioned climate change impacts:

- The establishment of The Israel Plant Gene Bank for agricultural research.
- Assessing the risks for different agricultural sub-sectors.
- Addressing forestry and forest fires, pests and pest invasion to agricultural crops.
- Intensification of water conservation by using crops which require less water, and have a higher productivity per m3 of water added (such as wheat, chickpeas, sunflowers, lettuce, and garlic).[85]
- Improve irrigation efficiency with improved water technologies and integrating vegetables between rows of orchards.
- Improvement in greenhouse technology to keep plants moist and protected from soil erosion. Encourage farmers to use "no-till" method to prevent soil erosion.
- Improve the shading and material used for livestock farms to relieve the farm animals of heat stress.
- Define and scale the breakdown of agricultural lands into irrigated and non-irrigated.
- Increase facility capacity for wastewater treatment that can be used for agriculture to 600 MCM annually in 2020 (compared to 503 MCM in 2015). In 2016, Israel recycled about 85% of its sewage to the highest level; the goal is to reach 95% by 2020.

Energy

The effect of climate change on energy consumption and production is vast. Heat waves are expected to affect peak energy demand level and duration, especially due to the heat island effect in crowded cities. Electricity consumption directly related to air conditioning is responsible for 45% out of the total consumption in Israel. Changes in the patterns of consumer demand is a result of reduced efficiency in air conditioners during extreme temperatures and increased electricity demand during nighttime. In addition, increased use of desalinated water will contribute further to growing energy consumption.[86]

The efficiency of energy production from fossil fuels is subjected to air temperature and air quality that may be degraded due to climate change and therefore will affect the determination of the fuel mix. Moreover, scarcity or degradation of the water supply may affect power station cooling, a process necessary for electricity production, leading to lower efficiency of power plants.[87]

Adaptation

To ensure that the energy sector is equipped to cope with climate change, an energy national adaptation plan is needed. The following measures are to be part of the national plan:

- Encouragement of high efficiency air conditioning technologies such as geothermal heat pumps, VRF air conditioners and solar air conditioners.
- Mandatory legislation of energy conserving buildings, green buildings and solar air conditioning on large buildings.
- Promoting domestic electricity production, as a reaction to the changes in energy demand.
- Research and development in energy related fields such as: desalination efficiency, the effect of water quality on power stations, augmentation of water supply (not from desalination), efficient energy production technologies, paleoclimatology, and energy management in buildings.

Simulations can be used to predict the energy demand patterns of consumers. Estimating these patterns will enable more efficient electricity management.

Israel in context

- The impacts of climate change prove to be widely interdisciplinary; many areas will

85 (Ministry of Environmental Protection, 2010)
86 (Proposed National Adaptation Plan, 2017)
87 (Proposed National Adaptation Plan, 2017)

be influenced by the combined effects of climate change. These include tourism, transportation, energy, economy, food security, fires, migration and geopolitics, including possible conflicts resulting from climate change. According to the ICCIC, Israel must account for impacts of climatic change on its domestic and foreign policy and national security, including challenges such: 1) the allocation of sufficient domestic resources for preparedness and adaptation, 2) possible dependence on foreign aid in times of crisis, 3) adjustments within the Israel Defense Forces (IDF) and the defense system as a whole, 4) the effects of climate change on Israel's neighbours.[88]

- There is currently insufficient knowledge on issues such as shifts in the geostrategic balance of power in the Middle East, water resources, migration patterns to or through Israel, accelerated energy consumption, food availability and preparedness of the defense system for the anticipated climate changes.
- Through an acknowledgement of these vulnerabilities, Israel has the power to transform these threats and risks into a lever for the advancement of projects that need to be carried out in any case and in particular enhancement of water production and securing the food and energy supply, etc. Special considerations include adaptation of the IDF to the changing conditions, including the location of facilities and bases (for example, relocation away from forests with high fire hazards), changes in military training, and construction of facilities that are better adjusted to the changing conditions.[89]

88 (Israel Climate Change Information Center, 2012)
89 (Israel Climate Change Information Center, 2012)

Photo: Pini Hamou

5. Research and systematic observation

Key developments since the last National Communication

- Creation of the Israeli Climate Change Information Center in 2011
- In 2011, the Israel Innovation Authority, in conjunction with Capital Nature investment group, established the Renewable Energy Technology Center.
- In 2012, Israel became a partner in The Climate and Clean Air Coalition (CCAC).
- In 2013, Israel joined the Global Biodiversity Information Facility, granting access to a global database of biodiversity knowledge.
- In December 2014, the US President signed into law the United States-Israel Strategic Partnership Act. This act, together with the Israel Government Decision of January 2016, extends the cooperation through "BIRD Energy" to 2024. "BIRD Energy" is a program for United States-Israel joint technological development.
- New research centers created for arid agricultural research and expected climate impacts.

Known as one of the world's start-up capitals, Israel has a strong focus on research and development as well as innovation.

Within Israel, many government programs are incentivizing research projects in the cleantech field, the goal being for Israel to become an international center of expertise in energy alternatives.

From 2010-2016, government-funded research supported by the Office of the Chief Scientist in the various ministries focused on the following fields:

- Climate change impact, mitigation and adaptation technologies
- Climate change and health related issues
- Clean renewable energy
- Alternative fuels for transportation
- Energy conservation and efficient use of resources.

Private institutions and academia, focusing on different issues of climate change impacts, adaptation and mitigation technologies and policy, conduct other domestic research activities. Israeli organizations participate in several international cooperative frameworks for research, such as CORDEX, Horizon 2020 and Circle 2 (until 2014).

Several institutions provide climate change observations. The most important is the Israel Meteorological Service, which provides meteorological and climate data and forecasts.

Systematic Climate Change Observation

To identify areas that require further research regarding climate change mitigation and adaptation, Israel has established a number of weather and air pollution monitoring institutions. These observation centers provide critical data for scientists and policy makers to determine the scope of possible climate impacts, critical areas of interest, and produce timelines for advancements.

The Israel Meteorological Service (IMS)

The Israel Meteorological Service is a unit of the Israeli Ministry of Transportation and is responsible for forecasting weather, supplying meteorological data and conducting climate research. The organization's primary functions and activities are as follows:

- Issuing public weather, climate change, and extreme weather events forecasts and warnings through all available media for different sectors of the economy, e.g., transportation, agriculture, water management, energy economy, environment, etc.
- Supervising meteorological services for civil aviation and supplying basic flight weather information.
- Establishing, operating and maintaining a nationwide network of meteorological stations - synoptic, climatic, agro-meteorological, and solar radiation stations - including a national database of basic meteorological and climatic data.
- Pursuing relevant applied meteorological research to advance and develop a better scientific understanding of weather and climate in Israel.
- Responsibility for Israel's international activities in the field of meteorology as part of its membership in the World Meteorological Organization, including providing raw meteorological data and analyses for different consumers in Israel and abroad. [90]

Israel Institute for Biological Research

IIBR's multi-faceted air pollution research includes numerous aspects of meteorological modeling and measurement, pollutant sampling, and risk assessment. The Institute employs and develops calculation tools for the prediction of pollution concentrations on various scales, from the indoor environment, through urban areas, to large, complex terrains. Activities include:

- Flow and concentration modeling at diverse scale
- Air pollution modeling
- Meteorological measurements
- Environmental surveys
- Granulometric, aerodynamic and image analyses[91]

IIBR researchers also perform assessments of environmental risk in various scenarios, such as those resulting from possible malfunctions in industrial processes involving hazardous materials. The Institute uses a wide array of high-tech modeling to assess potential environmental consequences for an area, for either point source problems or climate change.

National Institute of Oceanography (Israel Oceanographic & Limnological research)

The National Institute of Oceanography (NIO), located in Haifa on the Mediterranean coast, conducts a multi-faceted research program in oceanography and marine biotechnology and provides information and advice to government agencies and public and private sectors how to best use and conserve Israel marine and coastal resources.

Oceanographic research at the NIO focuses on Israel's three highly diverse seas: the eastern Mediterranean, the Gulf of Aqaba /Eilat (northeastern branch of the Red Sea) and the land-locked Dead Sea. Research activities involve field studies, theoretical and modeling work and laboratory experiments. The broad range of questions considered includes such diverse topics as ocean circulation and mixing; air-sea interaction; coastal erosion; biogeochemical cycles; physiology, developmental biology and ecology of marine organisms and their population dynamics and the impact of human activities on coastal and marine ecosystems and resources. The Israel Marine Data Center at the NIO serves as the national repository for oceanographic data, acquires archives and distributes data and information on Israel's marine environment.

The NIO provides a wide range of professional services including hydrographic, oceanographic and water quality surveys, analyses and modeling, climate change-related indices such as measurements of sea level, water temperature and water acidity; environmental monitoring and assessment; professional consulting; and technology transfer and licensing.[92]

The Geological Survey of Israel

The Geological Survey of Israel (GSI) is a public sector organization responsible for advising the Israeli government on all aspects of geoscience, including conducting research on paleoclimate and global climate change. Activities include consolidationing national policy regarding the development of infrastructure and its interaction with the natural environment; creating and maintaining databases for geoscience information; estimation of natural and human-caused geohazards; long-term planning of sustainable development of natural resources[93].

International research cooperation

Israel continues to access global tools to enhance its research capacity. Greater access to data and funds have allowed Israel to be involved in many research projects and expand the countries working knowledge on climate change impacts.

CORDEX

The IMS joined the Coordinated Regional Climate Downscaling Experiment (CORDEX), which coordinates multiple results from models all around the world, In the framework of the project, the IMS operates a numeric module modified for climate forecasts in local conditions. During the first stage, the ability of the module to reconstruct the past climate is being tested, and during the second stage, the module is tested twice using different GHG emissions scenario defined by the IPCC. The results, after analysis, will provide climate change forecasts on Israel and the Middle East, and advance knowledge sharing and cooperation with other research centers in the area and around the world. The

90 (Israel Meteorological Service, n.d.)

91 (Institute for Biological Research, n.d.)

92 (Israel Oceanographic and Limnological Research (IOLR), 2016)

93 (Geological Survey of Israel, 2016)

climate change module addresses not only the question of how much the temperature will rise or how precipitation levels will decrease, but the frequency and intensity of extreme events, the degree of dispersion of precipitation over time and space in the future and the behavior of atmosphere in general. [94]

Global Biodiversity Information Facility

Since 2013, Israel has been an associate member of the Global Biodiversity Information Facility, a global database of information on the composition, vibrancy, and biodiversity of different regions. GBIF offers free access and unlimited downloads for all records published via their network for use in research.[95] It is the largest biodiversity database on the Internet, and is a critical tool for Israeli scientists to both publicize their findings, and conduct their own research. This international cooperation has enhanced understanding of the spread of pests and diseases, biodiversity loss, and priority areas for conservation.

Horizon 2020

Horizon 2020 is the primary program of the EU to promote international cooperation in research and development with a focus on increasing innovation in a wide variety of fields, including environment. The program will operate for seven years, from 2014-2020, with a budget of €77 billion in grants. By the end of 2016, Israeli organizations had participated in two projects receiving NIS 1.6 million (approximately €416,000).[96]

CIRCLE-2

The Ministry of Environmental Protection was a member of the Climate Impact Research and Response Coordination for a Larger Europe, or CIRCLE-2. This is an international network of institutions from mostly European nations focused on the interface between climate change, science, and policy. Members of CIRCLE-2 were committed to maximizing the degree to which research outcomes address both national and international climate policy needs, especially policy focused on adaptation to climate change. Era-Net is a CIRCLE-2 scheme aimed at developing and strengthening the coordination of research programs across the European Research Area (ERA). Israeli researchers were involved in two of the projects between 2008 and 2011:

- The INTERMED project, organized by the universities of Palermo (Italy), Haifa (Israel) and Dubrovnik (Croatia), sought to evaluate the impact of climate change on the intertidal communities of the Mediterranean basin, and to analyze the socio-economic consequences.
- The CANTICO project adopted a firmly interdisciplinary approach, and was aimed at integrating the spatial issue (both maritime and coastal zones) and pressures linked to climate change and anthropogenic activities on the scale of the entire Gulf of Gabès. [97]
- Climate Adaptation Research Agenda (CARA), a common strategic research agenda on adaptation, through relevant topics and questions. Through CARA, Israel led an initiative researching forest fires and climate change. This included organizing an international conference by the MoEP and the Jewish National Fund in January 2012 titled: Climate Change and Forest Fires in the Mediterranean Basin: Management and Risk Reduction[98].

Climate and Clean Air Coalition

The Climate and Clean Air Coalition (CCAC) is a partnership of governments addressing the challenge of short-lived climate pollutants, such as black carbon, methane, and HFCs. Reducing these pollutants can have immediate benefits, including protecting human health and the environment in the short term, and together with long-term policies can slow down the rate of climate change. Israel became a partner in the coalition in 2012.[99]

94 (The Israeli Meteorological Service, 2015)
95 (Global Biodiversity Information Facility, n.d.)
96 (The Chief Scientist Office, 2014)
97 (The Ministry of Environmental Protection, 2015)
98 (The Ministry of Environmental Protection, 2015)

BSF and BSF Energy

The United States-Israel Binational Science Foundation (BSF) coordinates a joint program by the United States Department of Energy (DOE) and Israel's Ministry of Energy, known as BSF Energy, in which $1.2 million a year is invested in academic energy projects. The BSF promotes scientific cooperation between the two nations, by way of supporting joint research projects in various fields of basic and applied science. Examples of funded projects are:

- Pennsylvania State University and the Technion-Israel Institute of Technology: Ionomer and Catalyst Stability in Alkaline Membrane Fuel Cells.
- Pennsylvania State University and Technion-Israel Institute of Technology: Novel Thermoelectric for Harvesting Waste Heat Energy Technology.
- Northwestern University and Tel Aviv University: Relaxation, Polarization, Energetics, Design and Efficiency in Ordered Organic Photovoltaic Systems.
- University of California, Irvine and Tel Aviv University: Modular Topologies of Photovoltaic Systems.
- University of Illinois, Urbana-Champaign, Stanford University and Technion-Israel Institute of Technology: Stability by Design for Distributed Power Markets: Leveraging Control and Game Theory to Create Better Power Grids with Improved Performance, Better Stability and Efficiency.

BIRD Foundation

The United States Department of Energy (DOE), the Israel Ministry of Energy and the BIRD Foundation have established "BIRD Energy", a program for United States - Israel joint technological development, in which $3.4 million a year is invested in energy projects. This partnership between Israel and the United States began due to the United States-Israel Cooperation in Energy Independence and Security Act of 2007 and the Israeli Government approval of the program in 2008. BIRD's activities include connecting Israeli and American companies. It supports approximately 20 projects annually. The cumulative sales of products developed through BIRD projects have exceeded $8 billion. The first round of funding was provided by the two governments in FY 2009. Since then, collaborative projects have been initiated. Some of the joint projects and innovations funded by BIRD Energy are already realizing their commercial potential. In December 2014, the United States President signed into law the United States-Israel Strategic Partnership Act. This act, together with the Israel Government Decision of January 2016, extends the cooperation through BIRD ENERGY to 2024.[100] Examples of funded projects are:

- EnStorage (Yavne, Israel) and Princeton Power Systems, Inc. (Lawrenceville, NJ): Next Generation Energy Storage System for Uninterrupted Supply.
- GenCell (Petach Tikva, Israel) and Innovative Machine Corp. (Birmingham, AL): Development and Industrialization of a New Cathode for a Next Generation Electrochemical Fuel Cell Generator.
- Rafael Advanced Defense Systems (Haifa, Israel) and Aquion Energy, (Pittsburgh, PA): Advanced Energy System for Remote Off-Grid Systems.
- Winflex (Kibbutz Moran, Israel) and GE (Niskayuna, NY): Development of a Wind Turbine Generator with an Inflatable Rotor.
- B.G. Negev Technologies and Applications Ltd. (BeerSheva, Israel) and Southwest Solar Technologies Inc., (Phoenix, AZ): Utility Scale Solar Dish CPV Power Technology.
- Bromine Compounds Ltd., a company within Israel Chemicals Group and part of ICL Industries Products (BeerSheva, Israel) and Sustainable Innovations, LLC, (East Hartford, CT): Hydrogen Bromine Regenerative Fuel Cells for Smart Grid Energy Storage and Renewables
- Pythagoras Solar Ltd. (Petach Tikva, Israel) and BISEM Inc., (Sacramento, CA): Unitized UL Certified BIPV Glazing System.

99 (Ministry of Environmental Protection, 2013)
100 (Ministry of Energy, 2015)

Water Joint Programming Initiatives (WATER JPI)

Launched in 2010, the Water Joint Programming Initiative for a changing world, known as the WATER JPI, tackles the ambitious challenge of achieving sustainable water systems for a sustainable economy in Europe and abroad. The WATER JPI includes 20 partner countries: Austria, Cyprus, Denmark, Estonia, Finland, France, Germany, Ireland, Israel, Italy, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Turkey, United Kingdom, Moldova, Sweden and four observer countries: Belgium, Greece, Hungary, and Latvia.

Climate Change Indicators

Israel is in the midst of developing a set of indicators that will help formulate and implement a national plan for adaptation to climate change. In 2015, the Ministry of Environmental Protection organized two workshops with this goal in mind. They were organized within the framework of a joint project (IN-SEIS) on climate change indicators between the Ministry of Environmental Protection, Israel's Central Bureau of Statistics, the European Environment Agency (EEA), and the Austrian Environment Agency. The workshops were funded by the EEA. Participants included experts from government ministries and agencies, academia, and environmental organizations.[101] For example, climatic indicators can include reference to temperature (min, average, and max), rate and duration of heat waves; key precipitation indicators include extreme rain events, duration of the rainy season, and distribution of precipitation throughout the season.

Government-Supported Research

The Ministry of Environmental Protection, Office of the Chief Scientist

During recent years, The Office of the Chief Scientist of the Ministry of Environmental Protection has given increased support to research and development. Key climate-specific research includes:

- Long-term analysis of climate change affects the insurance market and the Israeli economy.
- Climate change shifts analysis and the connection to food-acquired disease in Israel in the years of 1995-2010, and the implication on future scenarios until 2030.
- The combined effect of climate change on urban and non-heat climatic stresses in Israeli municipal settlements.[102]

Other key areas of research funded by the Ministry of Environmental Protection's Office of the Chief Scientist were:

- **Energy from biomass**: The Ministry is funding academic research with commercial potential in the field of energy production from biomass.
- **Petroleum alternatives for transportation:** The Ministry is funding research into alternatives to petroleum-based fuels with commercial potential, with a focus on environmental implications of production facilities, processing, storage, transmission, distribution and use of alternative fuels for transportation, including the efficient use of natural resources, and related environmental regulation and standardization in this field.
- **Water technology and environment:** In a joint initiative along with the Ministry of Science, Technology, and Space, the Ministry of Energy, the Water Authority and the Ministry of Economy and Industry, the Ministries are funding research regarding advanced water technologies. The main foci of the research is: examining the effects of technologies of desalination on the marine environment; development of technologies to notify of contamination of the sea from land-based and marine infrastructures linked to the coast; development of optimal and economically feasible wastewater treatment methods;
- **Green buildings:** The Ministry is funding research regarding various aspects of green buildings, such as the cost of adding green building to existing structures being remodeled within the framework of the National Outline Plan for Reinforcing Structures to Sustain Earthquakes.

101 (Ministry of Environment Protection, 2015)
102 (Chief Scientist, Ministry of Environmental Protection, 2015)

Israeli Climate Change Information Center

The Israeli Climate Change Information Center (ICCIC) was established and funded by the Ministry of Environmental Protection at Haifa University in March 2011. Operation of the Center was coordinated with the Technion-Israel Institute of Technology, Tel Aviv University, and the Samuel Neaman Institute. The ICCIC was founded in accordance with Govt. Decision No. 474, approved in June 2009 that, inter alia, called for experts to generate knowledge on climate change and formulate a national adaptation program.[103]

The ICCIC brought together some 100 representatives from government, academia, industry, and NGOs to gather and analyze information, identify existing knowledge gaps, identify risks and climate change implications, and to submit recommendations on prioritized research requirements, for proposed national and local adaptation policy, and ways to market the scientific and technological knowledge collated for application in Israel and around the world. The policy documents developed by the center are to be integrated into the proposed national adaptation plan.

The ICCIC has released four reports:

- Review of Existing Knowledge and Identification of Knowledge Gaps and Priority for Completion (Updated in 2012).
- Policy Recommendations in the Areas of Knowledge of the Information Center (Issued in 2012).
- Outlines for the Preparation of Local Authorities to Climate Change (Issued in 2013).
- Adaptation to climate change in Israel-Recommendations and knowledge gaps (Issued in 2014).

The Ministry of Energy

Between the years of 2010-2016, the Office of the Chief Scientist at the Ministry of Energy invested in projects related to climate change mitigation and adaptation:

Renewable energy

Research conducted and funded by the Office of the Chief Scientist in the field of renewable energy focuses on:

1. Systematic aspects, such as increased energy security due to the diversification and decentralization of the sources for generating power.
2. Economic aspects, such as stability of electricity costs and development of local Israeli industry.
3. Technological aspects, including investing in research in storage technologies, increased solar conversion efficiency, improved wind turbines, and innovative technologies such as the energy tower, which exploits hot and dry desert air to create airflow based on temperature differentials that in turn powers energy turbines.

The Office of the Chief Scientist established a national center for solar energy in Sde Boker, creating a research network in the field of solar energy with a specialization in CPV (Concentrated PV) technology development and developed PV diagnostics. The integrated systems and knowledge acquired were the foundation for establishing companies in the field.

Energy efficiency and conservation

The Office of the Chief Scientist supports the creation of the knowledge base required to effectively update energy performance standards, and invests in research and development in innovative solutions in the field, such as development of software that will perform compatibility testing in terms of conformance of buildings to Green Building standards.

Alternative Fuels

The Ministry has established a dedicated administration for promoting the use of natural gas-based and other substitutes for petroleum-based fuels for transportation purposes:

- Establishing a comprehensive "Well to Wheel" policy for incorporating the use of natural gas-based petroleum alternatives.
- Collecting relevant professional expertise and conducting comprehensive research in

103 (Ministry of Environmental Protection, n.d.)

pertinent fields, for the purpose of analyzing and evaluating the various alternatives and the circumstances of their exploitation, taking into consideration their technical and regulatory aspects.

- Establishing a mechanism to promote and facilitate research and development efforts and their implementation in Israel.
- Supporting the establishment of the first factory to produce biofuel from cow manure in Beer Tuvya. Following the success of this factory, more were established worldwide.
- Supporting EnStorage in developing energy storage technology based on regenerative fuel cells that can be used to promote uptake of renewable energy storage.

Urban Sustainability Administration ("Smart Cities")

The Administration is responsible for defining a comprehensive policy to promote urban sustainability from an integrative perspective covering a diverse range of areas: energy, water, sewage, transportation, education, healthcare and leisure, as well as technological and planning issues. The Administration is developing a holistic and innovative methodology for urban planning.

Smart grid

The Chief Scientist established a team of experts and stakeholders to build the framework for a modern smart grid in Israel, and to help development in this field. A three-year long academic research project in this area, regarding consumer behavior, was funded and launched in 2015. In addition, support was provided for the first micro-grid implementation in Israel.[104]

Nuclear Power Plant (NPP) Administration

In 2013, a Nuclear Power Plant (NPP) Administration was established to promote nuclear energy as an additional alternative energy source available from 2030. The NPP Administration initiated a pre-feasibility study of nuclear power generation in Israel. Its main goal was to determine and analyze the major obstacles to the construction and operation of an NPP by 2030. The Administration also is responsible for the following activities:

- Supporting research activity and labor qualifications.
- Initiating several flagship projects to build the knowledge base and the infrastructure for research facilities, necessary for the implementation of a comprehensive feasibility study (e.g. a thermo-hydraulic NPP laboratory and others).
- A nuclear experimental facility (part of international collaboration) opened in October 2015.
- A thermo-hydraulic laboratory. The preliminary characterization stage was completed by late 2016.
- Collaboration with the International Atomic Energy Agency (IAEA) on "Writing updated siting criteria and a guideline document for NPPs" (IAEA TC project for 2016-17). An international workshop on NPP Siting Criteria, together with IAEA's experts took place in Tel Aviv in July 2016.[105]

Continental Shelf Research Program

The Continental Shelf Research program was initiated to explore the environmental impact of constructing infrastructure on offshore structures, such as artificial islands. The study, conducted by the Earth and Marine Sciences Administration, was designed to explore the long-term implications of such construction on marine dynamics and to provide decision makers with a practical set of tools for evaluating these offshore structures. The research included the following:

- Evaluation of the coastal cliff collapse with emphasis on sea-cliff interaction.
- Continuous collection of meteomarine information and operation of two marine observation points at Hadera and Ashkelon.
- Modeling the impact of tsunami waves on onshore and offshore infrastructure.

Other projects that are being examined are technologies regarding CO_2 sequestration, artificial islands technologies, water infrastructure, and switching storage and control technologies.[106]

104 (Ministry of Energy, 2015)
105 (The Chief Scientist Office Ministry of Energy, 2016)

The STARTERGY Fund

The Ministry established a start-up fund (STARTERGY) to encourage entrepreneurs and help startup companies reach the proof of concept/prototype stage, from which point they can proceed to raise private funds. The fund grants up to NIS 750,000 or 62.5% of the project budget.

Pilot and Demonstration Fund

The purpose of this fund is to assist companies scale their innovative products to full production. Priority is given to renewable energy and alternative fuel technologies in transportation. The fund grants up to NIS 1,500,000 (approximately $400,000) or 50% of the project budget. As of 2016, the grant was increased to NIS 3,000,000 (approximately $800,000) for alternative fuel projects.[107]

Fuel Choices Initiative

The Fuel Choices Initiative is a partnership of the Prime Minister's Office with nine governmental ministries to develop and research ways to reduce Israeli dependence on petroleum-based fuels for transportation. The strategy involves strengthening scientific and applied research in the field, simplifying bureaucracy, and strengthening entrepreneurship and industry. The initiative's objectives include:

- Reducing the share of crude oil in Israel's transportation sector by 30% by 2020 and by 60% by 2025 while supporting green growth.
- Transform Israel into a knowledge and industry hub for fuel alternative technologies.
- Raise awareness of alternative fuels choices and build a global partnership network.[108]

The Ministry of Economy and Industry Chief Scientist

The Office of the Chief Scientist of the Ministry of Economy and Industry (as of 2016, the independent 'Israel Innovation Authority') supports research and development in many sectors, including renewable energy. The Israel Innovation Authority operates an annual budget of US $300 million to help researchers and entrepreneurs get their ideas off the ground.[109]
Below are the key influential programs incentivizing innovation in the sustainability field:

Renewable Energy Technology Center

In 2011, the Ministry of Economy and Industry chief of science in conjunction with Capital Nature investment group established the Renewable Energy Technology Center. This technological center supports renewable energy industry in the Arava area to drive regional growth and boost employment. The center was established with a joint investment of NIS 70 million (approximately $18 million) and serves as an incubator, also including upgraded technology testing and conducting validation in actual field conditions.[110]

The Incubators Program

The Incubators Program is funded by the Ministry of Economy and Industry and provides a platform where technology incubators (support companies) give entrepreneurs an opportunity to develop their innovative ideas and set up new businesses to commercialize them. Established in 1991, the program continues to grow, and by the end of 2013 had matured אם over 1,600 companies, with 60% of these successfully raising private investments.[111]
Successful and developing projects include:

- Innovative and green electrical power distribution equipment.
- Environmentally friendly process for solvent recovery and production of high quality biofuels.
- Mass production of cost effective photovoltaic

106 (The Chief Scientist Office Ministry of Energy, 2016)
107 (The Chief Scientist Office Ministry of Energy, 2016)
108 (Rosner)
109 (Israel New Tech, n.d.)
110 (Ministry of Environmental Protection, 2011)
111 (OCS-Office of the Chief Scientist, 2010)

cells on rolls of flexible polymer.
- mCHP (micro Combined Heat and Power) for single family residences systems, based on an innovative micro gas turbines.
- High power LED lighting solutions based on unique heat dissipation technology. [112]

The MAGNET Program – Technological Infrastructure for the Industry

This program facilitates collaborations between companies and academic research groups to bring innovative ideas to fruition. The program was created due to the realization that many Israeli industrial companies are too small to bear the escalating costs of developing new technologies, while Israel's world class research universities operate largely in isolation. The Office of the Chief Scientist provides funding and support for these joint ventures to produce start-of-the-art technologies with international applications. After submitting a project proposal, industrial companies may receive a grant of up to 66% of the recognized expenses, while academic partners are granted 66%, 80% or 90% depending on the chosen track.[113]

The Ministry of Science, Technology and Space Chief Scientist

Over the period of 2010-2016, the Ministry of Science, Technology and Space invested in research activities related to climate change, with a focus on the following:

- Agriculture and environment, with an emphasis on climate change impacts.
- Energy, with an emphasis on renewable energy and biofuels.
- Marine environment, with an emphasis on developing capacity and tools to cope with the impacts of climate change and development on the marine environment.

The Ministry Chief Scientist published a call for 2017 for research regarding climate change and addressing the following topics:

- Climate change impacts on public health
- Climate change impacts on biodiversity
- Development of components to treat air pollution
- Climate change impacts on rain regime
- Climate model downscaling.

The Ministry further funded undergraduate research projects on alternative fuels for transport, such as biomass, energy storage, and solar fuel.[114]

The Ministry of Agriculture and Rural Development Office of the Chief Scientist

Over the period of 2010-2016, the Ministry of Agriculture and Rural Development's Office of the Chief Scientist invested in climate-change related research, including Joint research with the Jewish National Fund from 2011-2013:

- Adaptation measures for developing drought resistant types of Cupressus sempervirens. [115]
- Partitioning the hydrological balance in forests along the precipitation gradient in Israel to determine water-effective forest management.[116]
- Development drought-resistance trees – examining the response of trees to controlled drought stresses. [117]
- Interface Adaptation to Climate Change in Dryland Forestry (total budget of €120,000). [118]

Gilat Research Center for Arid & Semi-Arid Agricultural Research

Founded in 2011 as the southern branch of the Agricultural Research Organization of the Ministry of Agriculture, Gilat comprises research units that address the issues facing farmers in the Negev desert. The Center's vision is to find solutions for sustainable agriculture in Israel's arid regions. The

112 (Israel New Tech, n.d.)
113 (The Magnet Program, n.d.)
114 (The Ministry of Science, Technology and Space, 2014)
115 (Keren Kayemth leIsrael Jewish National Fund, 2012)
116 (Keren Kayemth leIsrael Jewish National Fund, 2012)
117 (Keren Kayemth leIsrael Jewish National Fund, 2012)
118 (Israel Climate Change Information Center, 2012)

Table 29: *Gilat Research Center for Arid & Semi-Arid Agricultural research goals and accomplishments*

Goal	Accomplishment
Develop knowledge, products, and technology to increase the yield of agricultural produce while protecting the environment.	Advancement of olive production in Israel. Improved handling of pests and diseases.
Develop solutions for impending crises such as climate change, water availability, desertification, and soil degradation.	Improved efficiency in water and fertilizer use in crops such as olives, peppers, tomatoes, and basil.
Initiate international cooperation in agricultural research in arid areas.	Long-term continuous collaborations with researchers from the United States, Thailand, China, Germany, and others.
Train the next generation for agricultural research by collaborating with higher education in the Negev.	Dozens of students annually study at the Center towards advanced degrees at Israeli and foreign universities.

The above table highlights most recent goals and successes of Gilat.[119]

The Ministry of Health Chief Scientist

The Ministry of Health Chief Scientist's Office addresses the impact climate change has on public health in general and on the incidence of diseases in particular. Over the period of 2010-2016, the Ministry of Health invested in the following research activities related to climate change:

- Yearly update on the incidence of West Nile fever in humans and mosquito infection.
- Joint research by the Ministry of Environment, Ministry of Health and the Israel Meteorological Service on the connection between fluctuations in temperature, which highlights climate change, and the incidence of skin Leishmaniosis. The research findings thus far indicate a rise of incidents occur about 12 weeks after a severe rise in temperature; this will improve understanding regarding the impact of absolute humidity on morbidity rates.
- Funded research conducted by Haifa, Ben-Gurion, Tel Aviv and Bar Ilan universities that found that a rise in temperature increases the risk for heart defects in babies born in the Tel Aviv area in 2000-2006. [120]
- Funded research currently conducted by Tel Aviv University, the Hebrew University of Jerusalem, and Sheba Medical Center (Heller Institute) on the impact of climate change on car accidents.
- Research conducted by the public health laboratories of the Ministry of Health and the School for Public Health at Tel Aviv University is examining the climate change shifts and their connection to incidences of zoonotic diseases transferred by food (salmonella and campylobacter) in the years of 1995-2010. The research will forecast the possible impacts of climate change on the incidence of these food contaminants in 2030.[121]

Independent and Academic Research Activities

In addition to government-supported research, significant climate change research and development, particularly mitigation technologies, are conducted independently by both industry and academic institutions.

Center for Renewable Energy

Located at Tel Aviv University, the Center was created to combat the two leading obstacles to large- scale solar infiltration in Israel: lack of energy storage technologies to enable solar energy storage, and the technical upgrades required for the electricity infrastructure. The Center brings together 300 researchers and serves as a platform

119 (Agricultural Research Organization, n.d.)
120 (Environment and Health Fund, 2014)
121 (Environment and Health Fund, 2014)

Table 30: *Summary table for private research institutes activities*

Research Institute	New Research
Grand Technion Energy Program[122]	• Advanced actuators integrated into the surfaces of **wind turbine blades** that offset the negative effects of varying winds and gusts. • Preliminary tests showed an increase in power output and reduced stress on the structure – extending turbine life.
Arava Institute[123]	• Production of **hydrogen** onboard motor vehicles using boron. • Eliminates the distribution, storage, and pumping of hydrogen to the vehicle, reducing GHG emissions.
Pythagoras Solar	• Development of **windows with solar cells** that generate energy from the sun and run the electricity through an AC/DC converter for the building.
SDE Wave Energy	• Advancing technology that harnesses **wave energy** in an efficient and fully automated method of suspension. Energy plants have been installed in 12 coastal destinations.
Brenmiller Energy	• Creating an entirely self-sustainable and self-cleaning 'floating' **solar thermal field** in the Negev. • Solar energy storage to generate electricity 20 hours a day.
Emefcy[124]	• **Turning wastewater to electricity** – bacteria with the ability to produce electric current while degrading the organic compounds of wastewater. • Revenue forecast of $100 million by 2017.
Ben Gurion National Solar Energy Center[125]	• Using fullerene (a recently discovered form of carbon) to produce high efficiency solar cells. • How solar panels age under conditions of desert usage. • Identifying optimal locations for future solar power plants.

for scientists to meet these challenges with new technologies. Other actions of the center include:

- Holding international conventions
- Offering funding for selected research projects
- Recruiting young scientists for the cause of renewable energy research
- Overseeing national studies on electric cars[122].

In 2016, the Center also developed an offshore marine biomass plantation to grow a fuel resource without additional use of arable land and drinking water.

The Environment and Health Fund

The EHF, an Israeli organization established in 2007, is mandated with enhancing research capacity and capabilities in the field of environmental health in Israel. The organization's vision is to improve public health in Israel by reducing exposure to environmental pollution and awareness of heat-related illnesses. The EHF offers a wide variety of services including research grants, doctoral and post-doctoral fellowships, professional roundtables and workshops, and short courses. These research projects focus on subjects like how chemical exposures prevent gene expression, and pollution's impact on asthma, cardiovascular health, and heat stress. EHF also sponsors in-service professional training and promotes dialogue and information sharing.[123]

The EHF published a report "Environmental Health in Israel 2014" to provide baseline metrics for research moving forward. The EHF is committed to improving expertise in and expanding knowledge about health in Israel.

Ben Gurion University Salinity Center

Due to continued challenges presented by water resource scarcity, as well as competition with urban and industrial demands, the agricultural sector faces potential scarcity of water for irrigation. To help address this challenge by maintaining the present levels of irrigation while expanding agricultural production, the Salinity Center researches plant response to the use of saline water. Among other topics, the Center researches:

- The plant physiology of salt tolerance
- The relation of developmental stages to plant responses to salt
- The genetic control of salt tolerance
- Salt and nutrient interaction in the soil[124]
- The research will aid in the development of special agro techniques in preparation for expected extended drought periods due to climate change.

122 (Tel Aviv University, n.d.)
123 (Environment and Health Fund, 2014)

124 (Ben Gurion University, n.d.)

Photo: Shai Epstein

6. Education, Training and Public Awareness

Key developments since the last National Communication

- Development and expansion of the Green Schools certification program to reach thousands of educational institutions across the country.
  - Over 100 Green Schools are certified each year
  - Currently 2230 Green Kindergartens
- Increase higher education opportunities related to sustainability, in both undergraduate and graduate degrees, with new programs at:
  - The Hebrew University of Jerusalem
  - The University of Haifa
  - The Porter School of Environmental Studies (Tel Aviv University)
  - IDC Herzliya
  - The Arava Institute
  - Kibbutzim College of Education
- New training programs to help environmental teachers and professors prepare an effective curriculum.
- New public awareness campaigns resulted in a significant decrease in water consumption and increase in recycling.
- Expansion of informal education opportunities and NGO involvement for public education.

Formal Education

Primary and secondary school education

In Israel, environmental education is part of the curriculum from kindergarten to high school.[125] The last few years have seen a growth of educational capacity and interest in sustainability in the educational system.

Green School Certification Expansion

In 2007, the Ministry of Environmental Protection and the Ministry of Education partnered to create a certification process to encourage schools to not only teach environmental subjects, but also to act in a sustainable manner by conserving resources, and promoting eco-efficiency. While the certification requirements vary by type of institution (kindergarten, school, campus), all three have successfully expanded in the last few years.

- **Green kindergartens:** Eligibility for Green Kindergarten accreditation includes preparation of an annual work plan on environmental subjects, carrying out community-oriented environmental projects, and behavioral expression of environmental literacy through activities intended to conserve natural resources and reduce environmental pollution.
  - From 2007 until today, more than 2230 kindergartens have been certified. In 2015 alone, 371 kindergartens received accreditation.
  - In 2016, 421 applications for certification were submitted.[126]
- **Green schools:** Guidelines for accreditation as a Green School include 30 annual hours of formal teaching of environmental subjects within the framework of subjects such as geography, science, and social studies. The schools are required to reduce consumption and collect waste for recycling, in addition to implementing community projects that increase environmental awareness. The following table demonstrates the growing number of educational institutions that received Green School certification and the number of those that reapplied annually. [127]
- In August 2016, the Ministry of Environmental Protection published a call for proposals to give grants to local authorities to encourage implementation of activities such as certifying Green Schools and promoting educational activities in kindergartens and schools on air pollution and quality, and a healthy environment. The budget for this project is up to NIS 11.4 million (approximately $3 million).[128]

The Environmental Leadership program

As of 2014, all 10th and 11th grade students are required to participate in a social involvement program to achieve their high school diploma. The Ministry of Environmental Protection developed the **'Environment Leadership Program'** in collaboration with the Ministry of Education. The program was concluded in 2016, after 60 schools participated during the 2015-2016 academic year and 30 schools participated during the 2014-2015 academic year. The program's goal was to allow the students to acquire environment and sustainability knowledge and values.

The program's structure involved:

- 20 hours dedicated to practical training including:
  - Team building
  - Learning environmental issues
  - Social and economic aspects of sustainability
  - Project planning
- 10 hours dedicated to a team project. Each team planned and implemented a project of their choice which addressed social and environmental improvement in a residential area. The projects were completed after hours of study and field trips and, in many cases, cooperation with organizations or local initiatives.
- The program concludes each year with a youth conference offering different activities and dialogues.[129]

Table 31: *Green Kindergarten certification*

Year	Green kindergarten certified (new)	Green kindergarten (renewals)
2012	158	17
2013	330	29
2014	292	46
2015	317	54
2016	346	43

125 (Ben Gurion University of the Negev, 2011)
126 (Ministry of Environmental Protection, 2016)
127 (Ministry of Environment Protection, 2015)
128 (Ministry of Environmental Protection, 2016)

Integrated plan for Sustainability Education

In 2013, guidelines to implement the **Integrated Plan for Sustainability Education** in the school system were published by the Ministry of Environmental Protection. The goal is to give Israeli students the knowledge and tools to make more environmentally conscious decisions. The plan was prepared in cooperation with the Ministry of Education and focuses on critical subjects as:

- Sustainable development
- Climate change
- Air pollution and GHG emissions
- Waste management
- Renewable energies
- Water sector and the water crisis
- Biodiversity and open areas

The plan also includes professional development for the teaching staff. It aims to have 80% of teaching staff participate in a 30-hour learning module: 6 hours on a professional tour and 24 hours dedicated to expanding the curriculum. Kindergarten teachers follow the same requirements. New kindergartens will receive professional guidance of 11 hours a year for each kindergarten, and the renewing kindergartens will receive professional guidance of 6 hours a year.[130]

Working Together on Energy

In 2012, the Ministry of Energy in conjunction with the Ministry of Education and Tel Aviv University launched an education program titled 'Working Together on Energy' for 1st-9th grade students. The program is intended to change thought and behavioral patterns regarding the energy consumption on a level where students can create an impact as citizens according to their personal capabilities: reducing energy consumption in school, at home and in the community. Reducing energy consumption includes efficient energy use and adopting energy saving behavior, while enhancing the scientific/technological/environmental knowledge of using renewable enery (advantages and disadvantages), use of efficient energy machinery/tools/appliances and buildings (home and school). In addition to the written series, the Ministry of Energy initiated and financed the development of

Table 32: *Green schools certification*

Year	Green schools certified (new)	Green schools (renewals)
2012	127	17
2013	156	23
2014	110	28
2015	154	35
2016	127	17

129 (Ministry of Environment Protection, 2015)
130 (Ministry of Environmental Protection, 2014)

Table 33: *Primary and secondary school education special programs*

Program's name	Number of participants	Budget allocated	Hours allocated
'Environment Leadership Program'	200 students	2,000,000	60 per school
Integrated Plan for Sustainability Education	1,000 teachers	22,000,000	30 per school

model kit to demonstrate and structure scientific and technological principles into the learning environment. The model kit is intended to assist teachers in demonstrating physical and technological principles applied in the "Working Together on Energy" program. The models support the tasks present in the written series, starting from the basic level of performing the tasks to the level of expanding and performing additional tasks.

From 2012 until today, more than 900 schools have received the written series and 500 schools have received the model kit.

The program also includes professional development for the teaching staff. In 2017, more than 300 teachers participated in a 30-hour training.

The program operates a website for teachers and students with additional information, financies commercials on energy reduction, and teaching materials including booklets and guides.[131]

Summary

Israel has put major emphasis on environmental leadership and public awareness through primary and secondary programs in recent years, including the funding of special programs in school academic programs. Table 33 summarizes the data on special programs described above.

Higher education programs

Higher education opportunities in environmental and sustainability fields continue to grow in Israel. All major universities and colleges in Israel offer graduate or undergraduate programs on environmental studies and environmental management.

The significant environmental programs established since the last National Communication Report:

IDC Herzliya School of Sustainability

Founded in 2012 by Israel Corp., this 3-year interdisciplinary Bachelor of Arts degree is the first of its kind in Israel. It has graduated 60 to 80 students a year since its inception. The program combines courses in environmental and earth sciences with economic and government classes, with the addition of local aspects unique to Israel. The program seeks to create educated decision-makers who spark innovation, technological progress, and policy reform in the sustainability arena. The program places a strong emphasis on practical experience with internships and a practicum, enabling graduates to fit into entrepreneurial startups, become lobbyists in the government, public sector, NGOs, or environmental experts in the business sector. Other special elements include:

- Endowing students with the practical tools and theoretical knowledge to create long-term sustainable change.
- Monthly outreach lessons to local primary and secondary schools.
- Energy efficiency projects with the Herzliya municipality.[132]

Arava Institute

The Arava Institute was founded in 1996 as an academic and research center for environmental leadership in the Middle East. By partnering with Ben Gurion University, the Institute began offering an M.A. in 2002 and a minor in Environmental Studies in 2012, in addition to a host of research programs and international cooperation initiatives. With a student body comprised of Jordanians, Palestinians, Israelis, and students from all over the world, the Institute provides the opportunity to learn from leading professionals to solve today's most pressing environmental challenges. The Arava Institute has more than 900 alumni from its educational programs. Here, the idea that nature knows no political borders is the curriculum and way of life.[133]

The Hebrew University of Jerusalem

The Advanced School for Environmental Studies in the Hebrew University of Jerusalem focuses on training top-level researchers and professionals to be able to combat current and future environmental issues both within Israel and globally. In recent years, the school has launched a variety of graduate programs in environmental studies in different faculties, all of which emphasize the distinct applicable environmental issues, such as policy, health and environment, and resource management:

1. M.A. in Natural Resources Management and Environmental Policy, including a possibility for specialization in urban planning
2. M.A. in Environmental Planning and Policy
3. M.Sc. in Environmental Sciences
4. Master of Public Health (M.P.H.) with specialization in health and environment.

The University of Haifa

The University of Haifa is leading research facility in a variety of environment sciences and related fields. This includes academic programs, special laboratories (such as the GIS laboratory, and the climate laboratory with a meteorological station). Under the Faculty of Management, the Department of Natural Resources and Environmental Management offers three M.A. programs and an M.B.A. program:

1. **Natural Resources and Environmental Management** – General track
2. **Energy Policy and Management**- The objective of the program is to broaden and deepen the knowledge of professionals who engage in the field of energy resources in Israel and around the world. The program emphasize social and managerial studies, the development of renewable energy and promotion of energy efficiency.
3. **Management of Sustainable Built Environment** - M.A. program in Management of Sustainable Built Environment offers a broad survey of sustainability and urban resilience to link research to policy and practice.
4. **An International M.B.A. Program Specializing in Sustainability** - Focus on issues of environmental and social sustainability that are increasingly at the heart of the responsibilities of business managers. This new M.B.A. program seeks to promote sustainability-oriented leadership by providing the students with the essential tools for business management and incorporating leading-edge sustainability principles throughout the curriculum.

The Porter School of Environmental Studies

The Porter School at Tel Aviv University is dedicated to the research, teaching and sharing of environmental knowledge in Israel. In 2015, the school added a number of new undergraduate programs in geophysics, law, and mechanical engineering, all with an environmental emphasis. Students graduate from these 4-year programs with the tools for a multi-disciplinary approach to some of Israel's biggest climate challenges. The Porter School offers M.A. and Ph.D degrees in of renewable energy, climate change, air pollution, environmental justice, and more.[134]

Master of Environmental Education at the Kibbutzim College of Education

This 2-year program provides training for environmental educators in primary and secondary schools. It offers courses on the philosophical, epistemological and ethical aspects of environmental education, in addition to practical components of lesson planning, shaping attitudes, raising awareness of environmental

131 (The Ministry of Energy, 2017)
132 (IDC Herzliya, 2013)
133 (Arava Institute for Environmental Studies, 2013)
134 (Tel Aviv University, 2013)

issues, and instruction. The Education Program offers professional advancement through internships in different environmental NGOs.

Scholarships by the Ministry of Energy

The Ministry of Energy Chief Scientist office decided to provide scholarship contributions to the development of human resources with scientific capabilities, knowledge and expertise, to make Israel an international center of excellence in the fields of renewable energy, alternative fuels and energy efficiency. The scholarship program began in 2011 and by 2014 had granted 77 scholarships totaling NIS 7.2 million (approximately $2 million).[135] The program includes:

- Coordination of environmental activities, guidance of fieldtrips, responsibility for extracurricular class in schools.
- Student leadership and community involvement on the environment.
- Implementing environmental education activities in informal education frameworks.
- Working in environmental studies programs in high schools.[136]

Green Campuses: Institutions of higher learning can be Green Campus-accredited if they allow each student to take one elective course in the environmental field, implement a community environmental project conducted by the administration and students, and implement a reduction program (for instance, for electricity or water consumption). In 2016, 25 Green Campuses were certified, of which 19 were renewals. In 2017, three additional campuses were accredited as green campuses, leading to 25 accredited green campuses. [137]

Informal education

Across Israel, informal education settings help solidify existing environmental knowledge and transfer new sustainable practices to the public. Teenagers in youth movements, "at risk" adolescents, and anyone interested in the environmental movement can become involved in these centers to create sustainable lifestyles. These programs and centers are also conduits of important knowledge exchange for vulnerable groups such as the elderly and poor about climate change impacts and mitigation.

Youth movement activities

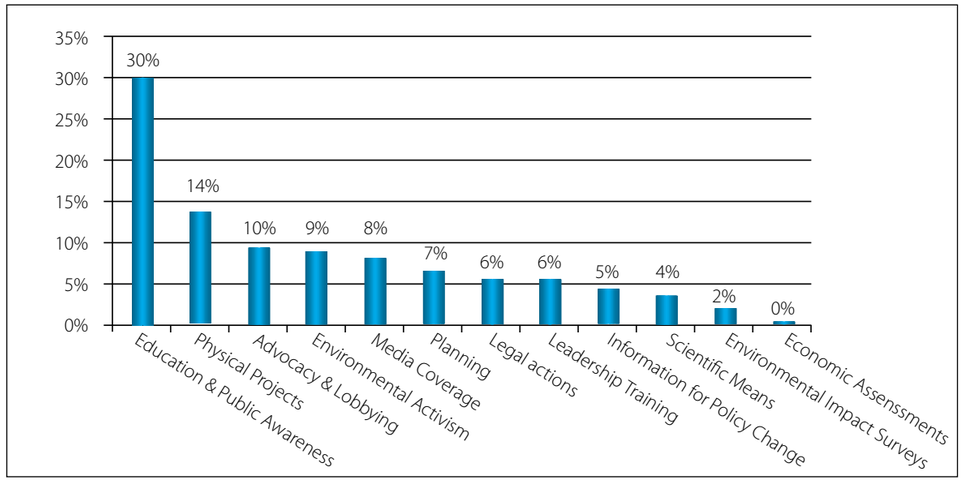
The Ministry of Environmental Protection, the Ministry of Education and the Youth Movement Council in Israel joined forces to enhance the youth movement activities for a more sustainable society. The Ministry of Environment Protection allocates between NIS 800,000 and NIS 1 million (approximately $200,000-250,000) annually for the program. Branches of the youth movement can now be accredited as 'Green Chapters' if the branch has an environmental committee, and acts for environmental awareness in the community. Since 2012, around 80 new chapters nationwide apply annually to become Green Chapters, and many have launched recycling projects and other sustainability initiatives. Training on environmental and sustainability issues is available to youth movement counselors through educational seminars.[138]

Yesh Matzav

The Yesh Matzav program provides a place for adolescents to create environmental and community projects and participate in activities in the field of sustainability. The program reaches out to teenagers aged 12 to 18 who study in a formal education system, and have been identified by the professional staff of the community or school as being "at risk". Yesh Matzav is the result of a cooperation between the Ministries of Welfare, Education, Health, Culture and Sport, Environmental Protection, the Society for the Promotion of Education, and Ashalim. The pilot program ran during 2010-2013 and engaged 344 students, many from single parent homes.[139]

135 (Ministry of Energy, 2014)
136 (Kibbuztim College of Education, n.d.)
137 (Ministry of Environment Protection, 2016)
138 (Ministry of Environmental Protection, 2015)
139 (Levy, 2014)

Figure 28: *Primary focus of NGO involvement*



Sustainability centers

Climate change and social justice are two related challenges facing Israel. The Ministry of Environmental Protection, the Heschel Center for Environmental Leadership and the Gvanim Association have collaborated to foster a sustainable lifestyle among vulnerable populations (the elderly, poor, disadvantaged youth, etc.). Twelve sustainability centers have now been established in areas and neighborhoods with vulnerable populations. The centers are in charge of creating environmental awareness through activities, housing committees and schools, and community gardens to empower effective leadership. As these groups are often the first populations to be affected by environmental problems, they merit special access to environmental education and a better understanding of the changes needed. These centers currently operate independently, and the Ministry of Environmental Protection continues to be a professional partner.

Public awareness

NGO involvement

Among the active environmental NGOs in Israel, environmental education and public awareness currently constitutes the most common operational activity. Researchers at Ben Gurion University compiled the following data in 2011 on what environmental NGOs considered their primary purpose, with education and awareness being the most prevalent at 30%.[140]

The number of environmental NGOs in Israel continues to increase. Life and Environment-The Israeli Union of Environmental NGOs is a non-profit non-governmental organization that represents and serves over 120 organizations with an annual budget of NIS 1.2 million (approximately $300,000).[141] Many of these organizations each conduct their own education and public awareness initiatives, contributing to the scope of the environmental movement. The following are examples of NGOs raising awareness on water quality protection and other climate issues.

Zalul

Founded in 1999, Zalul is one of Israel's leading environmental NGOs, dedicated to protecting the seas and rivers of Israel. Zalul accomplishes its mission through conservation, activism, raising awareness for research, and education. It strives through education to bring the issues of water preservation and environmental

140 (Ben Gurion University of the Negev, 2011)
141 (EuroMed, n.d.)

Table 34: *Percentage survey responders on 'starting to think green campaign*[150]

% of survey responders		
	Average for campaigns	Starting to Think Green
Memorable	59%	79-85%
Understood the message	61%	66-81%
Importance (1-10)	7.2	7.6-8

protection to front of the Israeli conscience. The group continues to wage strategic campaigns that to confront municipalities and corporations neglect water resources. Among the organization's achievements:

- Public education to stop diving activities in the Kishon Stream.
- Establishing sewage purification facilities nationwide.
- Changing laws relating to the sea and streams.[142]

EcoPeace Middle East

EcoPeace is an advocacy organization that seeks to build transboundary efforts to protect shared environmental resources. As climate change continues, water availability will decrease and conservation practices will become more important. The group addresses lack of sewage treatment, aquifer overuse , and diversion of water that threatens already scarce water resources. In 2010, EcoPeace began projects to protect and manage biodiversity and raise awareness among high school students regarding climate change related water issues.[143]

Green Rahat Association

Rahat is the second largest city in the Negev, established in 1972 to encourage Bedouins to settle in permanent settlements. Rahat is also Israel's poorest city, with 80% of its inhabitants below the poverty line and 60% of its residents under the age of 18. Despite the young population, the city has critically few green spaces and no playgrounds

In 2003, a group of teachers, students and members of the general public founded the Green Rahat Association, which since its inception has conducted many clean-up campaigns. The group established an environmental workshop to educate young people on how to be active in their city's future. The workshop's pivotal achievement was Rahat's first community garden, built by local children. The association has succeeded in introducing the concept of environmental quality to Rahat's residents.[144]

National public awareness campaigns

In Israel, public campaigns have had the ability to impact human behavior in areas such as water conservation, recycling, and smart consumption. The campaigns run by the Ministry of Environmental Protection have been found to be particularly effective; a survey conducted by the Ministry found that their campaigns were the most enjoyed (with 21% of responders choosing campaigns run by the Ministry of Environmental Protection) and among the most memorable.[145] The following are examples of successful recent national awareness projects.

Starting to Think Green

From 2010-2012 the Ministry of Environmental Protection ran a campaign dealing with subjects such as saving paper, saving fuel, lowering amount of food consumption and smart consumption,

142 (Zalul Environmental Association, 2013)
143 (Silver, 2011)
144 (Amrani, 2009)
145)Ministry of Environmental Protection, 2014)
146 (Ministry of Environmental Protection, 2012)

Table 35: *Training activities*

Subject	Training activity	Date	Notes
Developing financial mechanisms to provide incentives for investments in energy efficiency	1st workshop on the subject: The possibilities of integration of Israel in international financing mechanisms, hosted by Casper Van Der Tak, ClimaSouth	June 2, 2016	
Carbon Markets	Roundtable: Emissions trading in the Paris agreements	September 26, 2016	
Reduction of use of fluoridated refrigerant gases	Workshop to present cooling systems that use HFC alternatives, to present possible technical solutions using more efficient and less resource consuming alternatives; introduction to European regulations	June 15-16, 2016	The workshop was for relevant regulators (environment protection, energy, economics ministries) and relevant professionals.
	Technical Training Course (theoretical and practical) on the use of natural cooling gases.	October 2010	Two representatives were sent, one from the academia and other working in the field of air conditioning, to a course in Germany
Integrating renewable energy	Two workshops, in Israel and abroad, with expert participants from countries with a major share of renewable energy integration (California, Germany or others)	2016-2017	

electricity saving, waste separation, and green building. The campaign included commercials on TV and through the radio, and newspaper ads. The Ministry of Environmental Protection gave the statistics on the success of the campaign as can be seen in Table 34.

Water conservation campaign puts Israel safe from water crisis

In 2013, the Israeli government launched a widespread television advertisement campaign that Israel was "drying out". The campaign was launched within a severe water crisis, when prices of water were rising and supplies to agriculture were being slashed. The television advertisements were accompanied by the distribution of low flow water aerators.[147]

Recycling campaign pushes plastic bottle recycling to 50%

Starting in 2012, the Israeli government began placing colorful recycling cages in the streets. The campaign, coupled with educational videos about how to sort recyclables into different colored bins, appeals primarily to children. Coupled with infrastructure improvements, the campaign has seen a huge increase in plastic bottle recycling. The rate of plastic bottle recycling in Israel increased to 50% and glass bottles and cans to 77%. The recycling of bottles has saved Israel over 500,000 tons of waste that would have ended up in landfills and significantly reduced GHG emissions.[148]

Training programs

As the environmental education sector is expanding, the demand for environmental educators has also increased. Training programs have provided a knowledge base for how to educate students about environment issues, and how to incorporate sustainability practices across the disciplines.

Within the framework of implementation of the Paris Agreement targets, the Ministry of Environmental Protection developed a training program for 2016-2017 to build knowledge capacity for experts and for other professionals.

147 (Horovitz, 2013)
148 (Press, 2015)

The following training activities have been implemented as can be seen in Table 35.

Regional Heschel Fellows Program

The Heschel Sustainability Center offers a unique one-year program designed to train entrepreneurial leaders in a variety of fields. Each cohort may include a wide range of professionals, e.g., the manager of a chemical firm, a product designer, an environmental activist, an academic researcher, an architect, and a marketing director. The program trains its fellows to understand that sustainability requires synergy. They work together to craft environmental community projects such as campaigns to save open natural areas and endangered species. Heschel aims to be the premier institution promoting a broad-based social, environmental, and economic vision for Israel.[149]

Israeli Green Building Council

Founded in 2007, this non-profit organization aims to bring green building education to architects and builders in Israel, and to create a rating tool for real change in Israeli construction. The Israeli Green Building Council operates a Green Building School leading training programs and courses, such as attaining green building certification, urban agriculture, and green building toolbox for architects and construction workers.

Energy efficiency training for people with disabilities

In 2012, the Ministry of Energy in conjunction with the American Jewish Joint Distribution Committee, launched a special energy efficiency training course for people with disabilities. According to the Ministry, the average electricity consumption in homes of people with disabilities is 75% higher than the average consumption in all Israeli homes. The courses were designed for the needs of people with disabilities, helping them acquire tools to save energy in their home and surroundings. [150]

149 (Heschel Sustainability Center, n.d.)
150 (Ministry of Energy, 2013)

Photo: Government Press Office

7. Financial resources and technology transfer

Key developments since the last National Communication

OECD accession

In September of 2010, Israel joined the OECD an important step towards improving its environmental situation. The OECD provides a forum to work together to seek solutions to common challenges and enables peer learning. Israel is now required to meet certain environmental standards, to carry out significant GHG mitigation measures and to report on numerous environmental activities and plans. The Ministry of Environmental Protection's representatives are highly active participants in OECD Working Parties, e.g.:

- Working Party on Climate, Investment and Development
- Working Party on Biodiversity, Water, and Ecosystems
- Working Party on Integrating Environmental and Economic Policies
- Working Party on Environmental Performance.

These committees focus on policy analysis to ensure more environmentally friendly and cost-efficient outcomes.

Technology transfer

Israel is involved in many networks to exchange technologies relevant globally to climate change. MASHAV, Israel's Agency for International Development Cooperation, has conducted dozens of projects in developing countries to assist water conservation efforts and agricultural efficiency techniques.[151] Israel also cooperates with the European Union to develop these technologies, work with experts in the field, and protect other Mediterranean countries from natural disasters.

CTCN – Climate Technology Centre & Network

On August 10, 2015 Israel was accepted as a member to the United Nations Climate Technology Center and Network (CTCN). The CTCN was established as part of the UNFCCC to improve the development and transfer of technologies and aid developing countries with climate challenges. Its major target is to strengthen the abilities of developing countries to prepare and organize technological climate change adaptation and mitigation projects. The Ministry of Environmental Protection applied to be a member on behalf of the Natural Resources and Environmental Research Center (NRERC), which deals with socio-economic aspects of the environment in Israel.[152]

Innovation: Africa

For the past 9 years, Innovation: Africa has brought Israeli solar and agricultural technologies to African villages. This non-profit organization consists of a team of dedicated problem solvers with a mission to bring Israeli solutions and expertise to rural African villages. Innovation: Africa has installed 150 projects in eight countries, impacting nearly 1 million people. The organization has implemented projects, such as:

- Solar installations to pump water from the aquifers to provide clean water to villages for the first time.
- Drip irrigation allowing villagers to grow more food with less water, even during droughts.
- Solar powered medical centers provide indoor and outdoor light, as well as refrigeration for storing medications and vaccines for the first time.
- Solar powered schools and orphanages provide light and allow students to study with electric light for the first time. [153]

Israeli Technology Transfer Network

The ITTN is a private non-profit that unites various technology transfer offices throughout Israel. Its purpose is to permit Israeli-generated intellectual property to translate more easily into marketable products for the benefit of the United States and Israel. The organization works to improve public accessibility to new and innovative research findings and inventions. Currently, the ITTN is comprised of 12 partnering organizations that are affiliated with world-renowned Israeli universities and research institutions.[154]

Partnerships for information sharing

The EU Twinning Project 2015-2017

The Twinning Project was launched between the Ministry of Environmental Protection, Germany, Austria, and the UK after a successful first project that ran during 2013-2015. The program partnered experts in the environmental field from different countries to share information and strategies. The objective of the two-year project was to contribute to sustainable development and green growth in Israel with a modernized environmental management framework. Workshops, site visits (EU experts came to Israel), study visits (Ministry of Environmental Protection professionals traveled to the EU to learn about specific topics) and round table discussions facilitated the knowledge exchange. The Twinning Project was divided into three main components as can be seen in Table 36.

Table 36: *Twining project components:*

	Aim	Specific Goals
Component 1	Create and adapt regulations in different environmental fields (including permitting and inspection of businesses), and write manuals explaining the regulations.	Create an IPPC or "green licensing" system to streamline existing environmental permits into one integrated system.
Component 2	Introduce Israelis to different environmental management systems and use knowledge to design a system appropriate for Israel	Types of systems to be introduced: EU Eco-Management and Audit Scheme (EMAS) EMAS Global ISO 14001 – sets criteria and standards for environmental management
Component 3	Promote resource-use efficiency	Develop of national policy that accounts for cross-sectoral features of resource efficiency, including energy efficiency, use of raw materials, and research of material streams plastics.

The main issues addressed included soil and water protection, air pollution control, and environmental management practices in industry. The project was financed with EU funds, budgeted at €2.08 million[155].

TAIEX

The Technical Assistance and Information Exchange, or TAIEX, is an instrument managed by the European Commission's Directorate-General Enlargement. TAIEX is a European Neighborhood Policy program that supports partner countries with assistance and advice on the transposition of EU legislation into the national legislation of the beneficiary country, and the subsequent administration, implementation, and enforcement of such legislation.[156]

Through study visits, expert missions between countries, and workshops, TAIEX makes information available to the beneficiary country, and provides technical training and peer assistance.

Since 2006, TAIEX events have been held in Israel and in Europe on topics including:

- Contaminated soil
- Ecological status of rivers and streams
- Health and environment
- Environmental emergencies
- Waste management
- Resource efficiency
- Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
- Pollutant Release and Transfer Register (PRTR)
- Integrated Pollution Prevention and Control (IPPC).

ClimaSouth

Israel is one of nine partner countries in the ClimaSouth program that was launched in 2013. This EU-funded five-year project supports the transition of European Neighborhood countries bordering the Mediterranean towards low carbon development and climate resilience. ClimaSouth enhances regional cooperation, information sharing, and capacity development on climate change mitigation and adaptation with the EU. The Israel Ministry of Environmental Protection has participated in various ClimaSouth workshops and steering committee meetings, when the annual agenda was set.[157] Anticipated results include:

- Enhanced regional cooperation on NAMAs/ LEDs, the use of market-based mechanisms, and adaptation strategies.
- Better use and sharing of climate science data.

151 (Ministry of Environment Protection, 2015)
152 (Ministry of Environment Protection, 2015)
153 (Innovation: Africa, 2016)
154 (Israel Tech Transfer Organization, n.d.)

155 (Ministry of Environmental Protection, 2015)
156 (Ministry of Environmental Protection, 2015)
157 (Ministry of Environmental Protection, 2014)

Table 37: *Support received from international activities*

Name of project	Support received						
	2010	2011	2012	2013	2014	2015	2016
Joint HFC project with Government of Bavaria					€359,000	-	-
EU ClimaSouth	-	-	€712,500				

Union for the Mediterranean

Launched in 2008, Union for the Mediterranean works to strengthen political dialogue between countries surrounding the Mediterranean. One of its key initiatives is a joint civil protection program on prevention, preparation, and response to natural and human-made disasters. As climate change causes more severe weather events, the Union will help each country respond to its situation. Another key initiative is the depollution of the Mediterranean Sea, including coastal and protected marine areas.[158]

LIFE

The EU LIFE program funds environmental and climate action. The general objective of LIFE is to contribute to the implementation, revision and development of EU environmental and climate policy and legislation by co-financing projects with benefits to Europe. Since 2014, Israel has been eligible to apply for project funding in partnership with a LIFE member. Israeli institutions and research centers are able to establish environmental or climate change projects jointly with EU partner(s), where the EU is funding 60% out of the costs of each project. The program supports both climate change mitigation and adaptation projects.

Environment and Health process

The European Environment and Health Process (EHP) brings together 53 countries, including Israel, to address key environment and health challenges. This process is led by the World Health Organization and the UNECE. In order to achieve the targets set, the EHP framework set up national mechanisms and structures, to ensure implementation of the Parma Declaration on Environment and Health. commitments. It also created a European Environment and Health Ministerial Board and a European Environment and Health Task Force (as well as a Secretariat). In 2015, participants met in Haifa, Israel for an EHP mid-term review, to look at what's been accomplished since the Parma conference, and what must still be done before the next ministerial conference, in 2017. The review was hosted by Israel's Ministries of Environmental Protection and Health in the city of Haifa. Participants included senior health and environment officials from more than 40 countries, representatives of UN organizations, the European Union, the OECD, and non-governmental organizations.

158 (Ministry of Energy, 2014)

Financial Resources

Financial Contribution

Support received

Israel does not receive international support related to the preparation and submission of the National Communication or Biennial Update Report. As seen in table 37 above, the Ministry of Environmental Protection has received international support for projects related to climate change.

In addition to local activities on mitigation and adaptation Israel participates in and contributes to various environmental international activities which directly and indirectly relate to climate change.

The following table presents Israel's contribution to international environmental conventions and protocols during 2010-2016:

Table 38: *Israel's contribution to international environmental activities*

Protocol/Convention	Topic		Contributions						
			2010	2011	2012	2013	2014	2015	2016
UNFCCC	Climate change		€49,363	€48,285	€57,847	€58,431	€90,523	€ 42,619	€ 72,972
Kyoto Protocol to the UNFCCC	Emission reduction of GHGs		€36,858	€35,969	€26,890	€36,670	€41,531	€38,242	€39,348
Vienna Convention for the Protection of the Ozone Layer	Protection of the ozone layer		$2,518	$2,518	$2,312	$2,312	$2,312	$2,308	$2,380
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Control of transboundary movements of hazardous wastes		$23,061	$24,533	$21,816	$21,325	$24,133	$23,963	$23,660
Rotterdam Convention	International trade of hazardous chemicals and international trade		-	-	$9,516	$10,685	$12,097	$13,108	$13,108
Montreal Protocol on Substances that Deplete the Ozone Layer	Phasing out production of substances responsible for ozone depletion (Annual membership payment)		$17,860	$16,396	$16,396	$16,396	$16,881	$16,881	$16,881
Convention on Biological Diversity (CBD)	Sustaining the diversity of life on Earth		$59,047	$52,076	$57,847	$56,337	$59,062	$60,671	$62,851
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	Conservation of migratory species of wild animals		€18,593	€22,439	€16,658	€17,703	€19,961	€20,579	€20,378
Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)	Conservation of African-Eurasian migratory water birds		€15,004	€15,004	€15,004	€14,915	€14,915	€14,915	€14,915
Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution	Addressing specific aspects of Mediterranean environmental conservation		€81,427	€81,427	€81,427	€81,427	€81,427	€106,342	€131,256
Convention on Wetlands of International Importance (Ramsar Convention)	Conservation of wetlands of international importance especially as waterfowl habitats		CHF 17,218	CHF 17,960	CHF 18,736	CHF 19,372	CHF 19,325	CHF 19,325	CHF 19,325
Mediterranean Wetlands Initiative (MedWet Initiative)	Protection of wetlands in the Mediterranean region		CHF 3,671	CHF 3,671	CHF 3,671	CHF 3,671	CHF 3,671	CHF 3,671	CHF 3,671

The following is a table of additional payments and voluntary funding that Ministry of Environmental Protection has contributed to since 2010:

Additional payments	Type of payment		2010	2011	2012	2013	2014	2015	2016
United Nations Environment Programme (UNEP)	Voluntary funding		$20,000	$120,000	$20,000	$140,000	$435,600	$534,600	$534,600
Organization for Economic Cooperation and Development (OECD)	Project on household behavior and environmental policy		€ 23,500	€ 23,500	-	-	-	-	-
OECD	Participation in OECD subsidiary bodies (environment)		€ 11,529	-	-	-	-	-	-
OECD	Study on reform of energy taxation (case study of the Israeli "green taxation" on vehicles)		-	-	-	-	€ 7,500	-	-
OECD	Measurement of Well-being and Progress: the OECD Better Life Initiative - Diagnosis and monitoring of Israel		-	-	-	€ 200,000	-	-	-
OECD	Chemicals control program		€ 2,647	€ 8,802	€ 9,409	€ 9,716	€ 10,447	€10,958	€11,755
World Meteorological Organization (WMO)	Annual membership		-	-	-	-	-	-	CHF 286,770

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