Chapter 5

Managing the environmental protection ecosystem in Egypt:

Towards achieving a sustainable environment and addressing climate change risks

The Sustainable Development Strategy: Egypt Vision 2030 emphasizes the environmental dimension of sustainable development, and seeks to integrate environmental aspects into various economic sectors to achieve effective management and preservation of natural resources, and guarantee the rights of future generations to development. This will support economic competitiveness, create job opportunities, reduce poverty and achieve social justice. The strategy envisages a series of institutional reforms, such as establishing a higher council for sustainable development, strengthening the institutional and legislative structure for managing water resources, and reforming economic policy to promote sustainable consumption patterns. The strategy is also based on establishing the infrastructure necessary for the sustainable management of water resources. In addition, it identifies the main environmental issues in Egypt, which include waste management, air pollution, biodiversity conservation, protection of the coastal and marine environment, and climate change. The strategy promotes engagement with the private sector and civil society, encourages public awareness, and supports Egypt's commitment to its responsibilities under international environmental conventions.

5.1 Legislative and institutional framework of environmental management in Egypt

5.1.1 Environmental legislation

Egypt's 2014 Constitution comprehends special provisions for protecting and preserving the environment in Articles 45 and 46, which impose political and social obligations to protect the environment as a pillar of sustainable development. The current environmental legislative framework was established under *Law No. 4 of 1994,* as amended in 2005, and *Law No. 102 of 1983* (on Natural Protected Areas). However, there are many other existing laws and regulatory frameworks that include various environmental aspects. For example, *Law No. 48 of 1982* on Protection of the Nile River, and its amendments; *Law No. 12 of 1982* on Irrigation and Drainage, and its amendments; *Law No. 93 of 1962* on Discharge of Wastewater in Sewerage Networks, and *Law No. 15 of 2017* on the Facilitation of Granting Licenses to Industrial Facilities.

At the same time, Egypt has adopted a wide range of environmental regulatory tools that address various aspects of environmental protection and natural resource management. Many sector-specific laws include environmental considerations that have allowed some ministries, as well as industries and sectors, to monitor their environmental impacts.

Environmental policy in Egypt is formulated and implemented by many national institutions, including the Ministry of Environment, the Environmental Affairs Agency, the Ministry of Trade and Industry, the Ministry of Health and Population, the Ministry of Agriculture and Land Reclamation, the Ministry of Water Resources and Irrigation, and other agencies. Through the Ministry of Environment, the Cabinet coordinates the formulation and implementation of the environmental policy among the various ministries.

Law No. 15 of 2017 on the Facilitation of Procedures for the Granting of Licenses to Industrial Establishments, gives the Industrial Development Authority (IDA) authorisation for the first time to grant industrial establishments a unified license that covers, among other things, environmental aspects. Under the law, the IDA is authorized to receive and review the environmental impact assessment studies of industrial establishments and examine the licensed industries to ensure compliance with licensing requirements, including environmental aspects and periodic inspections during the license period. *Law No. 15 of 2017* provides for enforcement and verification procedures different from those stipulated in *Law No. 4 of 1994.* Under the new legislation, the IDA has the exclusive power to implement these procedures, with the assistance of oth-

er relevant authorities, as necessary. Based on these new legal developments, the responsibilities of the Environmental Affairs Agency regarding industrial establishments have been transferred to the IDA. Some experts believe that implementing this law will require administrative efficiency and excellent coordination between the relevant authorities to avoid creating a parallel system to existing environmental management that may lead to the fragmentation of institutional responsibilities. It is too early to gauge whether the IDA will be able to carry out its new environmental authorities and to what extent this new development will affect industry's environmental compliance and the quality of the environment in Egypt.

A new waste management law *(Law No. 202 of 2020)* was also recently promulgated to establish a new legislative and institutional framework for managing waste in Egypt. It also establishes a new Waste Management Regulatory Agency and transfers the competencies of the Environmental Affairs Agency related to waste management to this body, which reports to the Minister of Environment as an economic agency.

According to the Constitution, the legislative framework for the protection of the environment in Egypt also includes other international obligations within the scope of Egypt's membership in many bilateral, regional, and global environmental conventions, which developed significantly between the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (the Rio Earth Summit) and the United Nations Climate Change Conference in Paris in 2015. The development of the multilateral environmental convention system played a significant role in the inclusion of many environmental issues in the relevant laws of Egypt. The Ministry of Environment's responsibilities, and those of the Environmental Affairs Agency, were expanded to include many issues that have historically been included under the jurisdiction of other line ministries. These include water quality, environmental health, waste management, industrial pollution, public awareness of environmental risks, and many other similar issues. This has led to a growing need for coordination to avoid overlaps in governmental institutions' responsibilities and inconsistency in the formulation of public policies.

5.1.2 Institutional organization of environmental affairs

The institutional organization of environmental management in Egypt began in 1982 with the establishment of the Environmental Affairs Agency as the authority responsible for promoting and protecting the environment. In 1994, the Agency was re-established, per the Environmental Protection Law *(Law No. 4 of 1994)*, giving it public judicial status under the then-Minister for Environmental Affairs, who chairs its board of directors. The general objectives of the Environmental Affairs Agency are the protection of the environment and public health, and promotion of various environmental activities at the national level by mainstreaming environmental issues into all national policies, plans, and programmes. Given its coordinating role among all ministries, the Agency has been placed under the responsibility of the Cabinet. It was envisaged that the Agency's board of directors would be the leading entity within the Environmental Affairs Agency and would constitute a mechanism through which it could coordinate with other line ministries the mainstreaming of environmental considerations in sectoral development plans. As the delegated representatives of the ministries did not have the authorities needed to perform this role, there was an immediate necessity for a Ministry of Environment to play this role at the Cabinet level. Accordingly, the Ministry of Environment was established in order to fill this gap, and attempts to coordinate, formulate environmental policies, and control and monitor various environmental issues and indicators.

5.2 Cost of environmental degradation and its developmental impact

Egypt ranked 94th out of 180 countries on the 2020 Environmental Performance Index, scoring 43.3 out of a total of 100 points.[1] Egypt came ahead of Morocco (42.3 points), and South Africa (43.1 points), but behind other Middle Eastern and North African countries such as Tunisia (46.7 points) and Lebanon (45.4 points). This ranking was achieved due to improved air quality indicators, drinking water and sanitation services, low rates of greenhouse gas emissions due to energy policy reforms, expanded use of renewable energy, and improved energy efficiency. Despite the reforms, air, water, and soil pollution remain persistent problems which negatively affect the environment in Egypt. A World Bank report stated that the estimated cost of these effects on health was equivalent to 2.5 percent of Egypt's GDP in fiscal year 2016/2017.[2] The cost of ambient air pollution caused by particulate matter of less than 2.5 micrometres in diameter (PM2.5) in Greater Cairo was the highest, at an average of EGP 47 billion, equivalent to 1.35 percent of GDP. The cost of inadequate drinking water, sanitation and hygiene reached EGP 39 billion, equivalent to 1.15 percent of GDP.

Over the past few decades, the world has witnessed both a decline in infectious diseases and a considerable rise in diseases caused by the deterioration of the quality of the environment. The World Health Organization (WHO) estimates that environmental deterioration was the cause of 420,000 premature deaths in the Arab region, equivalent to about 20 percent of all deaths. Environmental deterioration has led to cardiovascular diseases, diarrhoeal diseases, respiratory infections, and cancers. The most significant environmental causes of these diseases include the deterioration of air quality, lack of access to clean water and sanitation services, and exposure to waste and harmful chemicals.

Goal 3 of the SDGs aims at ensuring healthy lives and promoting well-being for all by 2030. Achieving this goal calls for addressing the burden of environment-related diseases, as environmental exposure is deemed one of the main determinants of human health. Moreover, the environmental impact on public health will become more important in the future, with increasing rates of urbanization, which is often characterized by heavy traffic, air pollution, poor housing conditions, limited access to water and sanitation services, noise pollution, as well as other challenges, particularly climate change and loss of biological diversity.

5.2.1 Air pollution and public health

The main health risks resulting from exposure to ambient air pollution with particulate matter (PM2.5), as assessed by WHO and the Global Burden of Disease project, are cardiovascular disease, respiratory disease, and mortality and morbidity from lung cancer. In this case, the risk of disease is considered relative, meaning that disease risk is proportional to exposure to ambient air pollution with particulate matter (PM2.5).

According to Table 5.1 below, the average annual premature deaths due to exposure to ambient air pollution with particulate matter (PM2.5) in Greater Cairo are estimated at 12,600 deaths. Approximately 59 percent of the estimated deaths from exposure to ambient air pollution with particulate matter (PM2.5) are attributed to ischemic heart disease (IHD), 14 percent to acute lower respiratory tract infections (ALRI), 13 percent to stroke, and 14 percent to chronic obstructive pulmonary disease (COPD), lung cancer and type 2 diabetes. These estimates are based on the annual average exposure to ambient air pollution with particulate matter (PM2.5), estimated at 76 micrograms per cubic metre ($\mu g/m^3$).

Table 5.1 Health effects from exposure to ambient air pollution (PM2.5) in Greater Cairo, 2017		
Health effects	Average excess deaths	Average number of days lived with disease (millions)
Ischemic heart disease (IHD)	7,437	5.9
Stroke	1,601	8.6
Chronic obstructive pulmonary disease (COPD)	912	77.8
Lung cancer	262	0.11
Acute lower respiratory tract infections (ALRI)	1,701	6.2
Type 2 diabetes	655	151.3
Total	12,569	249.9

Source: (World Bank 2019).

In addition to deaths, ambient air pollution with particulate matter (PM2.5) in Greater Cairo is estimated to have caused about 250 million sick days during 2017. Type 2 diabetes accounts for the most significant proportion of these effects (about 60 percent of sick days), followed by COPD with 32 percent. The large number of days people spend sick each year is due to the chronic nature of most health effects. For example, a person who develops COPD or diabetes suffers from the disease all through the year. The annual cost of the health impacts of ambient air pollution with particulate matter (PM2.5) in Greater Cairo was estimated at EGP 45-48 billion in 2016/2017, with an estimated average of EGP 47 billion. This is equivalent to 1.3-1.4 percent of 2016/2017 GDP, with an average of 1.35 percent (table 5.2).

Table 5.2 Estimated costs of health effects from exposure to ambient air pollution (PM2.5) in Greater Cairo, 2016/2017 (EGP billion)			
	Low estimate	Average estimate	High estimate
Cost of deaths	36.9	38.3	39.5
Morbidity Cost	8.5	8.7	8.8
Total cost of health effects	45.4	47	48.3
Percentage of GDP	1.31	1.35	1.39

Source: (World Bank 2019).

It is worth mentioning that the World Bank conducted a similar study in 1999, and a comparison of the results with the latest study in 2017, suggests that the air quality in Cairo has improved, as the number of deaths and health costs due to air quality have decreased. Table 5.3 provides a comparison between the results of the two studies.

Table 5.3 Health effects and costs of air pollution in Egypt, 1999 and 2017				
Health effects and costs of air pollution	1999		2017	
	Greater Cairo		Greater Cairo	
	millions	%	millions	%
People exposed (in millions and in % of population)	11.9	17.63	17.3	17.95
Annual micro particulate matter (PM10) (µg/m3)	270			
Annual micro particulate matter (PM2.5) (µg/m3)	110		76	
Annual deaths due to micro particulate matter	18,924		12,569	
Micro particulate matter cost (percentage of GDP)	2.1		1.35	

Source: World Bank (1999), World Bank (2019).

5.2.2 Water pollution and public health

Controlling and monitoring water pollution in the Nile River is one of the areas in which Egypt has made significant progress. Twenty-one monitoring stations have been established to monitor the quality of the Nile water and the quality of industrial wastewater directly discharged into it. The number of monitoring stations is expected to reach 95 by 2030. In addition, there has been a significant decrease in facilities that discharge their wastewater into the Nile, especially sugar and paper production facilities, from 27 facilities to nine.It is estimated that 98 percent of the Egyptian population have access to an improved source of drinking water.[3] However, there is a clear discrepancy in provision of sanitation services between urban and rural residents. Sanitation services are available to 92.2 percent of urban households, compared to only 47 percent in rural areas.

However, over the past four years, 80 sanitation projects, covering 414 villages, have been completed at EGP 9 billion. Furthermore, sanitation services are planned to cover 100% of the rural population by 2030 at a total cost of EGP 200 billion.[4]

The World Bank has assessed the health effects and costs resulting from lack of drinking water and sanitation in Egypt, finding that they generated an average of 2.8 billion sick days, and around 8,200 deaths during 2017, as shown in Table 5.4. These results undoubtedly reflect the necessity of the projects undertaken by Egypt to increase sanitation and drinking water services coverage.

Table 5.4 Number of deaths and the days during which people suffer from disease due to the lack of water and sanitation, 2017		
Health effect	Average number of days during which people suffer from disease (millions)	Average deaths
Diarrhoeal	352	4,890
Typhoid/paratyphoid	0.34	193
Schistosomiasis	476	308
Intestinal nematode infections	1,950	0
Trachoma	20	0
Acute lower respiratory tract infections (ALRI)	1.58	433
Total	2,799	8,171

Source: World Bank (2019).

The average annual cost of health effects associated with insufficient drinking water and sanitation is estimated at EGP 39 billion (Table 5.5). This cost is an average of 1.14 percent of GDP in fiscal year 2016/2017.

Table 5.5
Costs of health effects of water and sanitation shortages, 2016/2017 (EGP billion)[1]

	Low estimate	Average estimate	High estimate
Cost of deaths (EGP billion)	20.2	20.2	28.1
Morbidity costs (EGP billion)	19.2	19.2	27.9
Total cost of health effects (EGP billion)	39.4	39.4	56
Percentage of GDP	0.75	1.14	1.61

Source: World Bank (2019).

5.3 Key environmental challenges

Given the huge population and economic growth resulting from the production of large quantities of waste, Egypt faces many environmental problems caused by air, water, and soil pollution. In addition, this situation puts great pressure on Egypt's limited natural resources. Due to the limited economic opportunities and poor infrastructure conditions in some areas, Egypt has witnessed an increase in rural-urban migration, which places additional strains on the urban environment.

5.3.1 Air quality

Air pollution is considered to be one of the major environmental challenges in Egypt given its significant negative impact on public health. Particulate matter, particularly PM2.5, is the outdoor air pollutant globally associated with the greatest health impacts, as explained above. In response to the growing evidence of health effects with very low PM2.5 concentrations, WHO has lowered its decade-long guideline to an average annual concentration of 10 micrograms per cubic metre of PM2.5 and 20 micrograms per cubic metre of PM10.

The national network for monitoring air quality at the Environmental Affairs Agency consists of 108 stations, as shown in Table 5.6.

Table 5.6
Air quality monitoring stations in Egypt

Greater Cairo	Alexandria	Nile Delta	Upper Egypt	Sinai and Suez Canal cities	Total
52	9	18	20	9	108

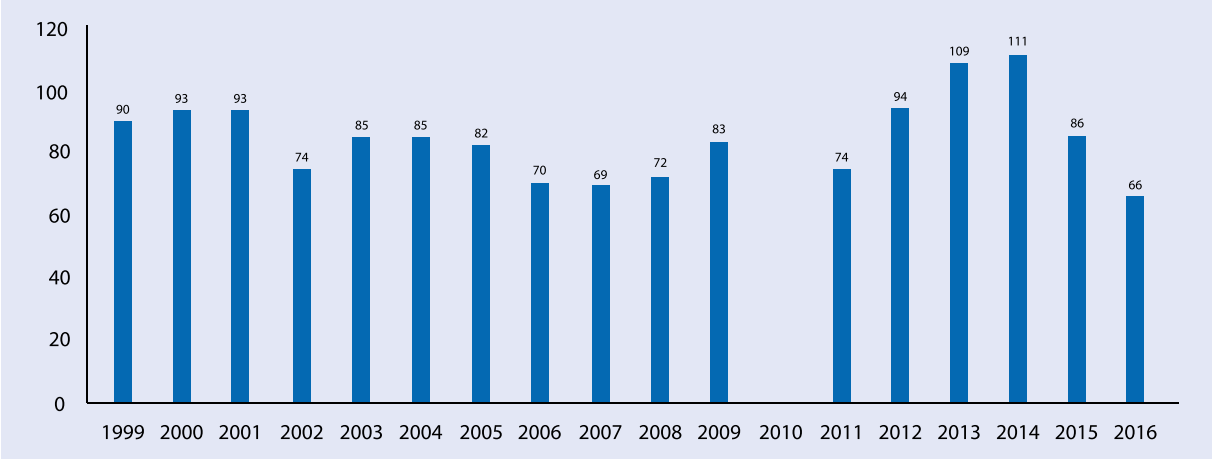
Source: Environmental Affairs Agency (2021).

The Greater Cairo area is the largest urban and industrial centre in Egypt, with more than 20 million inhabitants, and is surrounded by major heavy industries to the north and south. It is also surrounded by the four largest solid waste disposal sites in Egypt, which produce about 9.5 million tonnes of solid waste annually. It also has the largest number of vehicles on its roads, including 1.4 million private passenger cars and hundreds of thousands of taxis and trucks, all of which use the country's largest road network, extending over 10,000 kilometres.[5] Air pollution constitutes a chronic problem in Cairo due to the growing population, uncontrolled rural migration, rapid urbanization, and the presence of a large number of publicly owned chemical, metallurgical, and other heavy industries near residential centres. This is in addition to lack of proper management of solid materials and agricultural and hazardous waste. These problems have been increased due to the inefficiency of the relative administrative structures.

1 Including the cost of general cleaning.

The annual average of ambient air pollution with PM2.5 in Greater Cairo is much higher than the guidelines set by WHO for air quality. Figure 5.1 shows the average concentration over 18 years of 84 micrograms per cubic metre with the lowest concentration of 66 micrograms per cubic metre in 2016, which far exceeds WHO's standards.[6] Furthermore, it was found that open burning of different types of waste, vehicle emissions, and suspended particles are the most common sources of particulate matter emissions in Greater Cairo.

Figure 5.1 Average annual concentrations of PM2.5 in Greater Cairo (microgram per cubic metre)



Source: World Bank (2019).

As expected, air pollutants decreased in many cities around the world during the shutdown period of the COVID-19 pandemic, amid restrictions on various kinds of activities and the low demand for transportation. For example, nitrogen dioxide concentrations decreased by 50 percent and 62 percent in Barcelona and Madrid respectively during March and April 2020.[7]

The major sources of air pollution are also directly related to greenhouse gas emissions. As a party to the United Nations Framework Convention on Climate Change (UNFCCC), Egypt is committed to reducing greenhouse gas emissions. It has already articulated its Nationally Determined Contributions (NDCs), which highlight the importance of reducing emissions. The NDCs state that the objective is "to develop and implement a robust and economically viable mitigation programme that achieves targeted reductions for emissions by 2030."[8] The urgent priorities include the establishment of a national emission monitoring, reporting and verification system. In addition, Egypt is developing several programmes that address climate change as part of its Sustainable Development Strategy: Egypt Vision 2030, including improving policies and infrastructure to reduce air pollution and combat climate change. Given the commonalities in addressing emissions of both particulate matter and greenhouse gases, it is expected that measures such as improved control of emissions, and the procedures adopted to control air pollution, will result in significant co-benefits in terms of the mitigation of its effects, especially on the climate side, in line with national and international objectives.

5.3.2 Shared water resources: Adapting to water scarcity

Egypt depends on the Nile River for an estimated 97 percent of its freshwater resources, which makes the country's water security highly vulnerable to any developments in upstream countries, including the potential impacts of climate change. The average annual precipitation in Egypt is estimated at 18 millimetres a year and ranges from 0 millimetres per year in the desert areas to 200 millimetres per year in the northern coast re-

gion. Egypt also receives 55.5 billion cubic metres of Nile water annually. The total water resources currently available for use in Egypt amount to 59.6 billion cubic metres per year. Water use amounts to 80.25 billion cubic metres per year, in addition to food imports amounting to 34 billion cubic metres. The gap between current needs and water availability is filled by seawater desalination, agricultural wastewater reuse, shallow groundwater, and treated wastewater.[9]

Under the 1959 Nile Waters Agreement between Egypt and Sudan, 55.5 billion cubic metres per year of Nile water flows into Egypt. The Agreement calculated that the average flow of Nile waters during the period from 1900 to 1959 amounted to 84 billion cubic metres per year, and the evaporation rate of Lake Nasser and other losses were about 10 billion cubic metres per year, leaving a net flow of 74 billion cubic metres per year. About 18.5 billion cubic metres per year of this quantity was allocated to Sudan and 55.5 billion cubic metres per year to Egypt.

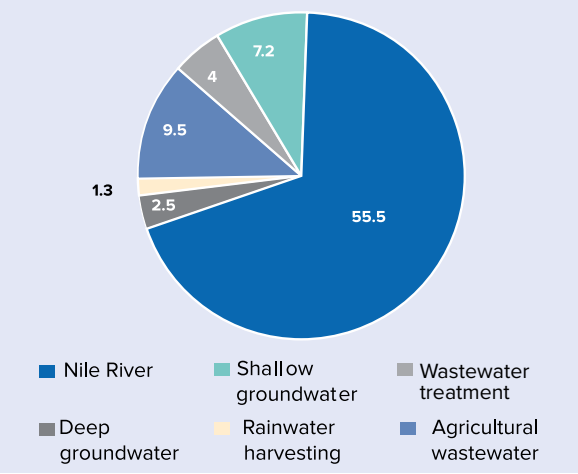
The Aswan High Dam is the main storage facility on the Nile. It began operations in 1968, ensuring Egypt's control over the annual flood waters and directing their use. The construction of the Aswan High Dam led to the formation of Lake Nasser, which is 150 kilometres long, with an average width of 12 kilometres and a depth of 180 metres, making it the largest artificial lake in the world. Lake Nasser is of great importance to Egypt's fishing industry, producing about 15,000-25,000 tonnes of fish annually. However, the lake has a high evaporation rate, losing about 10-11 billion cubic metres of water each year.

Elsewhere in Egypt, there are a number of other lakes. Sewage water feeds the natural Lake Qarun in the Fayoum Depression, which increases its salinity. Excess wastewater also feeds the lakes of Wadi El-Rayan, having been diverted there since 1973, resulting in two interconnected lakes. Furthermore, the Suez Canal connects to the Red Sea through Lake Timsah and the Bitter Lakes at the Gulf of Suez. Finally, on the Mediterranean coast, there are several lakes: Mariout, Idku, Manzala, Burullus, and Bardawil. These last two lakes, along with Qarun and Wadi El-Rayan, are among the four sites classified as wetlands of international Importance under the Ramsar Convention.[10]

It should be noted that Egypt has created the National Lakes Development Project which aims to maximize the utilization of natural resources, enhance economic return, and rationalize government spending by integrating government activities and optimal use of available expertise and capabilities. The goal is to improve water quality, treat pollution sources, restore the ecosystem, and increase the production of fish. Furthermore, the project aims to regulate and improve fishing controls, increase the efficiency of fishing workers, and improve their working conditions. An organizational structure for managing the National Lake Development Project has been developed and an integrated legal and structural framework has been drafted for its management. The Ministry of Water Resources and Irrigation (MWRI) also injects freshwater into these lakes and to preserve ecological balance and wildlife.[11]

Figure 5.2 shows the water resources available to Egypt in 2017. The Nile River makes up the largest portion, providing 69.2 percent of the total water resources available, which amount to 80.25 billion cubic metres in 2017.[12]

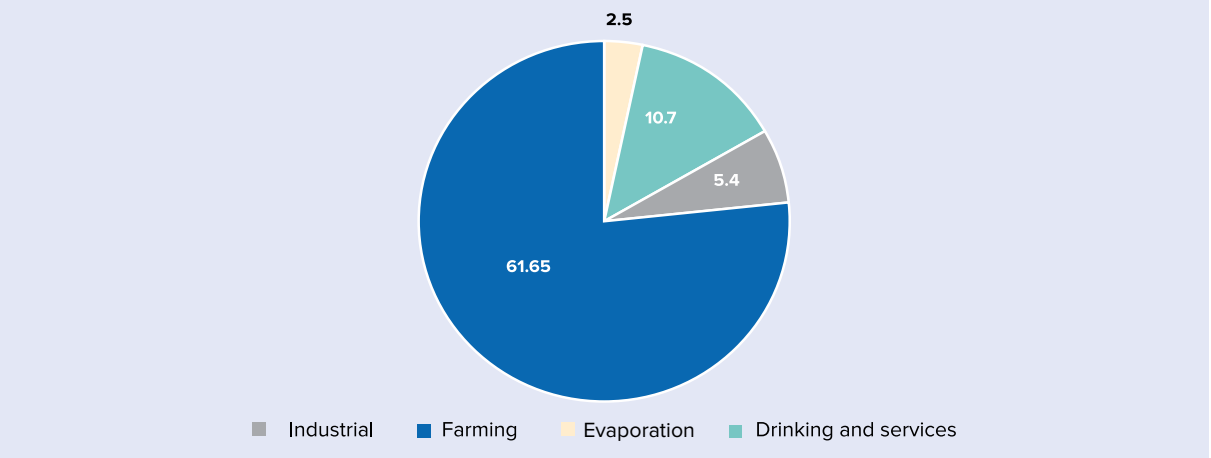
Figure 5.2 Available water resources in Egypt, 2017 (in billion cubic metres per year)



Source: Ministry of Water Resources and Irrigation

Agriculture is the sector that consumes the most water in Egypt, using approximately 3.738 million hectares (Figure 5.3).[13]

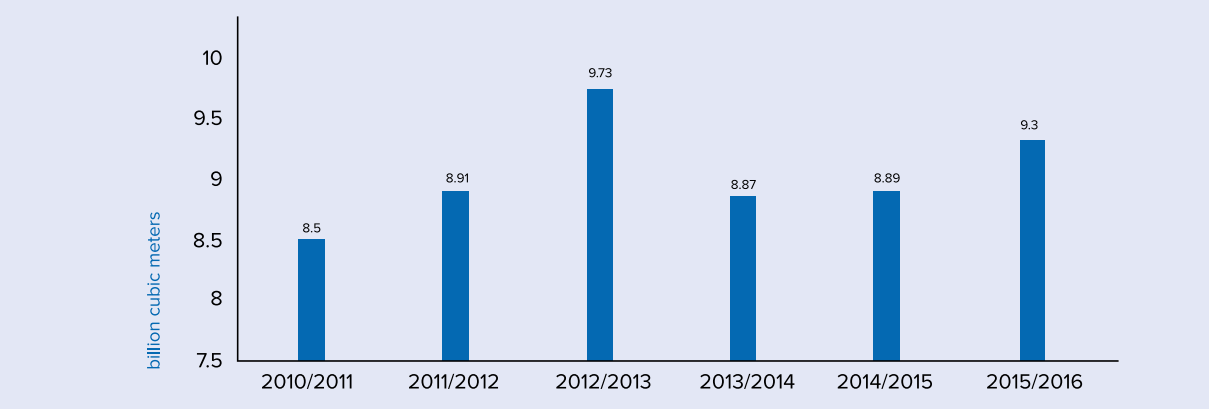
Figure 5.3 Water uses in 2017 (in billion cubic metres)



Source: Ministry of Water Resources and Irrigation

Drinking water production increased from 8.505 billion cubic metres in 2010/11 to nearly 10.7 billion cubic metres in 2016/2017 (Figure 5.4) to cover 98 percent of the population in urban areas and 95 percent in rural areas. Due to the limited resources available, the average availability of freshwater per capita in Egypt steadily decreased from about 900 cubic metres per capita in 2000 to 640 cubic metres per capita in 2015. Given the rate of population growth, it is expected that the per capita share will drop to less than 500 cubic metres by 2030, which will be below the absolute water scarcity limit.[14]

Figure 5.4 Production of drinking water (billion cubic metres)



Source: Center for Environment and Development for the Arab Region and Europe (CEDARE), 2019.

Table 5.7 indicates that the average share per capita of all possible freshwater resources will decrease in Egypt over time due to population growth, increasingly limited resources, and climate change. Moreover, the data indicates that Egypt has already entered the phase of water scarcity. This means that there will be an increased dependence and an urgent need to use non-conventional water resources, such as recycled agricultural wastewater, treated wastewater, and desalinated seawater. It also means that it is crucial to raise public awareness and adopt very strict environmental measures and regulations to maintain minimum water quality standards.[15]

Egypt has created a strategic plan to expand the establishment of seawater desalination plants to meet drinking water needs, divided into six five-year plans extending from 2020 to 2050. The goal is to provide a total capacity of 6.4 million cubic metres per day, and the expected total cost of the project is EGP 134 billion. The first five-year plan (from 2020 to 2025) covers the establishment of desalination plants with a total capacity of 2.866 million cubic metres per day in the governorates of Matrouh, Red Sea, South Sinai, Ismailia, Port Said, Suez, Dakahlia, Kafr El-Sheikh and Beheira.[16]

Table 5.7

Projected per capita share of freshwater resources through 2050

Year	2018	2025	2030	2037	2050
Annual per capita water (cubic metres)	585	496	444	387	303

Source: Ministry of Water Resources and Irrigation (2013).

An imminent challenge related to the Nile River and the Nile Delta is the construction of the Grand Ethiopian Renaissance Dam on the Blue Nile. This tributary of the Nile contributes much of the water that flows to Egypt. Although Egypt did not participate in the planning or implementation process of the dam, it has agreed to cooperate with Ethiopia and with Sudan, which is also downstream of the dam, by delegating international consulting firms to conduct the necessary technical studies to assess its design and its impact on downstream countries. However, these studies have not yet been completed due to differences in the initial report. Egypt has emphasized that any progress in the construction and filling of the dam must be based on consensus among the three countries regarding the dam's design, its impact on Sudan and Egypt, the filling of the reservoir, and the rules for its operation. Reaching an agreement concerning this issue is deemed an important component of Egypt's endeavours to achieve the SDGs, including ensuring the availability of water and sanitation (Goal 6).

It is expected that the process of filling the dam's reservoir will seriously affect the availability of water in Egypt and reduce the country's per capita share, thus affecting various economic activities, especially if Ethiopia fills the dam's reservoir in a manner that Egypt deems "uncooperative". For example, if the filling process takes five years, as Ethiopia has said it will, the cumulative water shortage rate at the Aswan High Dam will increase to 92 billion cubic metres, distributed over several years. Likewise, the water level in Lake Nasser will soon drop to 147 metres, making it impossible to compensate for the water lost.

Moreover, the filling and operation of the Grand Ethiopian Renaissance Dam will affect the hydroelectric power production of the Aswan High Dam. For example, if the filling process of the dam takes five years, the cost associated with the decline in the hydroelectric power production of the Aswan High Dam 10 years after the filling process will reach about $4.16 billion, which would hinder Egypt's ability to provide reliable and sustainable energy services to all people at an affordable cost (per Goal 7 of the SDGs).

Water in Egypt is used to produce 12,726 gigawatt hours (GWh) of hydroelectricity, according to 2017/2018 data, representing 6.5 percent of the total electricity generated. The total hydroelectricity capacity is 2,832 megawatts (MW), and the Aswan High Dam produces the largest share,[17] as shown in Table 5.8.

Table 5.8
Hydroelectricity power stations

Hydroelectricity plant	Installed capacity (MW)	Year operations began
Aswan High Dam	2,100	1967
Aswan Dam (1)	280	1960
Aswan Dam (2)	270	1986
Esna	86	1993
Nag Hammadi	64	2008
Assiut	32	2018

Source: Egyptian Electricity Holding Company, 2017.

The water quality of the Nile River is mostly good compared to national standards. The quality of surface water and groundwater in Egypt is monitored via the monitoring and follow-up systems of a number of ministries:

- The Ministry of Water Resources and Irrigation's network consists of 232 sites for monitoring surface water located on the Nile, along canals, and at main drains, as well as 203 sites to monitor groundwater quality.
- The Ministry of Health and Population's network consists of 154 sites for monitoring water quality along the Nile, including its two branches and some of its main canals, in addition to 20 sites in Fayoum governorate along Bahr Yusuf Canal.
- The Environmental Affairs Agency's network consists of 69 monitoring sites on the Nile.

According to the Environmental Affairs Agency, several gaps must be addressed to improve the efficiency of this system. These issues include:[18]

- Focusing only on conventional water quality parameters, such as total dissolved solids, chemical and biological oxygen requirements, and not providing any data on micro-pollutants (pesticides, heavy metals, hydrocarbons);
- Focusing on the traditional analysis of water only, and not analysing sediments, fish, and living organisms to indicate the presence and concentrations of micro-pollutants;
- An urgent need for coordination between the monitoring and control protocols (sampling techniques, measurement methods, quality assurance methods, etc.) across different ministries to support comparisons between data received from different ministries and verify their accuracy;
- The need for more cooperation between ministries to share monitoring data to maximize the benefits.

It may be necessary to consider integrating the various components of this system under a unified national system for monitoring and controlling water quality. This system should be capable of producing reports on water quality at the national level.

To protect freshwater from pollution in general and industrial effluents in particular, the Environmental Affairs Agency applies a pro-

gramme to enforce the law and compel industrial establishments to comply. The programme focuses on separating industrial effluents from domestic sewage water. The programme applies the Law on the Protection of the Nile River and Water Channels Against Pollution *(Law No. 48 of 1982)* so that the industrial wastewater discharged into water bodies conforms to the environmental standards stipulated in the law. There are around 129 industrial establishments along the Nile River or its branches, including 102 industrial establishments that directly or indirectly drain wastewater into the Nile at a rate of approximately 2 billion cubic metres per year.

About 75 of these establishments have completely stopped discharging their waste into the river, removing a total quantity of 547 million cubic metres, while other establishments are draining their wastewater in accordance with *Law No. 48 of 1982* and *Law No. 4 of 1994* for the Protection of the Environment. Companies that violate the law are obligated to implement an action plan for environmental compliance, and legal measures have been taken against violators.[19] In parallel, a programme financed by the World Bank, the European Investment Bank, and other development partners has provided technical and financial support to industrial establishments to help them implement environmental compliance action plans (see box 5.1.

Box 5.1 The Egyptian Pollution Abatement Project (EPAP)

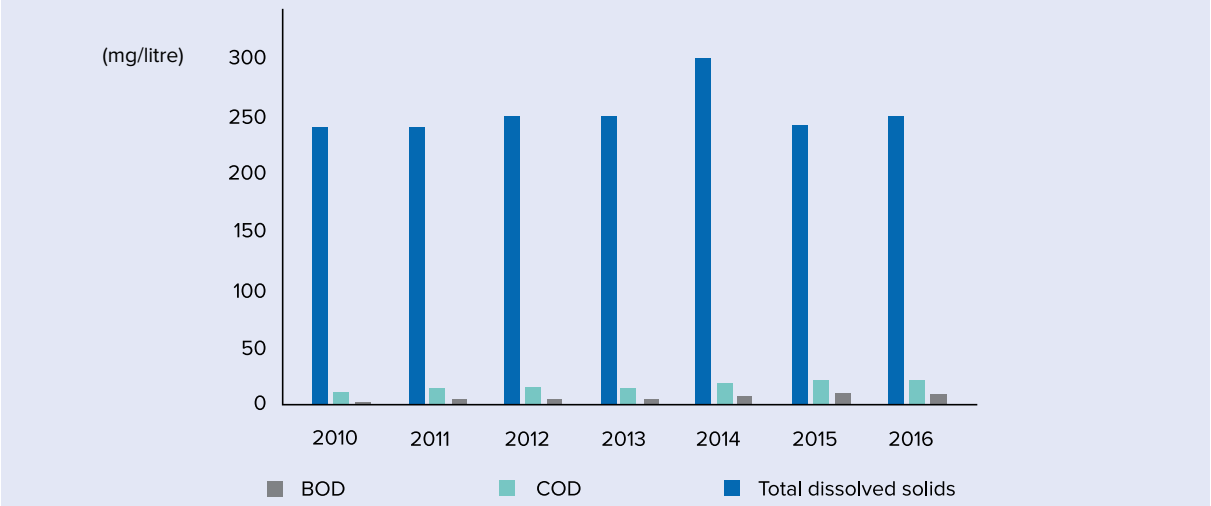
In cooperation with a set of development banks, including the World Bank, the International Bank for Reconstruction and Development, the European Investment Bank, the French Development Agency, the Japanese International Cooperation Agency, the German Development Bank, and the European Union, the Environmental Affairs Agency and the National Bank of Egypt developed and implemented a financing system for industrial pollution control. The programme was implemented in three phases, with a total funding of around $208 million (or €160 million).

This mechanism provided attractive financing for industrial establishments and represented a strong incentive for pollution-causing companies to comply with environmental legislation. The project offers end-users a financing package on concessional terms, 20% as a grant and 80% as a commercial loan. If the implementation is satisfactory according to the evaluation of the Environmental Affairs Agency, the beneficiary company pays back the amount of the commercial loan to the National Bank of Egypt, and the remaining 20% is considered a grant based on good performance. These benefits have led to a noticeable decrease in the amount of pollution emitted by these companies.

Source: Samir Mowafi and Maysoon Ali, EPAP Project Team.

Figure 5.5 presents the water quality standards in Greater Cairo, according to the water quality monitoring and control stations of the Ministry of Health and Population. It shows the deviations of chemical oxygen demand (COD) from national standards post 2013.[20] Moreover, water quality measurements in Lake Nasser are within the permissible limits: in 2016, COD was 9.6 milligrams per litre (mg/L) and biochemical oxygen demand (BOD) was 5.5 milligrams per litre.[21]

Figure 5.5 Water quality standards in Greater Cairo area (milligram/litre)



Source: CAPMAS (2018).

As part of efforts to achieve the 2030 strategy, Egypt plans to implement various projects that ensure the efficient use of water resources, increase the availability of freshwater resources, and improve water quality. These efforts include: expanding water reuse; lining and covering canals and water channels, in order to maintain the quality of reused water, protect the environment from pollution, and maintain public health; developing irrigation methods to reduce water losses and increase productivity; and the expansion of seawater and groundwater desalination, as stated above.

It is worth noting that the Egyptian government implemented a national project to renovate and line worn out canals and increase their efficiency. This project aims at overcoming the challenges related to the poor access of water at the ends of the canals, which has affected irrigation, agricultural productivity, and the standard of living of farmers, as well as having a negative impact on the environment and the health of living organisms. The project aims to maximize water resources by rationalizing their use, solving problems of water delivery to the ends of canals, and achieving justice in its distribution, thus increasing agricultural productivity and ending the problems facing farmers. In addition, the project is labour-intensive and the resulting job opportunities will reduce unemployment, which may reduce the rate of migration abroad. It will also create spaces on both sides of the canals, improving the capacity of the roads alongside, in order to accommodate the movement of vehicles and reduce the growth of weeds. The project aims at lining 20,000 kilometres of canals in 20 governorates over four years.[22]

The key strategic goal of Egypt's Water Development and Management Strategy 2050 is to achieve water security based on an integrated water resources management approach. The approach is based on four pillars: 1) developing conventional and non-conventional water resources; 2) conserving water and maximizing water use in agriculture, industry, and homes; 3) improving water quality; and 4) enhancing the enabling environment for the integrated management of water resources. The strategy also takes into account the impacts of climate change on water resources, which include: changes in rainfall that will affect the flow of water into the Nile River; sea water level increases that will negatively affect the Nile Delta, including via soil salinization and low crop productivity; the potential increase in water evaporation, which will reduce the availability of water; and increased demand for water in the agricultural sector.[23]

5.3.3 Solid waste management

Waste management has always been a major environmental issue in Egypt. The increasing rates of waste production can be attributed to population growth, changes in consumption patterns, changes in waste characteristics, the low level of technology used for waste disposal, and a lack of sustainable financing. Moreover, the diversity of waste sources and high rates of hazardous waste, electronic waste, and construction and demolition waste increase the complexities involved in waste management, which exceeds the capacity of many local authorities regarding financing, technology, and institutional authority. These challenges have caused unprecedented negative repercussions on quality of life, human health, freshwater resources, and the local environment. Furthermore, with the exponential growth of the population, solid waste also increases, exacerbating these existing problems.

Reliable data on solid waste generation and its components are scarce, and data collected from different sources are inconsistent, making it difficult to determine the true scale of this challenge. Based on the available data, Egypt produces about 90 million tonnes of solid waste annually, including 20 million tonnes of municipal solid waste (shown in Table 5.9). Only about 64 percent of the total municipal solid waste is collected, while the rest is sent to illegal landfills.[24]

Despite efforts made at all levels, such as efforts made by cleaning authorities, local level authorities and some private sector companies and informal sector, there is a long way to go on addressing solid waste management problems. Both transition from a linear economy to a circular economy, along with the promotion of sustainable consumption and production patterns should be considered, in order to reduce the amount and nature of the waste generated. Any management system must consider all components of the hierarchy system for waste management, including its collection, transportation, recycling, and treatment until final disposal. In addition, the waste management structure must be reformed to adopt the "polluter pays" principle, to enhance financial sustainability, strategic planning and decentralization, to build local authorities' capacities, to establish market incentives, and to encourage private sector participation.

Table 5.9

Production of solid waste, 2001 - 2016

Waste Type	Quantity (million tonnes)			
	2001	2006	2012	2016
Municipal waste	14.5	17	21	20
Building and demolition waste	3.5	4.6	4	5.8
Agriculture waste	23.5	27.5	30	31
Industrial waste	4.25	4.75	6	4.9
Hazardous waste				0.54
Health care waste	0.12	0.15	0.28	0.52
Sludge and mud	1.75	2	3	2
Dredging waste	20	30	25	25
Total	67.12	86	89.28	90.76

Source: Environmental Affairs Agency (2016), Ministry of State for Environmental Affairs (2013).

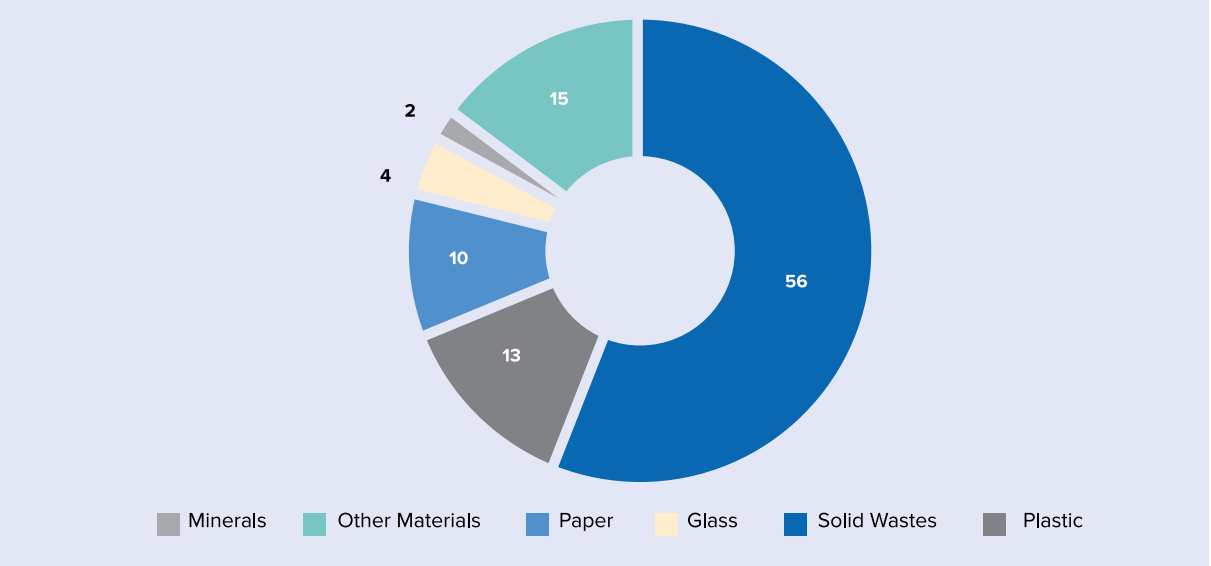
Efforts to regulate, legalize, support, and promote the waste-collecting community have been stalled for decades. Moreover, enhancing the capacity to enforce the law would reduce illegal practices of managing hazardous industrial and medical waste. Furthermore, there is an urgent need to address the perpetual problem of the lack of data on solid waste. Hence, using an electronic information system can be an effective tool for the availability of reliable data and essential information to policymakers, service providers in the private sector, and the public.

Municipal solid waste

The amount of solid waste generated varies according to the standard of living in any society. In Egypt, it is estimated that the waste generation rate ranges from 0.03 kilograms per capita per day in rural areas to 0.8 kilograms per capita per day in Cairo. However, this rate can reach 1.5 kilograms per capita per day in hotels and tourist resorts. These rates are relatively low and are similar to those in many other developing countries.[25]

The composition of municipal waste is shaped by factors such as socioeconomic status, consumption and production patterns. Low-income populations produce the largest amount of organic waste (mainly food). Paper, plastic, and other solid materials constitute the highest proportion of waste in high-income categories of the population in urban areas. Figure 5.6 shows the composition of municipal solid waste in Egypt, which reveals a high percentage of organic substances. Wet organic waste can be reduced or converted into beneficial organic products, such as organic fertilizers (compost) or soil conditioners, or used for energy production and animal feed.

Figure 5.6 Composition of municipal solid waste in Egypt (%)



Source: World Bank (2002).

The major adverse environmental impacts of improper solid waste management lie in the inappropriate or incomplete collection and restoration of non-recyclable items and the combined disposal of hazardous waste without first being separated. The population with access to reliable waste collection services in Egypt is between 40 and 80 percent, which leads to the accumulation of waste in the streets, the filling of rubbish bins in cities, and the emergence of illegal landfills and open burning. All these issues have severe prob-

lems for the environment and public health. The decomposition of organic substances produces methane, which can spontaneously ignite and cause fires or explosions. Furthermore, these substances contribute to greenhouse gas emissions. The biological and chemical processes within open landfills often produce large amounts of leachate that pollute groundwater. Fires also break out from time to time inside these open landfills, causing smoke that contributes to air pollution. In addition, food waste attracts birds, mice, flies, and other animals to landfills, and these pests may subsequently transmit diseases to humans living nearby.[26] Local solid waste management practices are considered to be poor and lead to adverse health effects, costing the Egyptian economy about 0.2 percent of GDP annually.[27]

It is worth noting that organic fertilizer production by open aerobic decomposition has been used for decades to treat the organic part of municipal solid waste. Sixty-five facilities for the production of organic fertilizer have been built by the government across Egypt since the 1990s, but there are only a few facilities currently in service. The performance of the now-closed plants was poor due to technical, financial, and operational factors and the use of mixed waste, which produces low-quality fertilizer. Another option for waste reuse is the production of waste-derived fuel, containing the organic components of municipal solid waste, such as plastics and biodegradable waste compressed into granules. In Egypt, waste-derived fuel is currently used, along with agricultural residues, as a non-conventional fuel in the cement industry. This fuel is effective, and as it is less carbon-intensive, it can generate revenues from the carbon on the global carbon market.

Moreover, the cement industry plays an important role in overcoming the waste challenge in Egypt. The municipal solid waste and agricultural residue problem can be solved by adopting a policy that obliges cement companies to use a percentage of waste-derived fuel and biomass fuel in their kilns. Conventional waste that can be used as an alternative fuel in cement kilns includes old tires, non-recyclable plastics, textiles and paper scraps, and sludge from water and sewage treatment plants.

Municipal solid waste disposal facilities are considered below the required standard, as only 2 percent of the country's waste is disposed of in valid and modern landfills. In 2011, the Environmental Affairs Agency identified 53 landfill sites. However, due to lack of resources, only a few of these landfills have been established. The Agency plans to establish 24 modern landfills in different governorates.

Waste management is a relatively complex process, as the responsibility for this process lies with a different set of ministries, governorates, and agencies. Responsibility for solid waste management is still divided between the Ministry of State of Environmental Affairs (represented by the Waste Management Regulatory Agency), the Ministry of Local Development, the Ministry of Housing, Utilities and Urban Communities, the Ministry of Health and Population, the Ministry of Irrigation and Water Resources, the Ministry of Agriculture and Land Reclamation, the Ministry of Trade and Industry, the Ministry of Finance, and the Ministry of Investment. This shared responsibility has led to overlapping in institutional roles and responsibilities, duplication of efforts, and weak accountability. The new Waste Management *Law No. 202 of 2020* has helped in defining the roles of the various entities operating in the waste management system at the national level.

Through the Environmental Affairs Agency, and recently through the Waste Management Regulatory Agency, the Ministry of Environment is developing a waste management policy and a tariff structure, while also enhancing the role of the private sector in waste management. In addition, it is working on providing guidance for the implementation of the national strategy for solid waste management and providing assistance to the Ministry of Local Development to develop plans for solid waste at the governorate level. Furthermore,

the Ministry plays a supervisory role in the enforcement of relevant laws. In addition, some international and national private companies, several small contractors, and cleaning agencies in some governorates collect the waste and transport it to treatment facilities.

The Ministry of Local Development is responsible for putting in place policies specifically related to municipal solid waste, and works directly with the governorates responsible for implementing these policies.[28] Local authorities provide collection services for municipal solid waste in most governorates, but these collection services in many cases lack good planning, the necessary resources, monitoring, and proper management. On the other hand, the involvement of the private sector in the Egyptian market has led to the emergence of many problems due to the weak capacity of local governments to manage private sector contracts.

Lack of funding for the formal municipal solid waste management system is a major problem. A Regional Network for the Exchange of Information and Experience report on solid waste management in the Levant and Maghreb networks found a funding gap of 35 percent between the cost of operating the existing municipal solid waste management system in Egypt and the revenue collected through the fees charged.[29] As a result, the local authorities were authorized to charge additional fees on electricity bills for collecting solid waste, in order to facilitate payments. The Electricity Authority pays the revenues collected to the local authorities to manage the waste at the local level. By contrast, illegal dumping of household waste is considered a way to avoid paying landfill fees.

It should be noted that the 2020 Waste Management Regulation Law reinforces a set of integrated principles for waste management, such as the “polluter pays” principle and the “extended responsibility of the producer” principle. The new law also reinforces the principles of reducing waste generation and the necessity of reusing and recycling waste. In addition, achieving financial sustainability for the system has been one of the most important challenges over the past years.

Waste management programmes should increase investment in communication, education, public awareness, and capacity-building. It has been proven that more success in waste management is achieved largely through public participation. To maximize participation, public acceptance must be achieved through appropriate communication between waste management service providers and the public. It is therefore necessary to include environmental education in school curricula to develop awareness at the public level. The Ministry of Environment is currently cooperating with the Ministry of Higher Education and the Ministry of Education and Technical Education to implement several initiatives to integrate environmental issues within schools and higher education institutions.

It is worth noting that Egypt has a complete informal sector of traditional waste collectors and recyclers. This sector, which consists of about 96,000 workers, provides many informal waste collection services, especially in Greater Cairo. Many workers in this sector also manage family-owned recycling companies, targeting specific materials (such as certain types of plastics, metals, textiles, etc.), which are then collected and sold to others in bulk or reprocessed on site into higher-value materials. Although recycling levels do not exceed 4 percent nationally, the informal sector has reached high recovery rates (up to 80 percent), as the recycling skill is essential to the livelihood of workers in this sector. Moreover, a few NGOs have emerged in the informal waste sector in recent decades which work to assist these informal workers. However, health and safety conditions are severely deteriorating in their workplaces.

The first step of the sustainable waste management hierarchy generally focuses on reducing the amount of waste generated. However, so far, little effort has been made to prevent and reduce waste production. All

over the world, waste management concepts have evolved from "downstream" waste management to more comprehensive resource management, i.e., from a linear economy to a circular economy in which materials are reused within the economic system to reduce waste production.

Hazardous waste

Like municipal solid waste, there is a lack of reliable information regarding the actual amount of hazardous waste generated in Egypt. The only facility to treat industrial hazardous waste in the country, Al Nasiriyah Hazardous Waste Treatment Centre, was established west of Alexandria in 2006. Furthermore, as a result of cooperation between the Republic of Korea and Egypt, the first facility for the treatment of mercury in fluorescent lamps was established in 2011 at Al Nasiriyah Hazardous Waste Treatment Centre. The facility consists of units for separating mercury, glass, metals, and other lamp components. In addition, two small waste incinerators were recently installed at the centre, used primarily for pharmaceutical waste.

In cooperation with the concerned authorities, and with the support of the World Bank, the Ministry of Environment has succeeded in disposing of 185 tonnes of equipment and oils contaminated with polychlorinated biphenyls (PCBs), and 241 tonnes of high-risk lindane that accumulated at Adabiya Port in Suez nearly 30 years ago, in addition to 471 tonnes of obsolete pesticides.

Electronic devices are considered another source of hazardous waste, as they are made up of hundreds of different substances that can be toxic, but are of high value. While the largest proportion of materials such as iron, aluminium, plastic, and glass represent more than 80 percent of the weight, there are smaller amounts of valuable and toxic materials. The proper recycling of hazardous materials, such as carcinogens like lead and arsenic, is necessary as they pose significant risks to health and the environment if not handled properly. A national committee has recently been formed to deal with this waste, and the number of electronic waste recycling factories in Egypt that are officially operating now numbers seven.

Hazardous medical waste is considered another source of health and environmental risk. It is estimated that about 28,000 tonnes of health care waste are collected annually and treated, mostly through incineration and sterilization. The main problems of medical waste management are concentrated in Greater Cairo, which produces nearly a quarter of all medical waste, and about 75 percent of this waste is not properly treated or disposed of, resulting in serious health and environmental risks. Untreated medical waste is mixed with municipal solid waste or illegally traded for recycling.

Hazardous medical waste is currently managed through three main systems, under the supervision of the Ministry of Health and Population and the Environmental Affairs Agency: 1) a government-run system in which medical waste is transported to incineration facilities located within public hospitals, which incinerates about 50 tonnes daily across the country; 2) a government system that relies on external sources affiliated to the private sector or private contractors to manage hazardous waste within public medical facilities; and 3) licensed private companies that collect, transport, and treat medical waste outside medical facilities centrally, with approximately 15 tonnes per day transported and treated at incineration and sterilization facilities.[30] The amount of health care waste is expected to increase significantly amid the COVID-19 pandemic.

5.4 Climate change: Challenges and opportunities

Egypt is considered an example of a country highly exposed to climate change, facing many risks to its economic, social, and environmental sustainability. Climate change is expected to increase the existing challenges related to the country's growing population and increasing demand for the limited resources.

Successive governments have recognized the threats of climate change to sustainability in Egypt since the Rio Earth Summit in 1992. Consequently, Egypt has been an active participant in global climate change efforts and has endeavoured to build its national capacities to address these threats at many levels. Egypt has presented three national reports to the United Nations Framework Convention on Climate Change secretariat. The fourth national report is currently being prepared. Egypt also issued a Nationally Determined Contributions report within the framework of its membership in the Paris Agreement.[31] As a result, Egypt was ranked among the group of countries with a moderate performance in the Climate Change Performance Index, and it advanced from 30th place in 2016 to 22nd in 2021, out of 57 countries whose combined emissions make up more than 90 percent of the world's total emissions.[32]

5.4.1 Vulnerability and effects

Egypt is highly vulnerable to the impacts of climate change, as outlined in the national reports under the United Nations Framework Convention on Climate Change[33], the 2007 UNDP Human Development Report[34], and as stated in the Fifth Assessment Report submitted by the Intergovernmental Panel on Climate Change (IPCC).[35] Projections clearly show that current and future changes in climatic conditions constitute a major environmental threat that will not only hinder the development path for Egypt, but also negatively affect poverty reduction strategies. The most vulnerable sectors and areas in Egypt include coastal areas, water resources, and agriculture and food security. Moreover, climate change will also cause severe damage to human settlements, large parts of the land designated for agricultural production, industrial areas on the northern coast, and touristic resorts on the Red Sea.

About 15 percent of the total population of Egypt lives in coastal areas, which are characterized by the diversity of their resources and abundance of potential for development. These areas represent a source of biodiversity and mineral resources and are vital for shipping and trade. It is expected that the coastal areas of the Nile Delta will be highly flooded as a result of sea-level rises. This could lead to soil subsidence at different rates, according to the terrain and geological features of the land. It is estimated that a sea-level rise above 0.5 metres will lead to permanent inundation of 1,800 square kilometres of the agricultural land in the low-lying areas of the Nile Delta and will accelerate soil salinity in the remainder.[36]

The Intergovernmental Panel on Climate Change estimates that, by 2050, the level of the Mediterranean Sea will rise by 1 metre due to global warming, resulting in the loss of a third of the highly productive agricultural land in the Nile Delta.[37] In addition to the loss of the populated and agricultural areas, it is expected that some industrial cities and cities of historical importance, such as Alexandria, Damietta, Rashid, and Port Said, will be inundated as a result of the sea-level rise. Moreover, threats to food security, damage to major investments in the tourism sector along the northwest coast, and the relocation of over 10 million people to the already densely populated Nile Valley region are among the expected impacts of this flooding. It is therefore expected to have a direct and serious impact on the overall Egyptian economy. For example, several studies conducted regarding the vulnerability of Alexandria, which is the second-largest city in Egypt, indicate that, in the event of a rise in sea levels of half a metre, 30 percent of the city will be inundated, which will lead to the relocation of nearly 1.5 million people or more, 195,000 job losses, and losses to land and property estimated at $30 trillion.[38]

Agriculture accounted for 12 percent of GDP in 2019, making it one of the most important sectors of the Egyptian economy. The agricultural sector provides food, textiles, and other products. It also supports the livelihoods of 55 percent of the population and provides jobs for 27.5 percent of the workforce. However, agricultural development in Egypt is impeded by many factors, including the scarcity of water resources. Moreover, land eligible for cultivation accounts for only

a small proportion of the total, and is located mainly in the Nile Delta. This, in turn, puts significant pressure on the growth potential for agricultural output. As most of the agricultural activity in Egypt is concentrated in the Nile Delta region, a sea-level rise is likely to affect agricultural productivity. The highly salinated water will likely penetrate large areas of the Delta, which will increase the possibility that the current agricultural land will become unsuitable for agricultural production. In addition, increasing temperatures and changing precipitation patterns will have different effects on main crops in Egypt. For example, cotton yields may rise by about 30 percent by 2100 due to the rising temperature effects, which will prolong the seasons suitable for its cultivation. Meanwhile, other crops such as wheat, rice, and maize will decrease by 11 to 36 percent over the same time period (Table 5.10). Agricultural yields may also be affected by changing plant pathogens due to changing rainfall patterns and increasing temperatures.[39]

Table 5.10
Expected changes in the productivity of key crops due to climate change (%)

Corps	Change %	
	2050	2100
Wheat	-15	-36
Rice	-11	
Maize	-19	
	-14	-20
Soybean	-28	
Barley	-20	
Cotton	+17	+31
Potatoes	-0.9 to -2.3	+0.2 to +2.3

Source: Ministry of Water Resources and Irrigation (2013).

To enhance the agricultural sector's contribution to the economy, Egypt aims to continue investing in land reclamation projects in order to increase the land available for agricultural production. In 2014, new plans were announced to reclaim 4 million acres of desert land, as part of Egypt Vision 2030.[40]

In addition, the agricultural sector consumes about 80 percent of freshwater, and due to the expected increases in temperature and possible declines in rainfall rates, the demand for water for agricultural purposes will likely increase, thus exacerbating the problem of water scarcity. Furthermore, as Egypt heavily relies on the Nile River for agriculture, agricultural development will be affected by climate change impacts on the Nile. Studies predict that the annual flow of the Nile will vary, with a potential increase of 30 percent, or a decrease of up to 70 percent. These two sharp changes could have serious repercussions in terms of the increased risk of floods or droughts, which would lead to a decline in food production and an increase in job losses. In addition, the impacts of the Grand Ethiopian Renaissance Dam, as discussed above, could exacerbate the situation and may lead to water disputes in the region.[41]

Additional possible impacts of climate change include human health risks due to outbreaks of vector-borne diseases caused by heat, and coral bleaching, which would affect one of Egypt's most valuable natural assets. Consequently, Egypt needs to develop the capabilities of human resources and institutions to adopt effective strategies for managing climate risks in key vulnerable sectors, and this process is currently being successfully implemented.

5.4.2 Adaptation to climate change

The Intergovernmental Panel on Climate Change defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."[42] Egypt has taken many steps towards achieving climate adaptation, and various institutions have developed different adaptation strategies. The Cabinet issued the National Strategy for Adaptation to Climate Change in 2011.[43] The Ministry of Water Resources and Irrigation also developed a climate change strategy in 2013 that targets adaptation in the water sector.[44] In addition, the Environmental Affairs Agency has issued a national strategy for gender mainstreaming and the role of women in climate change in

Egypt.[45] This strategy was based on the principles of gender equality and women's empowerment. As climate change affects women and men differently, a gender perspective based on equality is central to climate policymaking and decision-making and the development and implementation of mitigation and adaptation strategies. This strategy will include gender considerations in national plans and strategies related to climate change and integrate climate considerations in national plans and strategies related to women. In addition, it will contribute to the involvement of women's organizations in all stages of climate policymaking and implementation in Egypt.

In addition, the National Strategy for Adaptation to Climate Change and Reduction of Disaster Risks in Egypt aims to increase Egypt's capacity to address the effects of climate risks and enhance the national capacity to address those risks. The strategy is based on the international consensus to project a temperature rise of 2 degrees Celsius, in addition to projecting two scenarios through 2100 in terms of sea-level rise, a rise of 0.5 metres and a rise of 1 metre.[46] This strategy also focuses on the most vulnerable sectors: coastal areas, water resources, agriculture, health, and urban and touristic areas. It is recommended that the agricultural sector change cropping patterns to heat-tolerant ones, change farming systems and practices, adopt low-cost technologies appropriate to the local context, establish a special fund for agricultural adaptation, build scientific capacity, and improve public awareness. It is also recommended that the adaptation capacities of rural communities be enhanced through social protection and economic diversification.

With regard to water resources, the climate change adaptation strategy adopts integrated concepts and practices for the management of water resources. A set of adaptation measures have been determined, including improving the efficiency of the drinking water distribution infrastructure and changing consumer behaviours, improving irrigation efficiency, benefiting from rain and flood water, desalinating saline water and seawater, reusing wastewater, and increasing overseas agriculture.[47] Egypt has also obtained around $5.5 million from the Green Climate Fund to enhance adaptation to potential climate changes on the northwest coast (box 5.2).

While these plans and adaptation policies are relatively robust, their implementation is still in its early stages, as political leadership always prioritizes other development issues.

Box 5.2 Enhancing adaptation to climate change on the North Coast and in the Nile Delta

The Green Climate Fund projects is being implemented in cooperation with UNDP and aims at supporting Egypt's adaptation efforts in the Nile Delta, which was identified by the Intergovernmental Panel on Climate Change in its Fourth Assessment Report as one of three "extreme" hot spots in the world. The project aims to reduce the risk of coastal flooding on the north coast of Egypt due to the combination of the expected sea-level rise and more frequent severe storms.

The project focuses on building 69 km of sand dams along five vulnerable hot temperature points within the Nile Delta and developing an integrated plan for the management of the coastal areas of the entire Mediterranean coast. It also aims to manage the climate change risks in the long term and to provide Egypt with the ability to adapt to potential flood risks by integrating the additional risks of climate change into coastal management and planning, and adapting budgets and implementing measures to mitigate these risks.

Source: UNDP (2020a).

5.4.3 Governance on climate risks

Following the signing of the United Nations Framework Convention on Climate Change in 1992, a Climate Change Unit was established within the Environmental Affairs Agency. This unit acts as a focal point under the United Nations Framework Convention on Climate Change and later under the Kyoto Protocol. In 1997, the unit was modernized to become the Climate Change Central Department within the organizational structure of the Environmental Affairs Agency. In parallel, the Multilateral National Committee on Climate Change was established, which includes members from government, the private sector, the scientific community, and international organizations. In 2007, the National Committee on Climate Change was restructured by a prime ministerial decree which assigned the chairmanship of the Committee to the Minister of State of Environmental Affairs. In 2019, the National Committee on Climate Change became the National Council for Climate Change, headed by the Prime Minister. This council is considered the national authority concerned with issues of climate change. It aims to formulate the state's general policies in relation to dealing with climate change, and develop and update sectoral strategies and plans in light of international agreements and national interests. It also aims to formulate and update a comprehensive national strategy for climate change, as well as incorporate concepts and knowledge related to climate change within the different stages of education and build the institutional and individual capacities necessary to deal with climate risks. In addition, the National Committee for the Mechanism of Clean Development was established in 2005, which is also headed by the Minister of Environment. This committee is composed of high-level representatives of the government, the private sector, the scientific community, and NGOs.

In addition, energy policies are developed and implemented by the Supreme Council of Energy, the Ministry of Electricity and Renewable Energy, and the New and Renewable Energy Authority. The Supreme Council of Water Resources and the Ministry of Water Resources and Irrigation, which established the Nile Forecast Centre in the 1990s, deal with the issues related to water resources. The Ministry of Water Resources and Irrigation has also established the Environmental and Climate Change Research Institute. Since 1997, the Nile Forecast Centre has been actively working to forecast the flows of the Nile waters at different levels. The Centre has shown a high capacity for climate modelling. The Environmental and Climate Change Research Institute devotes greater attention to the environmental impact assessment and climate change, as well as possible adaptation methods. The Coastal Research Institute evaluates the impact of sea-level rise in coastal areas and participates in the development of an integrated plan for management of this issue. The Ministry of Agriculture and Land Reclamation also established a climate laboratory within the Agricultural Research Centre in the 1990s. The National Authority for Remote Sensing and Space Sciences has been monitoring the Earth since 2007 and receiving data from the US National Oceanic and Atmospheric Administration, France's Satellite pour l'Observation de la Terre (SPOT), and other entities. Moreover, the Institute of Graduate Studies & Research of the Environment at Alexandria University monitors the Mediterranean coastline, while the National Institute for Marine Sciences and Fisheries monitors the Red Sea coastline. Based on the above, it is clear that Egypt has made great progress in the past few years in establishing the institutional framework to deal with climate risks and building a relatively qualified national capacity.[48]

However, with regard to research on climate sciences, there is an urgent need to develop national capacity for better understanding of climate change and its impacts on coastal areas, water resources and human health. Finally, it is essential that organizations cease independent work, which can lead to a fragmentation of efforts, and instead work towards collaboration on climate-based issues. A national network of these institutions should be formed in order to allow the exchange of information, experiences and lessons learned.

It is also necessary to establish a national data system so that national climate data, information and knowledge are available to all.

5.4.4 Energy and Egypt's climate policies

The energy sector is the largest producer of greenhouse gases in Egypt due to the heavy dependence on oil and gas, especially in light of the gradual process of phasing out the use of coal as fuel in factories, to meet the increasing demand for energy. This sector, however, also offers a range of climate-friendly opportunities to mitigate the climate risks and achieve sustainable economic development at the same time.

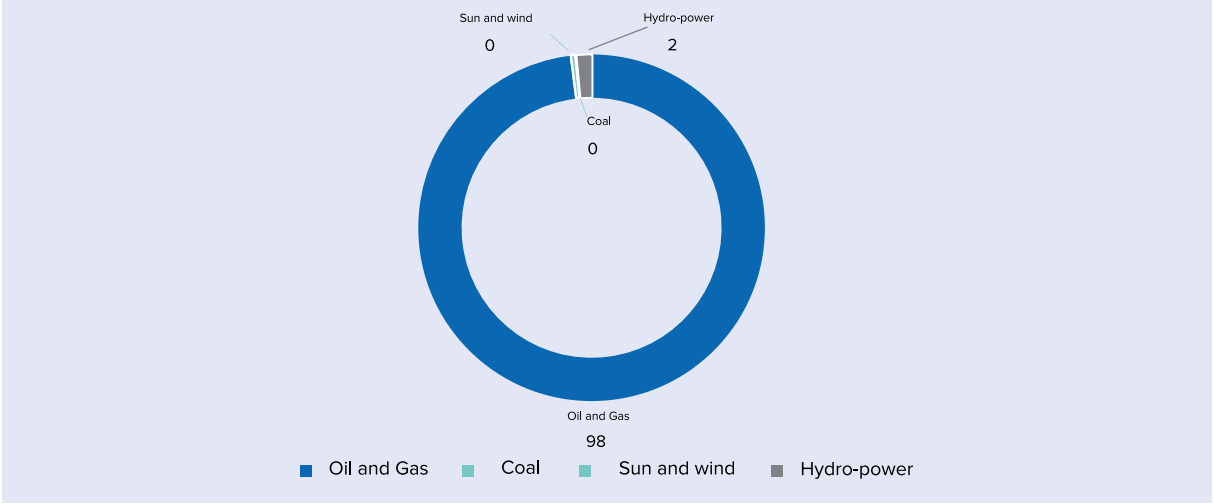
The COVID-19 pandemic has helped to clarify the interconnections between economic activity, energy systems, transportation, greenhouse gas emissions, and air pollution. With the closure of schools, businesses and public facilities, and reduced demand for transportation, the world has temporarily been forced to reduce the use of fossil fuels that cause air pollution and emit greenhouse gases. It is necessary to continue monitoring how the Egyptian economy responds after this temporary slowdown, and how these responses shape the trajectory of greenhouse gas emissions. During the global economic recession of 2008/2009, greenhouse gas emissions were significantly reduced, but they increased rapidly in 2010 due to the acceleration of economic activities. The same scenario could be repeated after the COVID-19 pandemic unless there are efforts to adopt a trajectory based on reducing carbon emissions and adapting to climate change in order to achieve recovery. Egypt has adopted policies to encourage green investment through a large group of sustainable mass transportation and renewable energy projects (Table 5.11).

Overview of energy sector and greenhouse gas emissions

The energy sector is responsible for providing the energy needs to feed the Egyptian economy. The sector's contribution to GDP has increased in recent years, particularly as a result of foreign direct investment. In order to achieve sustainable development, the energy sector must take into account national and global environmental considerations, and particularly Goal 7 of the SDGs, which is "provision of affordable and clean energy for all." Egypt has achieved remarkable success in this respect, as the percentage of population with access to electricity reached 99.7 percent in 2016/2017.[49]

The energy sector mainly depends on oil and natural gas, and especially the latter due to the recent exploration of new gas fields in Egypt's Western Desert and off the country's Mediterranean coastline (Figure 5.7).

Figure 5.7 Primary energy consumption (%)

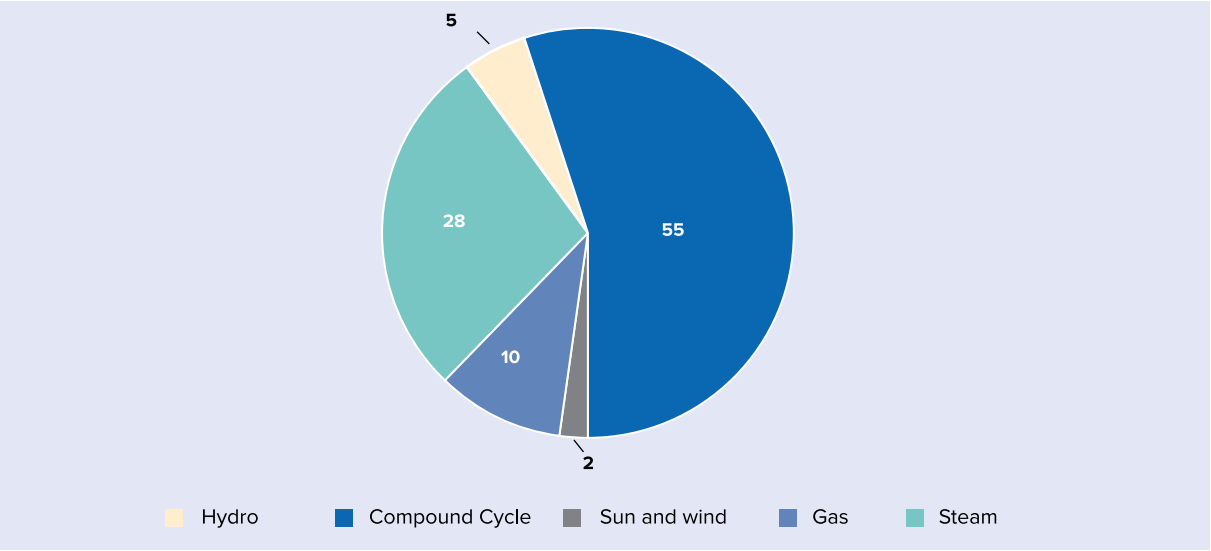


Source: IAE (2020b).

Given the slowdown in economic activity around the world amid the COVID-19 pandemic, carbon dioxide emissions will certainly decline during 2020 and 2021. The International Energy Agency (IAE) forecasts a decrease in global carbon dioxide emissions of 8 percent, or roughly 2.6 gigatonnes, to reach the levels prevailing 10 years ago.[50] Egypt will not be an exception, having also witnessed low demand for fuel in trade, transport and industry amid the pandemic. As the current decline in the world's oil prices will reduce the burden of fuel subsidies, it is recommended that Egypt, through its expected economic stimulus plan, continue to support renewable energy and energy efficiency in order to create new, decent jobs, enhance economic competitiveness, and improve the capacity of energy systems on adaptation.

Electricity is mostly produced by thermal power plants, the main capacity of which is based on highly efficient combined cycles (Figure 5.8).[51] However, a third of these plants have been in service for more than 20 years. In 2011, an electricity crisis took place, with a power shortage of 20-25 percent amid demand that was rising by 4 percent annually. To address this, Egypt initiated a major programme worth €6 billion to expand the power sector, which included the construction of three gas-operated combined-cycle power stations with a capacity of 4.8 gigawatts. The project modernized and expanded older plants to allow the transmission and distribution of electricity, as well as securing the natural gas supply for power generation. In less than five years, Egypt has been able to eliminate its electricity shortages and increase installed capacity by an annual average of 14.5 percent.[52]

Figure 5.8 Installed capacity by technology type (%)



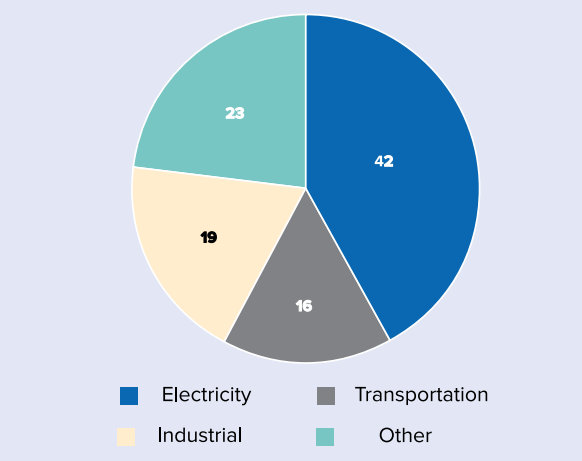
Source: Egyptian Electricity Holding Company (2017).

This ambitious programme, in addition to providing a reliable supply of electricity to vital health care systems and facilities, has provided Egyptians with the reliable power needed to meet their new needs amid the COVID-19 pandemic, such as teleworking, working from home, remote schooling, and shopping websites and other online activity. The pandemic has therefore demonstrated the effectiveness of the Egyptian vision for the energy sector, as well as the vital importance of electricity infrastructure as society moves towards greater reliance on digital technologies. Consequently, one of the lessons learned from

the COVID-19 pandemic is the need to invest in strengthening electricity and data networks in order to benefit from digital technologies.

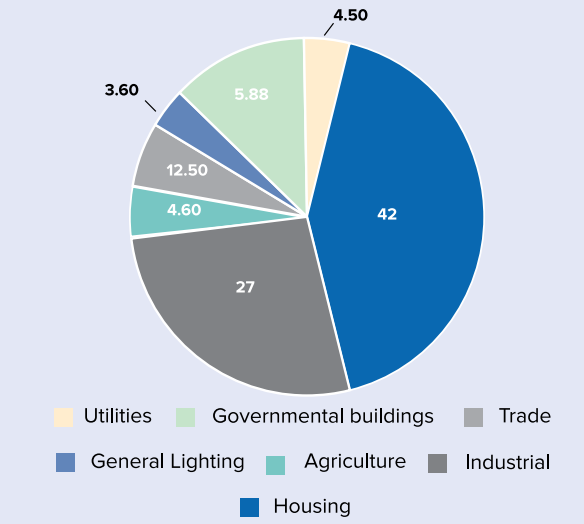
Egypt consumes 83 tonnes of petroleum and natural gas equivalent products, 42 percent of which is used in electricity generation (Figure 5.9). The residential sector consumes 42 percent of the electricity produced in Egypt, while industry consumes 27 percent, and the remainder goes to other economic activities (Figures 5.10 and 5.11). [53]

Figure 5.9 Sectoral consumption of oil and gas (%)



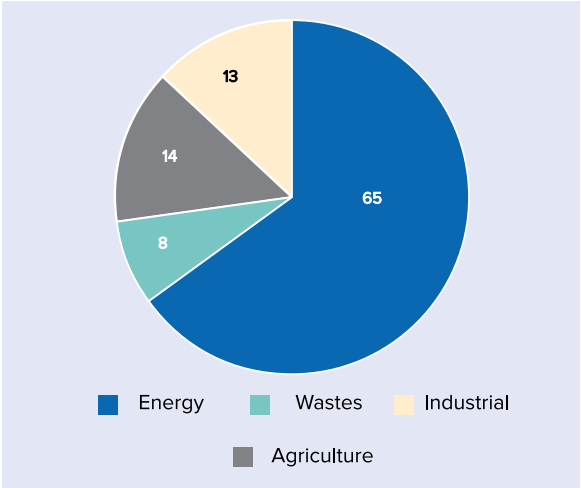
Source: https://www.statista.com/statistics/1087810/egypt-share-of-petroleum-products-and-natural-gas-consumption-by-sector/

Figure 5.10 Sectoral consumption of electricity, 2017 (%)



Source: Egyptian Electricity Holding Company (2018).

Figure 5.11 Greenhouse gas emissions by sector, 2015 (%)



Source: EEAA (2018).

Energy subsidy reform

Over the past decades, Egypt has provided energy at below-market prices. This practice has encouraged wasteful consumption behaviours, has weakened the economic viability of renewable energy economics and energy efficiency practices, and has been the main reason behind the delay in utilizing these renewable domestic resources. Energy subsidies, along with the economic recession, contributed to an increasing budget deficit, which amounted to about 12 percent of GDP in 2013. The decline in energy prices led to a high response and increased demand from various economic sectors, and thus the subsidy bill increased at a compound annual rate of 26 percent between 2002 and 2013.[54]

To address this, Egypt initiated a strong programme to reform and gradually eliminate energy subsidies over a period of five years. The first phase of the programme was implemented in 2014, the second phase in 2017, and the third phase in 2018. According to the economic development plan for fiscal year 2019/2020, Egypt's parliament has agreed to reduce fuel subsidies from EGP 90 billion to EGP 53 billion and to reduce electricity subsidies from EGP 16 billion to EGP 4 billion.[55] As a result of these reform efforts, the amount of total government spending on subsidies devoted to fuel subsidies declined from 56.8 percent in 2016/2017 to 30.8 percent in 2019/2020.[56]

During the COVID-19 pandemic, global oil prices declined sharply due to the decline in global demand, among other factors. This provides Egypt with a great opportunity to accelerate its fuel subsidy reform schedule, as consumers are less likely to feel the effects of this reform programme.

Energy efficiency support initiatives

Although the promotion of energy efficiency in Egypt began in the early 1980s, it has not been a government priority until recently, especially as a result of the energy shortages of 2012. However, a number of initiatives have been launched over the past 10 years to study and implement plans to enhance energy efficiency. Most of these initiatives have been financed by international development partners, e.g. UNDP, the United States Agency for International Development (USAID), the United Nations Industrial Development Organization (UNIDO), and the Global Environment Facility. These initiatives aim to overcome the technical, market and/or institutional constraints, which impede energy efficiency. On the technical side, many efforts have been exerted, but with limited success. Further, a number of energy consumption audits were carried out in the industrial and commercial facilities, but only a few projects have been implemented. In addition, some pilot projects were identified and implemented, but not widely replicated. Most of these projects were fully funded through grants provided within the framework of development partner programmes. These projects were not sufficient to stimulate investment in efficiency improvement projects. The main reason behind obstructing this matter for a long time is the low level of subsidized energy prices.

However, the driving factors for improving energy efficiency have increased recently due to energy price reform and the availability of energy efficiency technologies, especially energy-efficient lighting systems like LEDs. In response to the 2012 electricity crisis, the government allocated EGP 2.1 billion to an initiative to install high-efficiency street lighting systems (using high-pressure sodium and energy-saving bulbs or LEDs). Electricity distribution companies have also distributed nearly 13 million LED lights within the residential sector. These may be the only initiatives to improve energy efficiency and reduce electricity consumption ever funded from the public budget.

Box 5.3 Energy efficiency improvement project for lighting and home appliances
The Egyptian energy efficiency lighting market transformation (success story)

The project is being implemented by the Ministry of Electricity and Renewable Energy, in cooperation with UNDP and with the support of the Global Environment Facility. It aims to improve energy efficiency in the domestic sector, the largest consumer of electricity in Egypt, at 42 percent of the total, due to the growth in the use of modern home appliances, such as air conditioners and refrigerators. It also aims to provide savings for Egyptians, who face an increase in electricity bills in the wake of the reforms to electricity subsidies.

Egypt has implemented more than 15 pilot projects to improve energy efficiency in different places (including residential compounds, banks, shops, supermarkets, hotels, resorts, libraries, and private and public administration buildings), through the provision of the technical support and co-financing. This project has resulted in savings of around 25-40 percent of total electricity consumption. The project also supported the organization of public awareness campaigns aimed at promoting energy efficiency measures, changing perceptions and creating a market for energy efficient products. In addition, energy performance standards for fans and dishwashers have also been developed and implemented via a ministerial decree. The project also organized training courses on energy efficiency in street lighting in cooperation with the Housing and Building National Research Center.

The project won the Emirates Energy Award in 2017.

Source: UNDP (2020b).

In 2016, the Supreme Council of Energy approved the 2035 Integrated Sustainable Energy Strategy, which includes a component to improve energy efficiency. This component aims to improve energy efficiency without affecting the growth or productivity rates of economic sectors or affecting the level of consumer well-being. It also aims to achieve greater savings at the highest possible energy efficiency.[57] This component contains a set of measures to complete the institutional framework for improving energy efficiency, developing mechanisms for financing energy efficiency projects, implementing capacity-building programmes, and raising public awareness.

Egypt's development partners continue to support a range of activities to enhance energy efficiency, in cooperation with the relevant agencies. These activities include the determination by the Ministry of Electricity and Renewable Energy of the minimum energy efficiency standards for household appliances, such as dishwashers, fans, televisions, electric ovens and vacuums box 5.3, and provisions of technical assistance to the industrial sector to improve energy efficiency through the Egypt National Cleaner Production Centre, with the support of UNIDO. Furthermore, to overcome the funding constraints of recent years, some positive steps have been taken towards improving energy efficiency, including a number of financing facilities such as the Sustainable Energy Financing Facility provided by the National Bank of Egypt and the European Bank for Reconstruction and Development, and the Credit Risk Guarantee Company supported by UNDP and the Global Environment Facility.

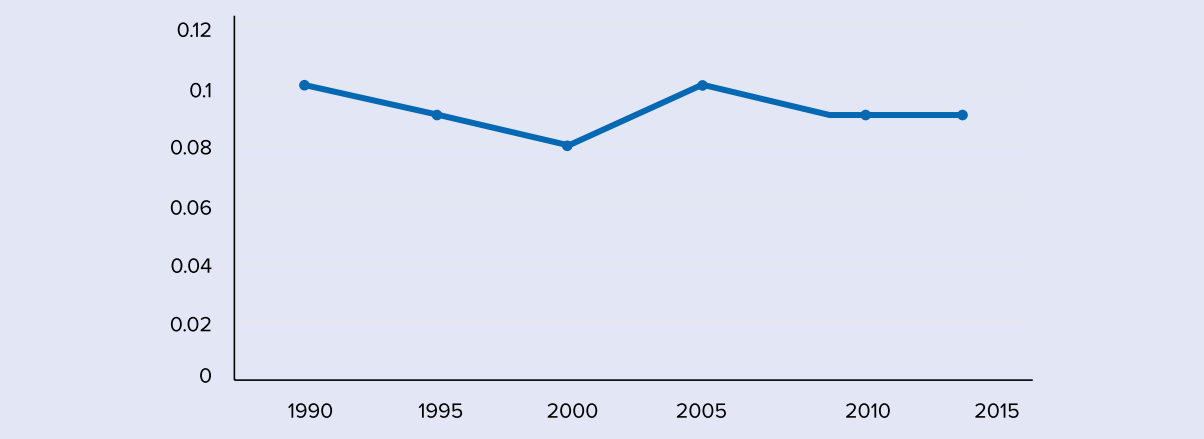
The Ministry of Electricity and Renewable Energy and the Ministry of Petroleum and Mineral Resources are currently implementing several activities aimed at completing and developing the institutional and legal framework to improve energy efficiency in Egypt on the supply and demand sides. They are also working to build and strengthen local capacities to achieve the national goals contained in Egypt's 2035 Integrated Sustainable Energy Strategy, which aims to reduce energy consumption by 18 percent by 2035.

In parallel with efforts exerted to improve energy efficiency in various end-use sectors, the Ministry of Electricity and Renewable Energy and its affiliate companies are seeking to improve the efficiency of the electricity supply system. The fuel efficiency for electricity generation has steadily improved due to the introduction of new and more fuel-efficient power plants and the suspension of old and low-efficiency plants. Losses in the transmission and distribution networks have also been reduced. Passed in 2015, the Electricity Law aims at promoting energy efficiency and regulating a number of energy efficiency measures, such as cogeneration and load management. It is worth noting that Egypt has declared energy efficiency a priority to mitigate climate change effects and separate carbon emissions from economic growth.[58] Between 2008 and 2018, carbon intensity (tonnes of carbon dioxide per $1,000 of GNP) decreased by 25.3 percent.[59]

The Ministry of Petroleum and Mineral Resources has also started building the institutional framework necessary to improve energy efficiency in all phases of the petroleum industry, in addition to implementing an expanded capacity-building programme. These efforts are being made in parallel to an integrated strategy to improve energy efficiency in the petroleum sector, which will serve as an integral part of the sector modernization programme.

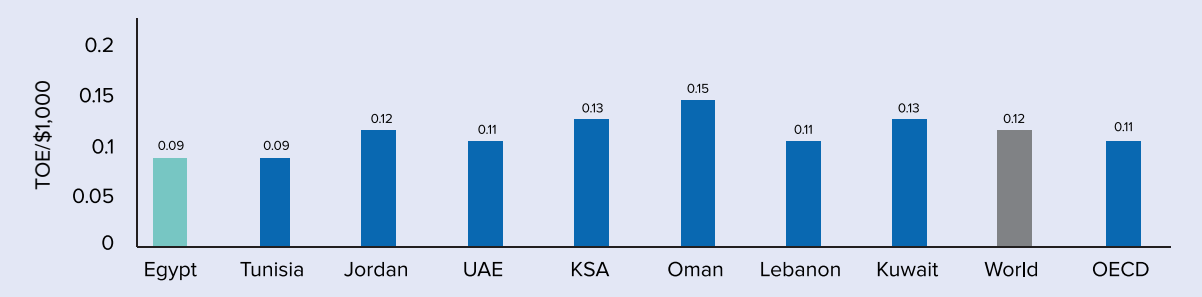
Energy intensity (tonne of oil equivalent per $1,000 of GDP) has decreased slightly since 2005 due to improved energy efficiency and some other structural factors (Figure 5.12). A comparison with other countries shows that Egypt consumes less energy than both Gulf Cooperation Council (GCC) countries and the global average (Figure 5.13).

Figure 5.12 Energy intensity (TOE/$1,000 of GDP)[1]



Source: IEA (2020a)

Figure 5.13 Energy density (TOE/$1,000 of GDP)[2]



Source: IEA (2020a).

Energy mix diversification: Nuclear power

Alongside efforts to increase oil and gas production, Egypt's energy sector reform strategy also requires a diversification of the country's energy mix by considering renewable energy sources, energy efficiency, nuclear power and clean coal technologies. Nuclear power is a low-carbon option that will provide a source of electricity generation with a carbon effect close to zero. The nuclear power option has additional advantages, including reducing dependence on imported fossil fuels, and it is therefore less vulnerable to fluctuations in international oil prices. On the other hand, nuclear power raises concerns about safety and environmental impacts. Nuclear facilities are also highly capital-intensive, ranging from $2 billion to $3.5 billion per nuclear reactor, with additional costs associated with reactors' end-of-life disposal and the disposal of nuclear waste. Nuclear power currently generates about 10 percent of the world's total electricity, with around 440 reactors worldwide. The United States, France and China top the list of 50 countries that use nuclear energy, and France generates about three quarters of its electricity from nuclear power.[60]

Egypt's activity in nuclear power began in the 1950s, but was intermittent, stopping after the war in 1967 and then restarting after 1973. In 1986, work on nuclear power stopped again after the Chernobyl disaster. At present, Egypt has two small research reactors, and in February 2015, Egypt signed an agreement with Russia for the construction of its first nuclear reactor for commercial purposes. The

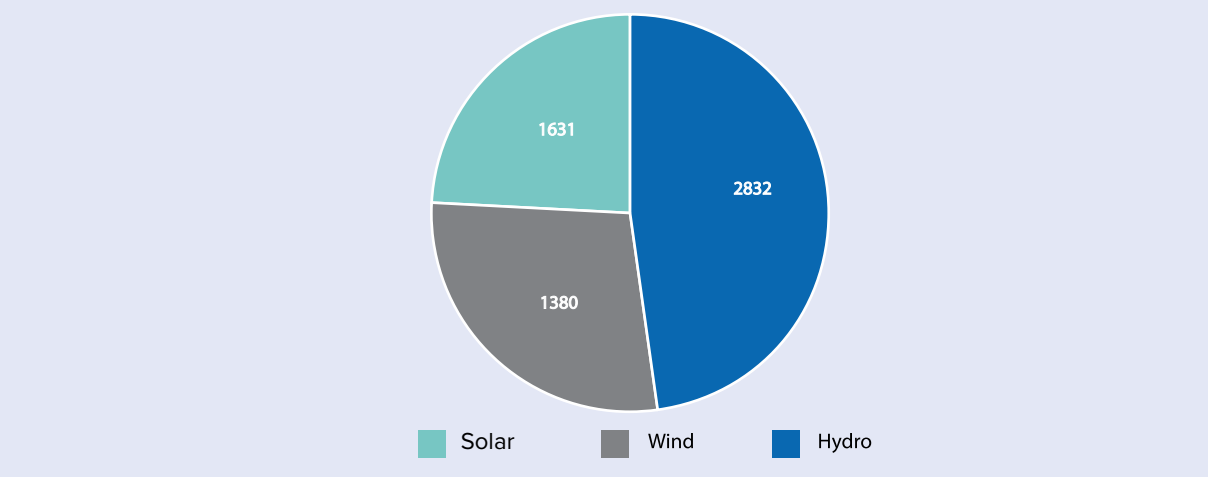
1 Tonne of oil equivalent/$1,000 (2010), purchasing power parity (PPP).
2 Tonne of oil equivalent/$1,000 (2010), purchasing power parity (PPP).

planned El-Dabaa Nuclear Power Plant, located on the Mediterranean coast 250 kilometres west of Alexandria, will have a capacity of 4.8 gigawatts. Construction of the plants started, with operations set to begin in 2026. The Russian company Rosatom State Atomic Energy Corporation (ROSATOM) will construct the plant, which will be owned and operated by Egypt's Nuclear Power Plants Authority. The plant will consist of four VVER-1200 nuclear reactors, each of which can produce 1.2 gigawatts of power. The first unit is expected to begin commercial operations in 2026, while the remaining three reactors are scheduled to be commissioned in 2028. The VVER-1200 reactor is a third-generation pressurized water reactor that fully complies with all international safety requirements issued by the International Atomic Energy Agency after the Fukushima disaster. Russia will provide a $25 billion loan to finance about 85 percent of the construction cost of the project. The loan will be repaid over 22 years at an interest rate of 3 percent per year. Egypt will source the remaining 15 percent of construction costs from investors in the private sector.[61] Nuclear power represents an energy source that must be taken into consideration as part of the country's plan to expand the construction of seawater desalination plants in the future.

Enabling environment for promoting renewable energy

Renewable energy is another option for sustainable, climate-friendly energy that Egypt has adopted, and which has strong potential for development. Egypt's 2035 Integrated Sustainable Energy Strategy targets generation of 42 percent of installed electric capacity from renewable energy sources by 2035. Currently, Egypt has approximately 5.8 gigawatts of renewable installed capacity (Figure 5.14).

Figure 5.14 Renewable installed capacity in megawatt, 2020



Source: NREA (2020).

In order to develop the renewable energy market, Egypt has made significant improvements to its renewable energy policy framework and has attracted more investment from the private sector as a result. Egypt has adopted a set of enabling policies, including a feed-in tariff for renewable energy supplies, a net consumption measurement policy, and competitive bidding and tender procedures. The feed-in tariff for large photovoltaic (PV) projects was completed in two phases: 14.3 cents per kilowatt-hour (kWh) for the first phase and 8.4 cents per kilowatt-hour for the second phase. Moreover, in 2019 a feed-in tariff system was approved for waste-generated electricity (EGP 1.40 per kilowatt-hour for

solid waste and EGP 1.03 per kilowatt-hour for liquid waste). However, due to the continuing decline of renewable energy technologies costs, the feed-in tariffs have gradually been replaced by competitive bidding and auctions.

This package of supportive policies led to the construction of Benban Solar Park with investments of $2.2 billion. The project produces 1,465 megawatts of power and is considered the largest solar complex in Africa. It also won the World Bank's Best Project award in March 2019 (Box 5.4). Other projects for solar and wind power production have been proposed by independent power producers, including the construction of three large-scale wind farms with a capacity of 500 megawatts each, on a build-own-operate basis, with a feed-in tariff of 3.1 cents per kilowatt-hour. Competitive bids submitted by independent power producers in Egypt (through auctions) have proven successful in achieving competitive prices in wind power at 2.8 cents per kilowatt-hour.

Box 5.4 Benban Solar Park

Benban Solar Park, based near Aswan in southern Egypt, is considered one of the largest solar power projects in the world. It is built on an area of approximately 37 km2 and includes 32 photovoltaic solar power plants with a total capacity of 1,465 MW, which is equivalent to about 90 percent of the capacity of the Aswan High Dam. Benban village was chosen based on studies and information sourced from the National Aeronautics and Space Administration (NASA) and other international scientific institutions, which confirmed that the project site is one of the brightest sites in the world.

The commercial commissioning of the project started in 2018, and the electricity generated was sold to the Egyptian Electricity Transmission Company through a 25-year contract at a price of 7.8 cents/kWh. The project reduces carbon emissions by 2 million tonnes annually.

The project takes advantage of the investment law issued in 2017 to increase foreign investments in order to support the national transition plan to clean energy and to put Egypt on the energy map in the Middle East and North Africa. The total cost of the project is estimated at about $4 billion, most of which is provided by the European Bank for Reconstruction and Development and the International Finance Corporation through soft loans and banking facilities for private companies investing in the project.

There is a large number of companies participating in the project, including 10 international companies and 30 percent Egyptian firms. The project also provides about 20,000 job opportunities during its implementation period. Experts believe that Beban's exceptional solar radiation levels, and the low maintenance costs, which are limited to cleaning the photovoltaic panels of sand, enhance the viability of the project. However, Egypt's success in implementing the Benban project, and renewable energy projects in general, would not have been possible without completing the legislative and institutional framework that attracted investments to this economically promising sector. The project won the Best Project award from the World Bank.

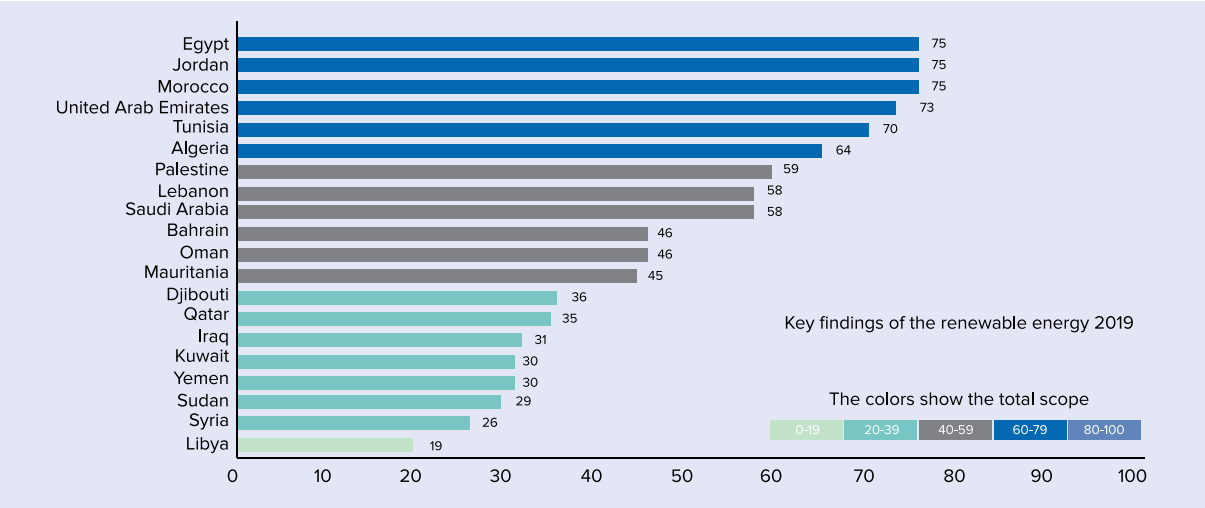
Source: Various sources.

The third support system to increase the utilization level of renewable energy is the net metering of consumption, which improves the work environment for solar power investments in the household, commercial and industrial sectors. It is worth noting that Egypt has raised the ceiling of those projects that apply to join the net consumption metering system to 20 megawatts, and thus allowing increased demand from industrial and commercial establishments. However, solar PV generation through this mechanism is still significantly underutilized.

According to the Regional Centre for Renewable Energy and Energy Efficiency's analysis of the main areas that promote the adoption of renewable energy by Arab countries, which included market structure, policy

framework, institutional capacity, financing and investment, Egypt ranks first among the Arab countries in developing the renewable energy market (Figure 5.15).[62]

Figure 5.15 Classification of renewable energy in Arab States (%)



Source: Regional Center for Renewable Energy and Energy Efficiency, 2019.

The recent unprecedented decline in oil prices due to the low level of demand as a result of the COVID-19 pandemic may threaten the efforts made by Egypt to promote renewable energy, despite the importance of diversifying energy sources to mitigate the impact of oil price fluctuations. However, it is too early to assess the implications of this decline, especially since the electricity market in Egypt is not fully open and consumer options are still relatively limited.

5.5 Government policies on environmental sustainability and climate change

Egypt has exerted ongoing efforts to improve the quality of the environment in order to protect and improve the health and quality of life of its population. However, there is still an urgent need to make several policy reforms in order to address the root causes of some environmental challenges, in areas such as solid waste management, the enhancement of sustainable consumption and production, greening the financial sector, incorporation of the environmental costs into the national economy, and strengthening the interconnection between water, energy, food and climate change. Therefore, in light of the analysis presented above, there is a set of policies that will be at the top of Egypt's priorities in the coming period in order to overcome these challenges, as outlined below.

- **Separation of resource use from economic growth**

Consumption patterns in Egypt, supported by economic growth, technological developments, and cultural and social factors, have undergone significant changes over recent decades. Car ownership rates have increased, leisure and business trips have become more common, and home appliances and communication tools have become increasingly popular. Many products, such as mobile phones and audio/visual equipment, are no longer considered Luxories but necessities, thus exacerbating waste issues. Egypt is therefore seeking, among its priorities, to work on changing consumption habits by making long-term and vigorous efforts on ed-

ucation and public awareness. These efforts include combining the development of government policies and business strategies, the involvement of NGOs and academia, and the contributions of the media, community leaders, and advertisers. Young people, who make up a major proportion of Egypt's population, constitute a large group of consumers, and therefore they will function as the active party and the main driver in achieving the SDGs. The habits today's young people acquire will play a significant role in future consumption patterns, markets and ways of living.[63]

In addition, in order to change the current unsustainable patterns of consumption and production, the Egyptian economy must go through a transitional phase towards building a circular economic model, in which waste incineration and disposal in landfills is minimized to the greatest extent possible. This transition will be achieved through the expansion of the recycling and reuse processes, and improvements in the utilization of raw materials, products and waste. There are many international experiences that can be adopted and utilized in this regard, such as the experiences of the European Union, Germany, Japan and China.[64] In order to facilitate this transition, Egypt will work to introduce a package of supportive policies of legislation and market tools, which may include, for example, imposing taxes on single-use products and packages (where there are reusable alternatives) to discourage their use, and setting up mandatory deposit and take-back systems for some products, such as lead-acid batteries and vehicle tyres, and for some packaging, such as beverage cans. Egypt will also seek to implement the "extended product responsibility" principle in relation to some products, such as ICT products. The newly issued Waste Management Regulatory Draft-Law offers a way forward to start this transitional phase.

- **Green public procurement**

Government spending could become an effective tool in stimulating sustainable consumption and production patterns in Egypt if it is directed towards green services and products. As well as acting as a role model for the public and the private sector, green public procurement can create markets and demand for green products and services. Green public procurement clients include public offices, schools, hospitals, other public buildings, public transportation systems, and public infrastructure projects, among others. The encouragement of green public procurement and practices is expected to make a significant contribution to a more sustainable and efficient use of resources in various sectors, and push the market towards cleaner production and more efficient consumption by purchasing locally-made products which use resources more efficiently.[65] Egypt therefore seeks to encourage green public procurement as a step towards encouraging sustainable consumption and production by setting the government as a good example to be followed. Egypt is also seeking to develop a list of standards and guidelines related to green public procurement that government agencies should take into account, and should work to obligate these agencies to follow. An Environmental Sustainability Standards Manual was recently issued, which aims to integrate sustainable development standards into development plans. It also aims to ensure the achievement of a specific development goal, which is the doubling of the percentage of green public investments that take into account the dimensions of sustainability from 15 percent in the 2020/2021 state budget to 30 percent in the 2021/2022 state budget.[66]

Box 5.5 Environmental sustainability standards manual

- Article 32 of the Constitution stipulates the necessity of preserving natural resources and considering the rights of future generations, and the sustainable development strategy, Egypt's Vision 2030, also states that the environmental dimension should be an essential axis in all development sectors in order to safeguard natural resources and support their fair use and optimal utilization, in a manner that guarantees the rights of future generations, and contributes to supporting competitiveness, providing new job opportunities, alleviating poverty, and achieving social justice, while providing a clean, healthy and safe environment for Egyptians.
- In line with these commitments, the Ministry of Planning and Economic Development cooperated with the Ministry of Environment to draft an Environmental Sustainability Standards Manual, with the aim of outlining general standards to integrate into sustainable development plans. The manual also aims to maximize the returns to public investment, to ensure doubling of the share of green public investments that considers the dimensions of sustainability, from 15 percent in the 2020/2021 state budget to 30 percent in 2021/2022 state budget. This will accelerate progress towards the SDGs and all relevant international commitments. In addition, it will insert environmental sustainability considerations into projects' financing criteria.
- The manual contains a methodology for integrating sustainability criteria into all stages of develop-ment plans (planning, financing, design, implementation, and operations).
- The manual also contains sector-specific environmental sustainability criteria for 13 sectors for projects with a direct positive impact on the environment, which must be used as a guide when planning these projects.

Source: MPED.

- **Sustainable financing: Environmental Protection Fund and green bonds**

The term sustainable finance refers to "any form of financial service integrating environmental, social and governance (ESG) criteria into the business or investment decisions for the lasting benefit of both clients and society at large."[67] One form of sustainable finance is environmental funds, which are environmental finance mechanisms that are increasingly common in developing economies. The rationale for establishing special environmental funds usually depends on two main factors: the failure of governments in addressing environmental problems due to their failure to establish a sound framework for environmental management policy and law enforcement, and the failure of financial and capital markets to provide access to finance under reasonable conditions. In order to improve the quality of the environment, huge investments are required, not only from government agencies, but also from other sectors. The aim of these investments is not only to reduce pollution, but also to support the development of environmentally-friendly technologies, provide environmental services, and establish sound environmental management systems. In order to facilitate the flow of these investments, Egypt established the Environmental Protection Fund, via the Environmental Protection *Law No. 4 of 1994*, as an independent entity affiliated with the Ministry of Environment.

The mission of the Environmental Protection Fund is to provide the necessary finance for investment in sustainable environmental projects. Specifically, it aims to support investments in pollution control, use of cleaner technologies, and environmental management and capacity-building projects. Furthermore, it is entrusted with establishing and operating environmental monitoring networks, and assessing environmental impacts, addressing environmental disasters, transferring low-cost environmentally sound technol-

ogies, and establishing and managing nature reserves. The Environmental Protection Fund also provides concessional financing, such as grants and loans with interest rate support, ownership-guaranteed loans, and concessional loans. The beneficiaries of the financing include entities belonging to the private and public sectors, local bodies, and NGOs. The potential sources of the fund's revenues include amounts allocated in the state's general budget, grants and donations received from national and foreign donor organizations, fines and penalties imposed for breaching the Environmental Protection *Law No. 4 of 1994* and *Law No. 102 of 1983* on Natural Protected Areas, compensation for environmental damage, and revenues received from the Environmental Affairs Agency for services provided to third parties. For several years, the Environmental Protection Fund has faced challenges due to the inflexibility of government regulations in the area of its purview, and it may be time to enhance its effectiveness by giving it more flexibility in managing its resources.

Other sustainable financing tools include green bonds, or climate bonds, which are a relatively new source of financing that is becoming increasingly popular in the capital markets. Green bonds are primarily intended to finance any projects or initiatives related to promoting a low carbon economy and addressing climate change challenges. The World Bank first issued green bonds in 2008 and has issued more green bonds in various currencies since then. Green bonds have also been issued by third parties, including the European Investment Bank, US government agencies, the International Finance Corporation, and the Asian Development Bank.

In 2019, the Egyptian Financial Supervisory Authority developed guidelines on green bonds based on the Green Bond Principles issued by the International Capital Markets Association. Examples of green projects included in these principles are renewable energy, energy efficiency, wastewater treatment, reduction of air emissions, mitigation of greenhouse gas emissions, soil disinfection, waste prevention and reduction, waste-to-energy recycling projects, products compatible with the circular economy, and climate change adaptation measures. In 2020, Egypt's Ministry of Finance issued the first green bonds in the Middle East and North Africa, an innovation that puts Egypt on the sustainable financing map in the region. The total value of the bonds is $750 million over five years, with a yield of 5.25 percent, due in October 2025. The issuance attracted investors from Europe (47 percent), the United States (41 percent), East Asia (6 percent) and the Middle East (6 percent). Final applications registered the subscription of 220 investors, including 16 new first-time investors in US dollar bonds, reflecting the efforts to diversify and improve the existing investor base. The proceeds of the green bonds will be used to finance green projects in various sectors, such as transportation, renewable energy and energy efficiency. The proceeds will also be used to reduce and control pollution, adapt to climate change, increase energy efficiency, and sustainably manage water and sanitation, in line with the national sustainable development strategy, which gives priority to green investment projects. The most important projects that will use the proceeds of the green bonds in their financing include the Cairo Monorail Project, which will see the construction of a monorail connecting the New Administrative Capital with 6 October City on the western outskirts of Cairo; the El-Dabaa water desalination plant; and the wastewater treatment plants in Arab Abu Saed and Port Said.[68]

Egypt has included a set of green projects that can be financed by these bonds in the 2020/2021 draft state budget, amounting to about 691 projects with a total cost of EGP 447.3 billion. These projects have allocations of about EGP 36.7 billion, which constitutes 14 percent of the total public investments in the state budget. The sustainable transport sector has the largest share of these projects, with 50 percent of the allocations listed for green projects in the plan. Table 5.11 outlines the most important of these projects.[69]

Table 5.11 Allocations for the most important green projects included in the 2020/2021 plan			
Project name	**Sector**	**Credit (EGP million)**	**Project's goal**
Electric Railway	Transportation	4,500	Connect the New Administrative Capital with the new cities of Al-Salam, Al-Obour, Al-Shorouk, Al-Rubiki, 10 Ramadan City and Belbeis through the fourth phase of the third line of the Cairo Metro.
Cairo Metro Line 3	Transportation	3,607	Aims to improve the traffic congestion in Greater Cairo. The length of this phase is approximately 17.7 km (15 stations).
Metro Line 4 (Al-Remaya Square/ Nasr City)	Transportation	4,387	Aims to improve traffic congestion in Greater Cairo. The first phase extends from Line 4 of the interchange station west of the Cairo Ring Road on the borders of 6 October City, passing through the Grand Egyptian Museum station, then Al-Remaya Square and Al-Haram Street, until Giza station, where it intersects with Metro Line 2.
Wind Power Plant (Gulf of Suez)	Electricity and renewable energy	2,144	Fulfils the increasing demand for energy and meets SDGs. Wind power plant with a production capacity of 25 MW.
Monorail Project (New Administrative Capital/ 6 October City)	Transportation	2,000	Fast, modern, safe and eco-friendly means of transportation that saves fuel consumption, reduces pollution, mitigates traffic congestion in main highways and streets, and attracts passengers to use this means of transportation instead of their private cars.
Solid Waste Management	Local development	2,000	Treatment of solid waste and increasing the efficiency of the waste cleaning system.
Fourth phase of Metro Line 3 (Al-Thawra Line)	Transportation	1,827	Aims to improve the traffic and transportation congestion in Greater Cairo. Completing the fourth phase of the Metro Line 3 through Al-Thawra, Imbaba and Cairo Airport stations, with a length of 18.7 km (15 stations).
Improving Damietta Port's Efficiency	Transportation	1,453	Aims to maximize revenues, increase the amount of cargo handled, increase container handling volume, and increase the port's capacity.
Dry Port in 6 October City	Transportation	720	Aims to diversify the Port Authority's revenues and store raw materials and cargo.
Photovoltaic Power Plant in Zafarana	Electricity and renewable energy	612	Aims at meeting the increasing demand for energy. Capacity of 50 MW.

Source: MPED.

In order to expand the scope of the green bonds market, Egypt is seeking to introduce the concept of green bonds to the local market and is considering a package of market incentives such as tax exemptions and/or subsidizing interest rates on green bonds. Egypt is also looking to establish a system to track the environmental performance of green bond projects, in cooperation with the Egyptian Environmental Protection Fund and the Environmental Affairs Agency.

- **Responsibility for carbon emissions**

Climate financing is another form of sustainable financing provided by the public and

private sectors for investments aimed at advancing low-carbon and climate-resilient development. Carbon emissions certificates are traded in the carbon market, encouraging countries and companies to reduce emissions. Further, emission certificate trading may permit the reduction of emissions at lower cost when they can be obtained from high-emitting countries, and thus reducing the economic cost of mitigating the effects of climate change.

The flexibility mechanisms provided under the Kyoto Protocol include the Clean Development Mechanism, which aims to provide an effective market mechanism to developed countries that will enable them to achieve some of their commitments to reducing emissions at a lower cost. This will be achieved by transferring green technology to developing countries. Since the Kyoto Protocol entered into force in 2005, nearly 8,000 projects have been registered.[70] Egypt has successfully developed a diverse portfolio of Clean Development Mechanism projects, including 20 projects, equivalent to about 4.2 tonnes of carbon dioxide annually until the end of 2015. The registered projects include renewable energy projects, energy efficiency projects, waste management projects, transition to low-carbon fuels, transportation, and industrial projects.[71] Currently, there is great uncertainty as to whether and how the Paris Agreement will address these projects. After the Paris Agreement, the projected expectations for the global carbon market depend on ongoing international negotiations within the global framework of climate change.

Internationally, carbon emissions charges have been used for a long time, as these charges are considered an effective way to absorb the external costs associated with carbon emissions from energy use, and thus help to mitigate threats resulting from climate change and encourage a faster transition to low-carbon economies. With the development of sustainable energy, appropriate costing of greenhouse gas emissions helps to attract the financial investments required to support renewable energy development, take measures for energy efficiency, and use low-carbon technologies in industry.

International carbon pricing initiatives include emissions trading regulations, imposition of taxes on carbon, emissions compensation mechanisms, and results-based financing directly linked to greenhouse gas emissions that enable correct estimation of the value of carbon emissions. Moreover, carbon pricing will increase the use-cost of fossil fuels and thus encourage increased efficiency of energy production and consumption. As of the beginning of 2020, there were 58 national and local carbon pricing initiatives in 46 countries, covering 20.1 percent of global greenhouse gas emissions.[72] Among 84 other countries, Egypt intends to consider the international carbon market to achieve emission reduction goals, as set out in its NDCs provided in the Paris Agreement.[73]

Government subsidies of fossil fuels may negatively affect carbon prices due to the low costs of using fossil fuels. The policy of gradually eliminating fossil fuel subsidies, which Egypt is currently implementing, should reduce this negative effect on the implicit price of carbon. This policy also helps conserve public resources to enable increased spending on social protection, health and education.[74] The package of measures currently being presented by the government to mitigate the negative effects of the COVID-19 pandemic is considered clear evidence of the effectiveness of the country's economic reform programme.

It is well known that taxation of fossil fuel consumption implicitly affects the cost of carbon emissions. Egypt is therefore seeking to consider, within the framework of fossil fuel subsidy reforms, the possibility of imposing taxes on fuel, as a part of the activities aimed at raising the cost of carbon emissions. These taxes may contribute to reducing transportation fuel consumption rates and improving energy efficiency in industry and power generation.

They would also help Egypt contribute to global efforts to mitigate climate change.

- **Nexus between water, energy, food resources and climate**

A better understanding of the nexus between water, energy, food and climate policy in Egypt creates an informed framework for identifying trade-offs and synergies that meet the demand for those resources, without compromising sustainability. The scarcity of these resources (energy, water and food) is considered one of the biggest challenges facing development in Egypt. In particular, the two main challenges facing the transition to a low carbon economy are water scarcity and the risk of drought, which may be exacerbated by the expected negative impacts of climate change and the heavy dependence on oil and gas to meet energy needs. In addition, Egypt is negatively affected by the fluctuations of the global food market, as it depends on imported products to cover nearly 50 percent of its food needs. Adopting a nexus approach is therefore essential to meet the resource challenge in Egypt, achieve the SDGs, and address climate risks. The need for continuous rationalization of energy subsidies through the energy reform programme is a major factor in dealing with energy scarcity, as it helps to eliminate wasteful consumption behaviours and promotes a shift towards renewable energy. This shift also helps support other resource challenges (water, food and climate). Furthermore, the attempts to find sustainable and innovative solutions to the challenges around climate change, water, food and energy by investing in innovation and building the knowledge capabilities of young people are important issues that must be taken into consideration.

In terms of the SDGs, three components of the nexus have been clearly identified. Goal 2 aims to end hunger, achieve food security, improve nutrition and promote sustainable agriculture. Goal 6 aims to ensure availability and sustainable management of water and sanitation for all. Goal 7 targets providing access to affordable, reliable, sustainable and modern energy for all. In addition, Goal 13 addresses climate change. This affirms the need to adopt a nexus approach and the important role it can play in formulating policies to achieve sustainable development and face climate risks.

In Egypt, water security, energy security and food security are closely linked, given its vulnerability to climate change. Accordingly, Egypt should adopt a nexus approach when addressing the management of these three vital resources. Climate change presents an additional challenge that, as outlined above, will exacerbate the scarcity of water and food resources. Moreover, the water scarcity problem in Egypt is exacerbated due to its multiple interconnections with various sectors, such as health, the environment, food, and energy. Therefore, it is important to address the various interconnections between the water sector and these other sectors in order to achieve effective and integrated planning and management of resources. Furthermore, the scarcity of freshwater resources in Egypt has prompted the country to use desalination technology, which is an energy-intensive process. As energy production is mainly dependent on oil and gas, it is critical to develop renewable energy technologies in order to operate desalination plants and ultimately reduce carbon emissions. It is worth noting that the first solar-powered desalination plant in Saudi Arabia, which produces 60,000 cubic metres of desalinated water per day, is also the largest solar-powered desalination plant in the world. This plant is an example of the necessity of adopting the nexus approach.

The nexus between water and food is also critical. As outlined above, the agricultural sector is the main sector in terms of water consumption, with relatively low consumption efficiency. The improvement of irrigation efficiency could therefore save water for other sectors. In addition, Egypt imports a large amount of the food its population consumes. Estimates suggest that the virtual water im-

ported to Egypt annually is about 55 billion cubic metres. Thus, importing water-intensive crops, and reducing exports of these crops, may be an option to address water scarcity.[75]

Another excellent example of the nexus approach in Egypt is the Lake Manzala Engineered Wetland Project, which has been shown to provide an economically and environmentally viable alternative to conventional wastewater treatment facilities by using treated wastewater for agriculture and fish farming. This example provides an empirical basis of the need to coordinate energy, water, and food policies, while reducing the environmental footprint and improving resilience to climate change at the national level.[76]

It should be noted that food supply is a public health issue at present due to the COVID-19 pandemic, as it is vital that people who are most vulnerable to the pandemic have access to healthy food, and the rise in unemployment may make this more difficult. The pandemic has resulted in the suspension of economic activity and has disrupted many supply chains, which may threaten food security. Border closures, movement restrictions, and disruption of shipping and aviation have affected international food supply chains, and thus exposing the countries with limited food sources to great risk.[77] Moreover, the pandemic clearly highlights the relationship between food security and health, and the need to institutionalize the nexus approach in developing and implementing public policies.

The potential food shortages evoke the financial crisis of 2007-2008, when major food exporters who were worried about food supplies placed restrictions on their exports, causing an increase in global prices. In the current period, the United States and Russia have placed restrictions on their wheat exports. The results of the disruptions to supply chains and food security will depend on each country's ability to withstand shocks. The most affected people will be the poorest and most vulnerable sections of the population, who have fewer resources to deal with job and income loss amid increased food prices and unstable food availability, and thus will have less ability to adapt to the crisis. For example, temporary workers are facing huge job losses and many will see a significant reduction in their incomes. Therefore, it is crucial to increase and support local food production by providing appropriate incentive packages to promote food adaptation, reduce food waste, and avoid over-purchasing, to ensure that all people have equitable access to food.

Egypt will therefore seek to implement institutional reforms that embed the nexus approach in the process of policy development and implementation, as part of the major efforts currently being exerted to achieve sustainable development and to address climate change. For example, the newly established Sustainable Development Council should play a leading role in promoting this approach as part of policy development.