MIDDLE EAST AND NORTH AFRICA

EGYPT

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

November 8, 2022

Table of Contents

Acknowledgments

This Country Climate and Development Report (CCDR) is a collaborative effort of the World Bank, the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA), produced by a core team led by Oliver Braedt (Program Leader), Kevin Carey (Lead Economist), Nancy Lozano Gracia (Lead Economist), and Ashok Sarkar (Senior Energy Specialist, Program Leader). The core writing team includes Jacqueline Marie Tront (Senior Water Resources Management Specialist), Rama Chandra Reddy (Senior Environmental Economist), Maria Eugenia Genoni (Senior Economist), Harsh Goyal (Urban Development Specialist), Ellen Olafsen (Senior Private Sector Specialist), Katharina Ziegler (Program Analyst), Nada Farid (Regional Economist, IFC), Federica Ranghieri (Program Leader), Evelyn Sanchez Hernandez (Sustainable Development Consultant), Rajesh Balasubramanian (Senior Water Supply and Sanitation Specialist), Nobuhiko Daito (Transport Specialist), Carlos Alberto Lopez (Senior Oil and Gas Specialist), Yanchao Li (Energy Specialist), Yousra Mohamed Ossama Mostafa Assaker (Senior Energy Specialist), Ihab Elmassry (Energy Consultant), Anthony Kubursy (Energy Consultant), Ankush Sharma (Urban Consultant). Marcela Tarazona (Genesis Analytics), Valentina Rodriguez (Genesis Analytics), Amr Osama (Integral Consult), and Ede Ijjasz-Vasquez (Consultant) provided overall guidance to the team.

A large team contributed to the report with inputs and background notes including Laila Abdelkader, Ghassan Khaled Ismail Al-Akwaa, Fatma El Zahraa Yassin Aglan, Mark Eugene Ahern, Mihasonirina (Miha) Andrianaivo, Arturo Ardilla, Affouda Leon Biaou, Nataliya Biletska, Andrew Burns, Camila Cortes, Michaela Mei Dolk, Krishnamurti Damodaran, Ira Irina Dorband, Eric Dunand, Svetlana Edmeades, Alia Eldidi, Mariam Hoda El Maghrabi, Mohamed Hisham El Shiaty, Amal Nabil Faltas, Salma Abdel Fattah, Catiana Garcia-Kilroy, Artavazd Hakobyan, Ghada Ahmed Waheed Ismail, Djibrilla Adamou Issa, Amira Kazem, Rachel Chi Kiu Mok, Arthur Kochnakyan, Susan Lim, Dahlia Lotayef, Harika Masud, Mohamed Nada, Alastair Charles Norris, Pia Peeters, Eric Raoul Philippe, Martijn Gert Jan Regelink, Adeel Abbas Syed and Monica Vidili.

Various inputs were also received from Maissa Gaber Ramadan Abdalla, Fatmaelzahraa Yassein Abdelfat Aglan, Heba Abuellei, Aijaz Ahmad, Heba Yaken Aref Ahmed, Fatimah Mutlaq H Alotaibi, Sara B. Alnashar, Harinath Sesha Appalarajugari, Damian Mckinnon Brett, Mena Cammett, Patrice Claude, Charles Caporossi, Lauren Culver, David, Groves, A S Harinath, Hosam Hassan, Wilfried Hundertmark, Alexander, Johannes Huurdeman, Salma Hany Adly Abdelfattah Ibrahim, Jon Kher Kaw, Arthur Kochnakyan, Peter Ladegaard, Enas Shaaban Mahmoud, Tom Remy, Rianna L. Mohammed, Christina Paul, Fida Rana, Manu Sharma, Maysra Mahmoud Ali Shamseldin and Thi Thanh Thanh Bui.

Detailed feedback, suggestions, and comments were received from internal peer reviewers: Stephane Hallegatte (Senior Climate Change Adviser), Mona Haddad (Global Director), Stephen Alan Hammer (Adviser), Serhiy Osavolyuk (Operations Officer), Fan Zhang (Lead Economist), Vivek Pathak (Director), Somik Lall (Lead Economist), Victor Mosoti (Chief Counsel), Pablo Fajnzylber (Director, Strategy and Operations), Alberto Rodriguez (Director of Strategy and Operations), Hoveida Nobakht (Practice Manager), Ahmadou Moustapha Ndiaye (Director of Strategy and Operations), and Andrea Kucey (Manager), and Lina Abd El Ghaffar (External Affairs Officer). Invaluable comments and inputs were also received from external reviewers: Celine Allard (International Monetary Fund). The CCDR benefitted from dialogue with the Government of Egypt.

The team benefited from close collaboration and feedback from participants to a series of inter-ministerial consultation workshops, and consultations with private sector, think tanks, academics, civil society, and development partners. Inputs from GoE were provided under the overall guidance of the National council for Climate Change, headed by H.E. Prime Minister Moustafa Madbouly, H.E. Dr. Rania

A. Al-Mashat (Minister of International Cooperation) and H.E. Dr. Yasmine Fouad (Minister of Environment).

The CCDR was prepared under the guidance of Ferid Belhaj (World Bank Regional Vice President of Middle East and North Africa), Ethiopis Tafara (World Bank Vice President and Chief Risk, Legal and Admin Officer), Sergio Pimenta, (Regional Vice President, IFC), Marina Wes (Country Director for Egypt, Yemen and Djibouti), Ayat Soliman (Regional Director for Sustainable Development), Paul Noumba Um (Regional Director of Infrastructure), Lia Sieghart (Practice Manager, Environmental, Natural Resource and Blue Economy Practice), and Irina Astrakhan (Practice Manager, Finance and Markets Global Practice).The English version of the report was edited by Erin Aylor.

Acronyms

BAU	Business as Usual
CBAM	Carbon Border Adjustment Mechanism
CCDR	Country Climate and Development Report
CCS	Carbon Capture and Storage
CCUS	Carbon Capture Usage and Storage
CO2	Carbon dioxide
EU	European Union
EV	Electric Vehicle
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IPPU	Industrial Processes and Product Use
MtCO2e	Metric Tonne of Carbon Dioxide Equivalent
NDC	Nationally Determined Contribution
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
SO2	Sulphur Dioxide
tCO2e	Tonne of carbon dioxide
TWh	Terawatt Hour
AAP	Ambient Air Pollution
ASME	Agricultural Sector Model for Egypt
BCM	Billion Cubic Meter
BESS	Battery Energy Storage System
BRT	Bus Rapid Transit
Bscf	Billion standard cubic feet
BUR	Egypt's Biennial Updated Report
CAGR	Compund Annual Growth Rate
CAIT	Climate Analysis Indicators Tool
CAPMAS	Central Agency for Public Mobilization and Statistics
CBE	Central Bank of Egypt
CC	Climate Change
CCCD	Climate Change Central Department
CCGT	Combined Cycle Gas Turbine
CH4	Methane
CIB	Commercial International Bank of Eqypt
CNG	Compressed Natural Gas
COP	Conference of the Parties
CPAT	Carbon Pricing Assessment Tool
CPS	Current Policies Scenario
DSM	Demand-side Management
EbA	Ecosystem-based Adaptation
EBRD	European Bank for Reconstruction and Development
EDGE	Excellence in Design for Greater Efficiencies
EE	Energy Efficiency
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egtyptian Electricity Holding Company
EG	Environmental Goods
EGAS	Egyptian Natural Gas Holding Company
EMIS	Energy Management Information System
ENR	Egyptian National Railways
EPM	Electricity Planning Model
EPR	Extended Producer Responsibility
ESCO	Energy Service Company
ESG	Environmental, Social and Governance

ETI	Energy, Transport and Industry
EWRA	Egyptian Water Regulatory Agency
FI	Financial Institution
FRA	Financial Regulatory Authority
GAFI	Egyptian General Authority for Investment and Free Zones
GCF	Green Climate Fund
GCI	Global Competitiveness Index
GIZ	German Agency for International Cooperation GmbH
gm/kWh	Grams per Kilowatt Hour
GOE	Government of Egypt
GoPP	General Organization for Physical Planning
GW	Gigawatt
GWh	Gigawatt Hour
ha	hectare
HEICS	Egyptian Integrated Household Survey
HFO	Heavy Fuel Oil
IAC	Infrastructure Access Charging
ICE	Internal Combustion Engine
ICT	Information and Communication Technologies
ICZM	Integrated Coastal Zone Management
IDA	Industrial Development Authority
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ILO	International Labor Organization
IPCC	Intergovernmental Panel on Climate Change
ISES	Integrated Sustainable Energy Strategy
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
KPI	Key Performance Indicator
LCH	Low Carbon Hydrogen
LIH	Low Income Housing
lpcd	Liters Per Capita per Day
MACC	Marginal Abatement Cost Curve
MENA	Middle East and North Africa
MFMOD	Macroeconomic and Fiscal Model
MIGA	Multilateral Investment Guarantee Agency
MiNTS	Misr National Transport Study
MLD	Ministry of Local Development
MMBTU	1,000 British Thermal Units
MoE	Ministry of the Environment
MOETE	Ministry of Education and Technical Education
MoF	Ministry of Finance
MoHP	Ministry of Health and Population
MoHUUC	Ministry of Housing, Utilities and Urban Communities
MoI	Ministry of the Interior
MoLD	Ministry of Local Development
MoP	Ministry of Petroleum and Natural Resources
MoPED	Ministry of Planning and Economic Development
MoT	Ministry of Transportation
MoTI	Ministry of Trade, Industry, and Small and Medium Projects
MPA	Marine Protected Area
MRV	Monitoring, Reporting and Verification
MSME	Micro, Small and Medium Enterprises
MSMEDA	Micro, Small and Medium Enterprises Development Agency
MSP	Marine Spatial Planning

Mt	Metric tonne
MTI	Ministry of Trade and Industry
MW	Megawatt
MWRI	Ministry of Water Resources and Irrigation
NbS	Nature-based Solution
NCCC	National Council on Climate Change
NCCS	National Climate Change Strategy
ND-Gain	Notre Dame Global Adaptation Index
NEEAP	National Energy Efficiency Action Plan
NG	Natural Gas
NGFS	Central Bank and Supervisors' Network for Greening the Financial System
NM^3	Normal Cubic Meter
NMT	Non-motorized Transportation
NPV	Net Present Value
NRW	Non-revenue Water
NUCA	New Urban Communities Authority
NWFE	Nexus on Water, Food and Energy
NWRP	National Water Resources Plan
NZ100	Net Zero 100%
NZ60	Net Zero 60%
NZ80	Net Zero 80%
O&M	Operation and Maintenance
ORP	Operational Response Plan
PEVC	Private Equity and Venture Capital
PIM	Public Investment Management
PM	Particulate Matter
PPP	Purchasing Power Parity
PPP	Public Private Partnership
PSP	Payment Service Provider
RCP	Representative Concentration Pathway
RCSF	Regional Center for Sustainable Finance
SCADA	Supervisory Control and Data Acquisition
SCD	Systematic Country Diagnostic
SLR	Sea Level Rise
SME	Small and Medium-sized Enterprise
SNS	Social Networking Services
SOB	State Owned Bank
SOE	State Owned Enterprise
SPC	Shadow Price of Carbon
SWD	Storm Water Drainage
SWM	Solid Waste Management
T&D	Transmission and Distribution
TJ	Liquid Fuels Consumption
TKP	Takaful and Karama Programme
ToD	Transit-oriented Development
TTP	Tertiary Treatment Plant
UHI	Urban Heat Island
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	US Dollar
VAT	Value Added Tax
VKM	Vehicle Kilometer Traveled
WB	World Bank
WRI	World Resources Institute
WWF	World Wildlife Fund
WWT	Wastewater Treatment

WWTP	Wastewater Treatment Plant
μg/m3	Micrograms per Cubic Meter

1. Framing the climate challenge in Egypt's development context

Main Messages

- Climate change will exacerbate Egypt's current vulnerabilities, with the potential to deepen persistent human development and spatial disparities. Climate change increases the uncertainty in availability of water resources in the country, increases heatwaves and desertification affecting biodiversity, and threatens food security and availability.
- Egypt's economic and emissions growth are still tightly linked to each other, as reflected in total GHG emissions from 1990 to 2019, which grew 163% in absolute terms and 47% per capita.[1] Just between 2005 and 2015, emissions increased by about 31%, from 248 Mt CO2eq in 2005 to 325 Mt CO2eq in 2015.[2]
- In 2019, Energy, Transport and Industry accounted for about 80% of total emissions[3] GoE estimates that for 2015 the Energy sector, which includes transport and industry emissions (65%), and Industrial Processes and Product Use (IPPU) (12%), together represented 77% of emissions.[4] Egypt's global emissions remain at around 0.6%.[5]
- A growing urban population (estimated to be 41.4 million by 2050) will put additional strain on urban-area service provision and deepen the exposure of assets and people to climate risks, with those risks disproportionately borne by most vulnerable population.
- Taking action now can bring important savings for Egypt, by limiting the future costs of climate change impacts. Estimates for Egypt suggested that by 2060 the combined impact of climate change will represent between 2% and 6% of Egypt's GDP.[6]

1.1. Progress in development outcomes has been considerable, but structural challenges remain

Egypt's growth continues to show resilience two years into the COVID-19 pandemic, but incipient balance of payments stresses have resurfaced due to spillovers from the war in Ukraine. COVID-19 caused a decline in economic activity, especially in Egypt's key export-oriented sectors, with overall real GDP growth decreasing to 3.3% in FY2020/21, from 3.6% during FY2019/20 (pre-pandemic growth averaged 5% since FY2016) (see Figure 1). Reforms implemented since 2016 through the National Program for Economic and Social Reforms helped cushion the effects of the global economic downturn, but the impact of the pandemic remained significant.[7] The global economic slowdown negatively impacted growth, unemployment, and foreign income sources; however, the economy quickly rebounded, with GDP growth reaching 9.8% in the first quarter of FY2022.[8,9]

---

[1] In 1990 emission were 134 Mt CO2eq and 2.38t CO2 eq per capita, in 2019 emissions were 352 Mt CO2eq (~163% increase from 1990) and 3.51t CO2eq per capita (~47% increase from 1990). Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.

[2] Egypt's First Biennial Updated Report (BUR), 2018. and estimates from the Global Carbon Project for 2020.

[3] In 2019, CAIT suggested that the contribution of these sectors to emission reached over 80%, from Energy (incl. electricity & heat (32%), transportation (16%), manufacturing (11%), fugitive and other fugitive emissions (10%), building (5%)), and 8% from industrial processes. Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.

[4] Egypt's Biennial Updated Report (2018).

[5] Egypt's Biennial Updated Report (2018).

[6] Estimates consider changes in water supplies, agriculture, air quality, heat stress, and tourism. Other sensitive sectors, including water pollution, energy consumption, and biodiversity, are not included in this assessment of impacts. Smith JB, McCarl BA, Kirshen P, Jones R and others (2014) Egypt's economic vulnerability to climate change. Clim Res 62:59-70. https://doi.org/10.3354/cr01257

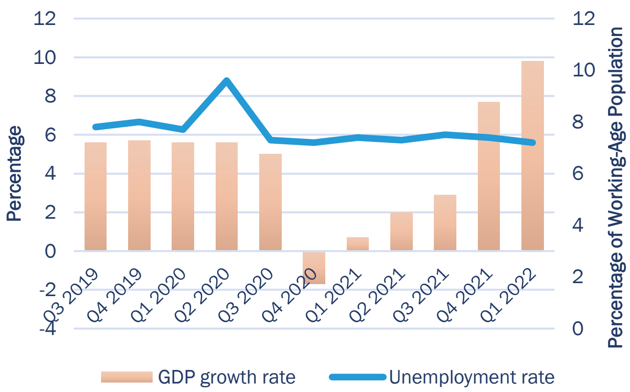
[7] The first phase of the National Program for Economic and Social Reforms was launched in 2016, and it was focused on monetary and financial policies and introduced a targeted social protection program. Its second phase, launched in April 2021, is focused on three sectors: technology-intensive transformative industries, agriculture, and information and communications technology.

[8] Alnashar *et al. 2021/ Egypt Economic Monitor, December 2021: The Far-Reaching Impact of Government Digitalization (English).* World Bank (2021)

[9] Ministry of Planning and Economic Development, data on Real GDP Market Prices (annual % growth). Reviewed on February 28, 2022.

The recently completed World Bank Systematic Country Diagnostic (SCD) identifies key development challenges, including rising poverty, persisting unemployment, and limited productivity growth. Learning poverty remains at 70% and lack of education limits the future productivity of a child born today to only 49% of her potential. [10] Egypt's share of poor (using international poverty benchmarks) increased between 2010 and 2017. According to the national poverty rate (~US$3.80 a day - 2011 PPP USD), the percentage of the poor was 32.5% in 2017-18, although the poverty rate of 29.7% reported for the October 2019-October 2020 period suggests small pre-pandemic gains in people's welfare.[11] That said, the provision of quality basic services and infrastructure have not kept pace with population growth.

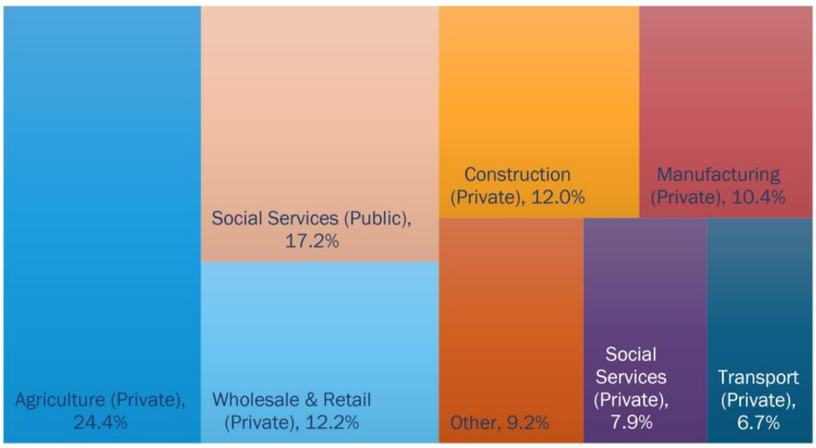
Figure 2. Real growth and employment rates in Egypt (FY2016Q1-FY2021Q4)



Source: CAPMAS and Ministry of Planning and Economic Development

Challenges remain both in the level and structure of growth. Growth has been based on employment opportunities created either in low value-added sectors or in sectors that have experienced a productivity decline.[12] The largest employers are agriculture (24.4%) and the public sector (17.2%), including social services (see Figure 1). Further, at 2.5 percent per year, growth in output per worker (labor productivity) remains low in Egypt.[13] Between 2003/04 and 20017/18, employment creation and sector productivity growth were negatively correlated; this challenge is exacerbated by the Egyptian economy's shift away from tradable sectors, which offer more possibilities for expanding employment in potentially higher value-added sectors.[14] Exports are mainly driven by primary commodities, with oil products accounting for more than 25% of total exports; however, non-tariff and export restrictions hinder Egypt's integration into global value chains.[15,16] An upstream move towards higher value-added, complex manufacturing activities is limited by the costs and the lack of availability of high-quality inputs and technology critical to production. These factors, along with the extensive role of the State-Owned Enterprises (SOEs), regulatory gaps for competitive neutrality, and a need for a more detailed enforcement of contracts, deter the private sector and firm-level productivity from reaching their full potential.

Figure 1. Largest employers remain relatively low value-added (FY16-FY18)



Source: World Bank (2020). Egypt Economic Monitor: From crisis to economic transformation: Unlocking Egypt's productivity and job creation potential

[11] *Egypt Economic Monitor, December 2021: The Far-Reaching Impact of Government Digitalization (English).* World Bank (2021).
[12] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update* World Bank (2021).
[13] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update* World Bank (2021).
[14] Egypt Economic Monitor: *From Crisis to Economic Transformation: Unlocking Egypt's Productivity and Job Creation Potential.* World Bank (2020).
[15] Observatory of Economic Complexity, Egypt's Profile, https://oec.world/en/profile/country/egy
[16] *Country Private Sector Diagnostic: Creating Markets in Egypt*. IFC (2020).

High population growth and rising fertility rates suggest that creating jobs for youth and women will remain a challenge. The employment rate has declined, with structural impediments to labor demand affecting youth and women most deeply. Even before the pandemic, labor force participation was in decline, falling from a peak of 49% in 2010 to 42% in 2019,[17] although it had rebounded slightly to 44% by the end of 2021.[18] While supply-side labor market issues do exist, including skill mismatches and low education quality and relevance, the main drivers of youth unemployment are on the demand side, particularly: (i) an overall decline in the employment rate; (ii) a slow rise in formal private sector employment, mostly in SMEs; (iii) a substantial increase in informal private sector employment from 26% in 2007 to 42% in 2018 in non-agricultural activities; and (iv) a decrease in the quantity and quality of jobs in the past few years, resulting in limited growth in high-skilled occupations.[19,20] Currently, 76% of Egypt's population is under the age of 40, however in 2019, only 24% of youth (ages 15-24) were participating in the labor force.[21] Egypt's high population growth (2.1% across the past ten years) and rising fertility[22] rates mean that creating jobs for these future generations will remain a challenge. In 2021, women's formal labor force participation rate was only 16%, compared with men's 74%,[23] with a notable drop during the pandemic, illustrating this group's vulnerability to external shocks.[24] In addition, poor women are one of the groups with the lowest human capital accumulation in Egypt, putting them at a disadvantage in the labor market.[25]

Addressing these challenges requires reforms and investments, but Egypt faces a financing shortfall to support development projects due to limited fiscal space, low savings rates, and a lack of foreign investment. Egypt is struggling with higher-than-average inflation and lower-than-average savings rates. A large proportion of domestic savings are consumed by an overall budget deficit that is higher than that of Egypt's peer countries, especially due to the size of debt service.[26] Thus, limited domestic financing is available for new investments. The financing gap for development projects was forecasted to reach 6.4% of GDP in 2021/2022.[27] Further, there is room to expand foreign direct investment (FDI) inflows both in size and scope. In 2018 net FDI inflows amounted to 2.7 percent of GDP, slightly down from net inflows of 3.1 percent of GDP in 2017.[28] Such inflows have been concentrated in the petroleum sector (74.3% of the total FDI).[29] In May 2022, the Prime Minister announced a strategy to deal with the implications of the war in Ukraine. The strategy includes enhancing the role of the private sector in the economy, localizing national industry and expanding production, reducing public debt and budget deficit by 2026, revitalizing the Egyptian stock market through a public offering program, enhancing social protection, and ensuring availability of basic commodities.

1.2. Increasing climate risks could exacerbate the existing development challenges

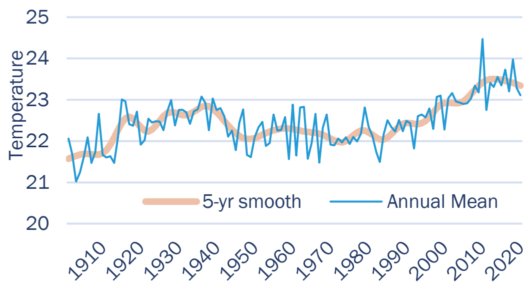
Climate change is expected to increase mean temperatures and heat extremes in an already dry, arid environment. Temperatures in Egypt have already increased over the past decades (0.53°C per decade over the last 30 years; see Figure 3). By mid-century, temperatures are expected to increase between

---

[17] https://data.worldbank.org/indicator/SL.TLF.CACT.NE.ZS?locations=EG
[18] *Egypt Economic Monitor, December 2021: The Far-Reaching Impact of Government Digitalization (English),* World Bank (2021).
[19] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update,* World Bank (2021)
[20] Fedi, L, M Amer, and A Rashad. 2019. "Growth and Precariousness in Egypt." Working Paper No. 2. ILO/SIDA Partnership on Employment.
[21] World Development Indicators (2019). Labor force participation rate for ages 15-24, total (%) (modeled ILO estimate) (SL.TLF.ACTI.1524.ZS)
[22] Average fertility rate averaged 3.35% from 2010-2020. World Development Indicators (2020), Fertility rate, total (births per woman) (SP.DYN.TFRT.IN).
[23] Calculations based on Egypt in Figures March 2022, Central Agency for Public Mobilization & Statistics. https://www.capmas.gov.eg/Pages/StaticPages.aspx?page_id=5035, last accessed on August 22nd, 2022
[24] *Egypt Economic Monitor, December 2021: The Far-Reaching Impact of Government Digitalization,* World Bank (2021).
[25] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth: Egypt Systematic Country Diagnostic Update,* World Bank (2021).
[26] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update,* World Bank (2021).
[27] Human Development Report: Egypt, UNDP (2021).
[28] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth: Egypt Systematic Country Diagnostic Update,* World Bank (2021).
[29] *Country Private Sector Diagnostic: Creating Markets in Egypt*, IFC, (December 2020).

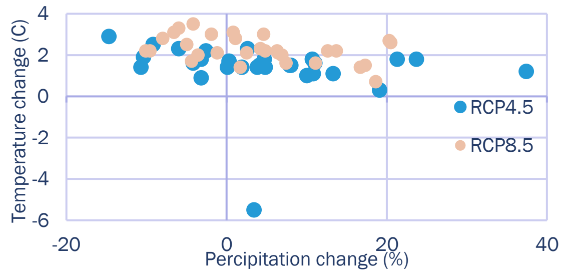
1.5°C and 3°C, with greater increases in the country's interior and during the growing season.[30] Heat waves will increase in their severity, frequency, and duration, with an average of 40 additional days of extremely hot days per year projected by mid-century.[31] High temperatures and more heat waves will raise the already high evaporation rate, accelerate crop transpiration, functionally increase soil aridity, and elevate water requirements for human consumption and agriculture. Finally, evidence shows that temperature increases from 26°C to 31°C can lead to a 30% drop in labor productivity.[32]

Figure 3. Observed temperatures for Egypt



Source: World Bank (2020) Climate Risk Country Profile: Egypt.

Figure 4. Projected precipitation and temperature change values for the Nile Basin, 2050



StaData, Provided for the 29 models recognized by the IPCC for two warming scenarios (RCP4.5; RCP8.5) for September, an example rainy season month

There is high uncertainty around the timing and volume of Nile River water available to Egypt due to climate change impacts. The Nile River accounts for about 97% of freshwater resources in Egypt. Changes in temperature, evapotranspiration (ET), and precipitation in the Nile Basin induced by climate change will significantly affect Egypt's water availability. The global models recognized by the Intergovernmental Panel on Climate Change (IPCC) consistently predict increased temperatures in the Basin but show a wide range of possible precipitation changes (Figure 4). Due to the Nile Basin's unique hydrology and large size, even small changes in precipitation dramatically affect water availability in Egypt. For example, a 1 mm change in precipitation results in roughly a 3 billion cubic meter (BCM) change in runoff at Lake Nasser.[33,34] In the coming century, the variability of the region's rainfall is projected to increase with estimates showing a 50% increase in variability by 2100, thereby impacting the Nile flow into Egypt. This change will result both in more frequent drought years and more frequent high-flow years, as well as increase the frequency and intensity of flash flooding in Egypt's coastal areas.[35,36] Changes in global and regional weather patterns are also altering the seasonal timing and intensity of rainfall in Egypt's coastal areas, which will not materially impact availability of water resources in Egypt given that coastal rainfall provides a small portion of overall water resources,[37] but

---

[30] Historical data used in the Climate Risk Country Profile is produced by the Climatic Research Unit at the University of Est Anglia. Harris I, Osborn TJ, Jones P and Lister D (2020) Version 4 of the CRU TS Monthly High-Resolution Gridded Multivariate Climate Dataset. Sci *Data* 7, 109 (2020). https://doi.org/10.1038/s41597-020-0453-3.

[31] Max daily temperature greater than 40ºC. Source: Harris I, Osborn TJ, Jones P and Lister D (2020) Version 4 of the CRU TS Monthly High-Resolution Gridded Multivariate Climate Dataset. Sci *Data* 7, 109 (2020). https://doi.org/10.1038/s41597-020-0453-3
Climate Risk Country Profile: Egypt, World Bank (2020).

[32] Lee, SW., Lee, K. & Lim, B. Effects of climate change-related heat stress on labor productivity in South Korea. Int J Biometeorol 62, 2119–2129 (2018). https://doi.org/10.1007/s00484-018-1611-6

[33] While median values for temperature and precipitation changes are forecasted to result in almost no change in overall runoff (because the impact of slightly increased precipitation is offset by losses from increased ET) many of the global climate models, together with hydrological models, either predict greatly increased runoff (e.g., +20% by 2050) or greatly reduced runoff (e.g., -15% by 2050). The more extreme dry global climate models with reduced runoff predict a drastic reduction in water availability in the Basin.

[34] *Climate Change and Future Flood Impacts in Alexandria, Egypt's CCDR Background Note. World Bank (2021).*

[35] Siam M. S. and E. A. B. Eltahir (2017) Climate change enhanced interannual variability of the Nileriver flow. Nature Climate Change vol. 7

[36] Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart, 2014: Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

[37] The increase in flash flood events in coastal areas due to climate change is broadly accepted and is referenced in the following reports. Seneviratne, S.I., X. Zhang, M. Adnan, W. Badi, C. Dereczynski, A. Di Luca, S. Ghosh, I. Iskandar, J. Kossin, S. Lewis, F. Otto, I. Pinto, M. Satoh, S.M. Vicente-Serrano, M. Wehner, and B. Zhou, 2021: Weather and Climate Extreme Events in a Changing Climate. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors,

will cause more frequent and intense flash-flood events in Egypt, putting an additional 1.1 million people annually at risk.[38]

Densely populated cities and urban areas in the Nile Delta will be significantly impacted by the combined effects of sea level rise (SLR), increasing flood events and water availability challenges.[39] Local SLR in Egypt has been occurring consistently across the past decades. Sea levels rose from 1.8 mm annually until 1992 to 3.2 mm annually after 2012 and are expected to rise 1-6 mm/year along the coastal zones.[40,41] As highlighted in Egypt's updated NDC, the spatial concentration of cities and fertile agricultural lands in the Nile Delta, which lies ~1 m above mean sea level, and along the Mediterranean Sea and Red Sea coasts, amplifies the potential climate change impacts of SLR on Egypt's population and economic productivity. Egypt ranks fifth in the world in terms of SLR's potential economic impact on urban areas, with damage costs under a medium SLR scenario (RCP4.5 SSP2) of 1% of GDP annually by 2030.[42] Assessments of coastal flooding scenarios conducted for this CCDR estimate that in Alexandria, rising sea levels will also lead to saltwater intrusion, inundation, and erosion, which will amplify climate change impacts on water available for agriculture and affect the quality and availability of drinking water.[43]

Climate change is a compound risk that can deepen current social and economic challenges, in particular persistent human development vulnerabilities and spatial disparities. The poor and most vulnerable are often the most severely affected by the impacts of climate change, while possessing fewer resources to cope with and respond to climate change risks. For Egypt to achieve a just transition, it must ensure that the future growth model accounts for the interdependence between environmental effects and social issues, heterogeneity in the impacts of climate change and climate policies, and adjustment costs over time. It is expected that the population living on less than US$4 a day (approximately the expected national poverty line)[44] will increase by 0.8% by 2030 due to a subset of climate change impacts (effects on agriculture, health, temperature, and increase of natural disasters).[45] Effects will not be felt equally across all regions. Upper Egypt, where about half of the poor live and rely primarily on agriculture for their income (Figure), is expected to see deeper impacts. Further details of impacts on the most vulnerable are provided in Chapter 4.

The health impacts of climate change and extreme weather will affect everyone, but vulnerable groups such as the elderly, children, women, individuals with underlying health conditions, and the rural poor will feel them most deeply. Dust and sandstorms, already common in Egypt, are associated with increases in infectious diseases such as influenza and pneumonia, and the worsening of non-infectious diseases such as respiratory health problems in children and chronic cardiopulmonary diseases in the elderly. Similarly, climate change will indirectly affect health through changes in the ecological ranges and distribution of vector-borne diseases and water-borne pathogens, the availability of water and food,

---

C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1513–1766, doi:10.1017/9781009157896.01, and Climate Risk Profile: Egypt (2021): The World Bank Group

[38] *Climate Change and Future Flood Impacts in Alexandria*, Egypt's CCDR Background Note. World Bank (2021).

[39] Ganges-Brahmaputra delta in Bangladesh and the Mekong delta are the other extreme vulnerability hotspots. IPCC Fourth Assessment Report: Climate Change (2007).

[40] *Climate Change and Future Flood Impacts in Alexandria* Egypt, CCDR Background Note, World Bank (2021).

[41] *Resilient Cities and Coastal Economies*, Egypt's CCDR Background Note, World Bank (2021).

[42] Medium SLR (RCP 4.5, SSP2) scenario follows the historical growth SLR patterns, with an estimates SLR of .13 meters by 2030, .24 meters by 2050 and .58 meters by 2100, The SLR estimates for Egypt were produced using the DIVA model (Dynamic Interactive Vulnerability Assessment model 2.0.1, database 32), a global model to estimate the long-term impacts of SLR. For details in the model, please refer to Nicholls RJ, Hinkel J, Lincke D and van der Pol T, 2019. Global Investment Costs for Coastal Defense through the 21st Century, World Bank Policy Research Working Paper 8745, World Bank, Washington DC. The latest estimates of the DIVA model were updated for the Egypt CCDR background paper, Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021).

[43] *Climate Change and Future Flood Impacts in Alexandria*, Egypt CCDR Background Note, World Bank (2021).

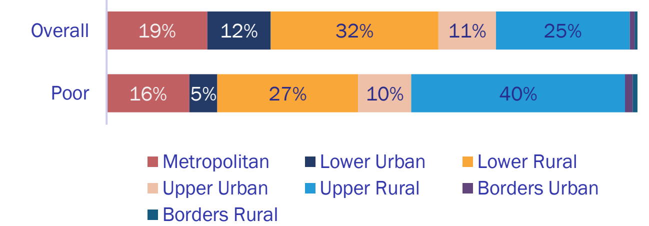
[44] In 2017/2018 the national poverty line was 736 EGP per capita per month or approximately US$3.80 per day (2011 PPP USD).

[45] Additional people below $4 as % of the total population. Data from the report: Hallegatte, Stephane; Bangalore, Mook; Bonzanigo, Laura; Fay, Marianne; Kane, Tamaro; Narloch, Ulf; Rozenberg, Julie; Treguer, David; Vogt-Schilb, Adrien. 2016. Shock Waves: Managing the Impacts of Climate Change on Poverty. Climate Change and Development. Washington, DC: World Bank.

and the association between weather variables and physical and mental health, with particularly acute implications in urban settings.[46,47]

Climate change will also significantly affect biodiversity and critical ecosystems, which will have a multiplier effect on the rest of the economy because they support the income and employment of local communities.[48] The preservation of natural resources is directly connected to the economic growth of the country: 10% of Egypt's revenues come from natural resources.[49] The cost of environmental degradation for the country was estimated at over 3% of GDP in 2018.[50] Climate change will put significant pressure on the country's land and water resources, which are already strained by high population growth and rapid urbanization. The Notre Dame-Global Adaptation (ND-Gain)[51] Index classifies Egypt as "highly vulnerable" to climate change effects.[52]

Figure 5. Distribution of the Overall Population and the Poor Population, by region



Source: Staff's calculations using HEICS 2017/18 following the official poverty methodology.

The cost of limited action on climate change and the associated economic losses, lives lost and decreased health, can outweigh the cost of early action. Global studies cited by the IPCC show that limiting warming below 1.5°C can prevent significant economic costs in the future, with estimates suggesting global GDP losses as high as 2.6% by 2100.[53,54] Moreover, limiting warming to 1.5°C rather than 2°C by 2060 can result in co-benefits of between 0.5% and 0.6% of world GDP.[55] Estimates for Egypt suggest that the combined impact of climate change on water resources, tourism revenue, coastal resources, agriculture and human health through air pollution and water stress, represent between 2% and 6% of Egypt's GDP by 2060.[56]

1.3. Future water availability is uncertain, bringing challenges for consumption and productive sectors

Egypt is currently using more water than its renewable resources supply and is expected to require even more water in the near future, given population growth and the productive sectors' increasing water needs. The potential impacts of climate change in water are recognized in the First Update to Egypt's Nationally Determined Contributions (NDC). According to Egypt's National Water Resources Plan (NWRP 2017), the annual water availability from the Nile River averages 55.5 BCM (Billion Cubic Meters), which is 33.75 BCM less than demand reported in the NDCs. Egypt is considered water scarce but has still

---

[46] For analysis on the climate change and its impact on infectious disease, see Infectious Disease in Relation to Climate Change in the Arab World. In: Laher I. (eds) Handbook of Healthcare in the Arab World. Springer, Cham, 2019; DOI https://doi.org/10.1007/978-3-319-74365-3_135-1, Publisher: Springer Nature https://link.springer.com/referenceworkentry/10.1007/978-3-319-74365-3_135-1

[47] *Climate and Health Profile – Egypt*. World Health Organization (2015). URL: https://apps.who.int/iris/bitstream/handle/10665/208860/WHO_FWC_PHE_EPE_15.06_eng.pdf?sequence=1

[48] Dasgupta, P. (2021), "The Economics of Biodiversity: The Dasgupta Review." (London: HM Treasury).

[49] Natural resources revenue includes those generated by forests (timber and ecosystem services), mangroves, fisheries, agricultural land (cropland and pastureland), and protected areas. *The Changing Wealth of Nations 2021: Managing Assets for the Future*, World Bank. 2021.

[50] Heger, Martin Philipp, Lukas Vashold, Anabella Palacios, Mala Alahmadi, Marjory-Anne Bromhead, and Marcelo Acerbi. 2022. "Blue Skies, Blue Seas: Air Pollution, Marine Plastics, and Coastal Erosion in the Middle East and North Africa." World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

[51] Notre Dame – Global Adaptation Initiative (ND-Gain) assesses a country's vulnerability to climate change and readiness to improve resilience.

[52] ND-GAIN (2021). Egypt. Retrieved from https://gain-new.crc.nd.edu/country/egypt

[53] Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J.Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018, "Impacts of 1.5ºC Global Warming on Natural and Human Systems. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty."

[54] While estimates vary across studies, Burke et al. (2018) indicates that a temperature increase of 3.66°C will result in a global GDP loss of 2.6% by 2100, compared to a loss of 0.3% with a 1.5°C increase.

[55] Burke, E.J., S.E. Chadburn, C. Huntingford, and C.D. Jones, 2018: "CO2 loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2.0 °C."

[56] Smith, J., Jones, R., Elshamy, M and Hassanein, M. (2014). Egypt's economic vulnerability to climate change. *Climate Research.*

not reached the extreme water scarcity threshold of 500 m^3 per person per year (water availability in 2018 was 570 m^3 of freshwater per person per year).[57]

If available water resources remain constant and population growth continues to increase along current trend-lines, estimates suggest that Egypt will reach the extreme water scarcity threshold in 2033.[58] Periods of low flow rates from the Nile will further complicate the existing water scarcity. Drinking water supply is the first priority for water allocation, and the population is most heavily impacted if there is insufficient drinking water due to water stress and scarcity. The average per capita production of drinking water is between approximately 150 lpcd (liters per capita per day) and 300 lpcd, but can be much higher in large cities like Cairo and Alexandria, which produce more than 450 lpcd.[59] The NWRP 2037 recognizes the challenge posed by increased water scarcity and estimates a reduction in per capita drinking water allocation from 309 lpcd to 242 lpcd by 2037, even as total demand will increase from 11.5 BCM to 13 BCM.

The impact of climate change-induced water scarcity will be large, affecting productive sectors such as agriculture. Agricultural and agribusiness products account for 21% of exports, and the agri-food sector provides jobs to a third of Egyptians.[60,61] Recent biophysical and economic model analyses using IMPACT[62] and the Agricultural Sector Model for Egypt (ASME) conclude that by 2050, every crop type will be vulnerable to the biophysical impacts of climate change, including insufficient water, water salinization, heat stress, and heat shocks. Examination of the impacts of reduced water availability show that a reduction from 55 BCM to 45 BCM in Nile River inflow to the High Aswan Dam, a reduction that may be expected during the increasingly frequent droughts in the Basin, can reduce irrigated land by 22%, productivity per irrigated hectare by 11%, and agricultural employment by 9%. Further, overall food production in Egypt is projected to decline by 5.7% by 2050, a higher share than the 4.4% decline predicted for the rest of the world.[63]

1.4. A low emissions pathway can build economic resilience and competitiveness

Egypt's economic and emissions growth are still tightly linked to each other. Egypt's historical share of global emissions is not high, estimated at 0.6% of the global emissions.[64] Despite achieving a relative decoupling, with GHG emissions growth lower than GDP growth, GDP and emissions remain closely linked, with emission growth remaining positive for most of the last 30 years (see Figure 6). GHG emission levels trended upwards between 1990 and 2019, in both absolute (~163% increase) and per capita (~47% increase) terms.[65] Between 2005 and 2015 only, emissions increased by about 31%.[66,67] In 2019, CAIT suggested that the contribution of energy, transport, and industry sectors to total emission reached over 80%, with 74% of emissions coming from Energy (incl. electricity & heat (32%), transportation (16%), manufacturing (11%), fugitive and other fugitive emissions (10%), building (5%)),

---

[57] Egypt First Updated Nationally Determined Contributions, June 2022

[58] Author's calculations based on World Bank population data. In 2018, the GoE estimates an expected fall in water availability to 390 cubic meters per year by 2050. Ministry of Water Resources and Irrigation Strategy 2050 (issued 2016), cited in Egypt First Updated Nationally Determined Contributions, June 2022.

[59] Egyptian Water Regulatory Agency Report for 2017-18.

[60] United Nations COMTRADE database (2020)

[61] The agrifood system–including both farming and off-farm components–accounts for over a third (35%) of all total jobs in Egypt according to WB staff calculations. Estimates from a series of 10 years of LFS data by the Michigan State University/World Bank show that on-farm agricultural activities accounted for 24% of total primary employment in Egypt in 2017, and a further 5% in agroprocessing, 4% in downstream commerce and distribution, and 2% in food preparation.

[62] Perez, Nicostrat's D.; Kassim, Yumna; Ringler, Claudia; Thomas, Timothy S.; and ElDidi, Hagar. 2021. Climate change and Egypt's agriculture. MENA Policy Note 17. Washington, DC: International Food Policy Research Institute (IFPRI).

[63] Perez, Nicostrato D.; Kassim, Yumna; Ringler, Claudia; Thomas, Timothy S.; and ElDidi, Hagar. (2021b). "Climate change and Egypt's agriculture". MENA Policy Note 17. Washington, DC: International Food Policy Research Institute (IFPRI).

[64] Official numbers suggest Egypt's emissions represented 0.6% of global emissions in 2015.Egypt's Biennal Updated Report (2018). Estimates from the Global Carbon Project suggest Egypt contribution to global emissions has remained at around 0.6% in 2020).

[65] In 1990 emission were 134 Mt CO2eq and 2.38t CO2 eq per capita, in 2019 emissions were 352 Mt CO2eq (~163% increase from 1990) and 3.51t CO2eq per capita (~47% increase from 1990).

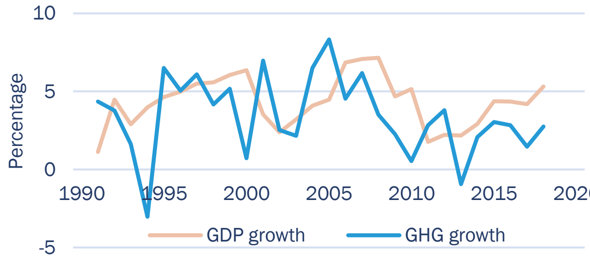
[66] Egypt's First Biennial Updated Report, shows an increase from 248.770 Mt CO2e in 2005 to 325. 614 Mt CO2e in 2015.

[67] CAIT data reports an increase from 244.26 Mt CO2e in 2005 to 352 Mt CO2eq CO2e in 2019. Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.

and 5.4% from industrial processes.[68] Importantly, electricity and transport are the only sectors with an upward growth trend in emissions (Figure 7). Official government sources estimate that for 2015, the Energy sector, which includes transport and industry emissions (65%), and Industrial Processes and Product Use (IPPU) (12%), together represented 77% of emissions.[69]

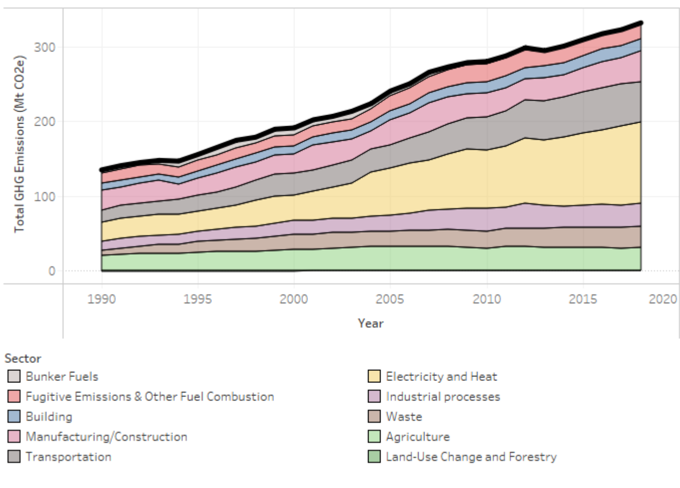
In the energy sector value chain, the production and, particularly, the use of Natural Gas (NG) and crude oil remain the main primary energy supply and GHG emission sources. Despite the ambitious targets for both the integration of renewable energy and adoption of energy efficiency measures in Egypt's Integrated Sustainable Energy Strategy ISES 2035, NG and oil together still represented about 92% of the total primary energy supply in 2019. Oil products alone accounted for 7.6% of total primary energy supply (Figure). According to official data natural gas and petroleum products satisfied 98% of the total primary energy consumption in FY 2014/2015 compared to 1.5% from hydropower, 0.4% from coal, and 0.1% from wind and solar power [70] Egypt's large available power generation capacity surplus of 21 GW in 2022[71] is still largely reliant on thermal plants (90% of installed capacity).[72] This surplus and the remaining lifetime of gas-based power generation capacity limit the space - and need- in the short- to medium term for the integration of RE in the generation mix. This is particularly relevant given the new thermal, combined cycle power plants (14.4GW) commissioned in 2018 accounted for 25% of the actual generation in FY21. These new three plants are highly energy efficient, with comparative low fuel consumption rates (150gm/kWh). In 2021, according to the Egyptian Electricity Holding Company (EEHC) 2020/2021 annual report, the share of non-hydro RE in the total energy mix was just 5% (10,202 GWh generated from wind and solar compared to total generation of 204,794 GWh), still well below its potential.

Figure 6. Decoupling: GHG Growth vs GDP Growth, 1990-2018



Source: Climate Watch. 2022. Washington, DC: World Resources Institute.
Note GHG growth between 2005 and 2015 aligns with official government data (Egypt's First Biennial Updated Report, 2018), as both report a 31% increase in this period.

Figure 7. Emission Profile



Source: WB team elaboration, using data from Climate Watch. 2022. Washington, DC: World Resources Institute. https://www.climatewatchdata.org.

A low carbon transition can foster Egypt's competitiveness and economic growth, as market preferences shift toward greener and lower carbon content products and policies. One example is the European Union's planned implementation of the Carbon Border Adjustment Mechanism (CBAM). As

[68] CAIT data of 2019, from Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org. Official government sources estimate that for 2015, the Energy sector, which includes transport and industry emissions (65%), and Industrial Processes and Product Use (IPPU) (12%), together represented 77% of emissions. Egypt's First Biennial Updated Report (BUR), 2018.

[69] Egypt's First Biennial Updated Report, 2018.

[70] Ibid.

[71] Egypt ERA, March 2022 Report.

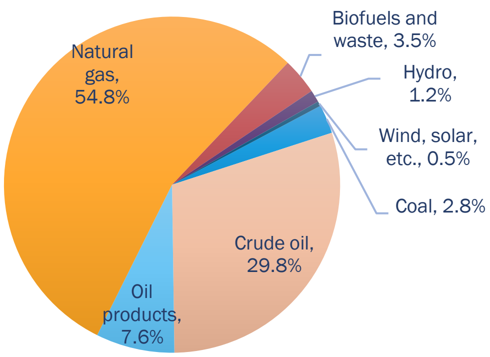
[72] 53 GW of thermal power capacity out of the 58.8 GW total power capacity. In terms of power generation, the share of thermal is 88% (180 GWh thermal out of 204.7 GWh total). Egyptian Electricity Holding Company, FY21 Report.

further discussed in Chapter 3, transitioning to a low carbon path could help Egypt prepare for an uncertain future by strengthening the competitiveness of Egyptian products

There are significant opportunities for decarbonization in the energy sector value chain. In a recent assessment of sustainable energy policies and regulations, Egypt scored 79, above the MENA regional average of 66.[73] Egypt has focused its attention on using NG for meeting its energy needs, increasing levels of renewable energy (RE), and improving energy efficiency on both the supply and demand sides. Today, renewable electricity generation sits at 12.2% of the total power generated in 2021, with installed capacity at 18.9%[74], in line with Egypt's Integrated Sustainable Energy Strategy (ISES) 2035 interim target. Egypt has a strong comparative advantage in RE, with high potential for wind and solar generation. Accelerating the integration of RE in the system in accordance with the NCCS and update NDCs, will require more facilities, including storage systems, to accommodate and stabilize the network.

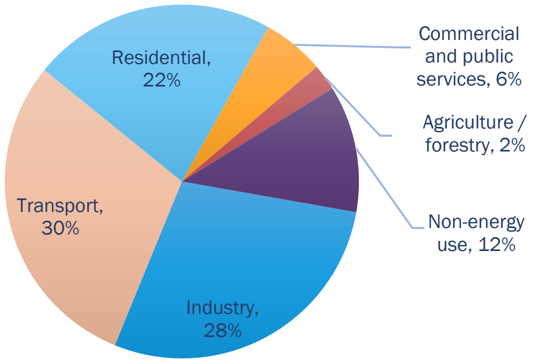
Demand for energy will increase, due to the combined effects of climate change, population growth, urbanization, growing incomes and industrial development. Climate change-driven rises in temperature will have a multiplier effect on demand growth in many of these sectors, for instance by increasing energy demand for the cooling of physical spaces. Moreover, elevated temperatures can decrease the efficiency and lifespan of industrial equipment (e.g., motors, coolers, electrical/electronic components), leading to higher energy consumption. Figure charts total final energy consumption by sector in 2019. For 2015, Official data estimated that energy industries accounted for 43% of energy consumption, manufacturing industries and construction for 23%, transport for 23%, other sectors such as residential for 8% and fugitive emissions from oil and natural gas for 3% of fuel combustion activities.[75]

Figure 8. Egypt's Primary Energy Supply by source (percent), 2019



Source: IEA statistical data, 2019

Figure 9. Final Sectoral Energy consumption by sector (percent), 2019



Source: IEA statistical data, 2019

Transport, the fastest-growing sector, accounts for 30% of energy consumption [76] **and is one of the largest air pollution emitters.** These factors impose a high economic and health toll. Between 2005 and 2019, transport emissions increased 75%, from 31.47 in 2005 to 55.2 MtCO2e in 2019, at a faster rate than total GHG emissions growth (44%).[77] Likewise, Official estimates indicate that between 2005 to 2015 transport emissions increased 66%, from 29.1 MtCO2e in 2005 to 48.3 MtCO2e in 2015, at

[73] RISE is a set of indicators to help compare national policy and regulatory frameworks for sustainable energy. It assesses countries' policy and regulatory support for each of the four pillars of sustainable energy—access to electricity, access to clean cooking (for 55 access-deficit countries), energy efficiency, and renewable energy. Retrieved from https://rise.esmap.org/country/egypt-arab-rep
[74] The 18.9% is calculated by the GoE as the ratio between the RE generation capacity, including solar, Wind and Hydro, to the peak load, not to the total generation capacity which has a huge surplus. In 2019, the Hydro installed capacity was 2.8 GW, and 2.2GW from Wind and Solar, while the total generation capacity including thermal was 58.3 GW. There is a slight change in FY21, as the Hydro installed capacity remained 2.8GW, and the Wind/ Solar was 3 GW, together representing 10% RE out of total generation capacity of 58.8 GW.
[75] Egypt's First Biennial Updated Report, 2018.
[76] Total Final Consumption by sector, IEA statistical data, 2019.
[77] Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.

double the rate of total GHG emissions growth (31%) during the same period.[78,79] As of 2017, road transportation accounted for 11% of overall CO2 emissions,[80] the result of suburban sprawl, passenger cars in large urban regions, and dependency on trucks for freight transport. Emissions in Greater Cairo are among the highest of all global cities, imposing a toll on the health of its inhabitants. Even in MENA, which leads the world in rates of morbidity and mortality due to ambient air pollution (AAP), Egypt has the highest rates. More than 150 per 100,000 people died prematurely in Egypt due to AAP in 2019.[81]

According to the IEA, the industry sector, a key source of economic growth, development, and employment, is the third-largest consumer of energy at 28%.[82] The importance of the industry sector, which contributes one-third of Egypt's GDP, means that it must green its production processes and energy sources. The highest-emitting priority industries for Egypt are iron and steel, aluminum, cement, and oil refineries, which together emit 29 MtCO2e annually (equivalent to about 9% of total GHG emissions in 2015).[83] Emissions in these sectors are expected to continue to increase in tandem with the growing population if no action is taken.[84] Neither the best available energy efficient industrial production technologies nor green management practices, which could both help reduce emissions intensity, are currently practiced widely in the MENA region.[85]

1.5. Growing urban population puts additional stress on services and contributes to increased exposure to climate hazards

Egypt is undergoing high population growth combined with rapid urbanization. The UN estimates that Egypt's population will reach 159.9 million by 2050, up from 102 million in 2020, with 55.6% of the total population living in cities by 2050.[86] Under these forecasts, cities will be required to deliver services to an additional 41.4 million people over the next three decades. Demand will be higher for electricity, water and food, as well as health and education services.[87] In Greater Cairo alone, the urban population is expected to increase by 36% to 28.5 million by 2035.[88]

---

[78] Official estimates indicate that between 2005 to 2015 transport emissions increased 66%, from 29.1 MtCO2e in 2005 to 48.3 MtCO2e in 2015, at double the rate of total GHG emissions growth (31%) during the same period. Growth calculations by the WB staff using data from the Egypt's First Biennial Updated Report (BUR), 2018. In particular, 2005 numbers correspond to those presented in Table 2.1 pg. 64 under BUR estimates. Values for 2015 are extracted from Annex C GHG emissions (CO2e) in 2015 (pg. 141).

[79] Official estimates indicate that between 2005 and 201, the intensity of transport emissions per person increased: per capita emissions increased 29% from 0.41 tCO_2e in 2005 to 0.52 tCO_2e in 2015. Transport emissions per unit of GDP increased at a lower rate – 8% - over this period, from 0.18 tCO_2e per $1,000 (2010 Constant) to 0.19 tCO_2e per $1,000 (2010 Constant). World Bank calculations using data from the Egypt's First Biennial Update Report, 2018.

[80] Emission data provided by Egypt's Fourth National Communication, 2017 emissions. Emissions for road transport are reported at 38,452 Gg CO2e, from a total national emission of 351,192.48 Gg CO2e.

[81] Heger, Martin Philipp; Vashold, Lukas; Palacios, Anabella; Alahmadi, Mala; Bromhead, Marjory-Anne; Acerbi, Marcelo. 2022. Blue Skies, Blue Seas: Air Pollution, Marine Plastics, and Coastal Erosion in the Middle East and North Africa. MENA Development Report. Washington, DC: World Bank

[82] IEA statistical data, 2019.

[83] Team calculations using numbers from Egypt's First Biennial Updated Report (BUR), 2018. Annex E, pg 156-157. The following categories are aggregated: Cement production, Iron and Steel Production, Aluminum and Steel production and Oil.

[84] Energy Transition: Energy, Transport and Industry, Egypt CCDR Background Note, World Bank (2022).

[85] In the MENA region, only 20% of firms adopted any energy efficiency measures, 10% of firms adopted any air pollution control measures, 12% engaged in climate-friendly energy generation on site, 11% adopted water management measures, and 23% adopted energy management measures. European Bank for Reconstruction and Development (2019). Transition Report 2019-2020.

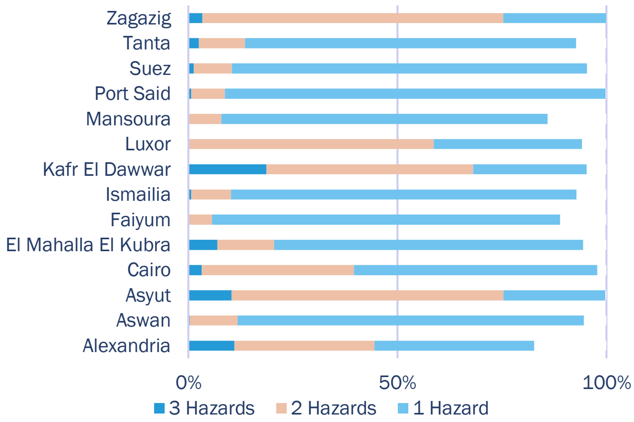
[86] World Urbanization Prospects: The 2018 Revision, Online Edition, United Nations, Department of Economic and Social Affairs, Population Division (2018).

[87] World Bank Open Data, Data Retrieved December 2019. Data Bank: World Development Indicators, Egypt. URL: https://databank.worldbank.org/source/world-development-indicators.

[88] *Resilient Cities and Coastal Economies*, Egypt's CCDR Background Note, World Bank (2021).

Cities, the engines of economic development, may face significant risks to resilience and livability.[89] Egypt's urbanization is centered around 14 medium-to-large-sized cities/urban agglomerations (out of a total of 192), which account for 72% of the country's urban population. Greater Cairo contributes between 47% and 49% of Egypt's GDP, while coastal governorates contribute between 24% and 28% of GDP.[90] A major proportion (between 80% and 100%) of the people in these 14 major cities is exposed to at least one major climate risk, and a substantial fraction faces more than one such risk (Figure). These risks include flooding, heat stress, air pollution, desertification, and, for coastal areas, SLR.[91]

Figure 10. Percentage of Population Exposed to 1, 2, or 3 or More Climate Change Hazards



Source: Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021) using data from the Urban Climate Risk Analysis (World Bank, GFDRR City Resilience Program)

Rapid urbanization has exacerbated urban population vulnerabilities. The rapid growth of Egypt's urban population has resulted in unplanned urban expansion, inadequate access to services, and inappropriate land use. Analyses of the 14 key cities show that urbanization has decreased green areas by ~8.6%, resulting in reduced resilience through the densification of impervious land area. With significant amounts of urbanization on the horizon, a lack of climate-smart planning systems could lead to urban transitions wherein the lock in-effects are not easily reversable: for instance, not incorporating natural air flow in building construction can increase heat and further degrade the livability and productivity of Egyptian cities. This is exacerbated in informal settlements, where no or limited urban planning has already led to limited access to infrastructure including access to clean water, transport services, and good quality housing, which put the most vulnerable at high risk for climate change impacts. In 2019, informal settlements covered around 38% of the built area and housed around 5.2% of the urban population.[92]

Estimates for this report suggest that 80% of Egypt's direct CO2e emissions come from cities.[93] City emissions have increased more than tenfold across the past five decades, from 18 MtCO2e to 182 MtCO2e. Per capita emission intensities in cities have quadrupled between 1970 and 2015, from 0.58 to 2.43 t CO2e.[94] The increase is driven not only by urban growth, economic activity, rising incomes, and changing consumption patterns, but also by policy choices and investment decisions that guide land use planning, building materials and location selections, and the provision of urban mobility services, and

[89] Climate change risks to cities, settlements and key infrastructure will rise rapidly in the mid- and long-term with further global warming, especially in places already exposed to high temperatures, along coastlines, or with high vulnerabilities (high confidence). By 2100 the value of global assets within the future 1-in-100 year coastal floodplains is projected to be between US$7.9 and US$12.7 trillion (2011 value) under RCP4.5, rising to between US$8.8 and US$14.2 trillion under RCP8.5 (medium confidence). *IPCC (2022): Climate change impacts, adaptation and vulnerabilities.*
[90] GDP data comes from Ministry of Planning and Economic Development. (https://mped.gov.eg/Governorate/Index?lang=en).
[91] *Resilient Cities and Coastal Economies*, Egypt's CCDR Background Note, World Bank (2021).
[92] Egypt's 2021 Voluntary National Review, Ministry of Planning and Economic Development.
[93] World Bank staff calculations using EDGAR emissions data combined with information on urban extents. Crippa et al., 2021. "Global Anthropogenic Emissions in Urban Areas: Patterns, Trends, and Challenges. EDGAR data is a global dataset and is based on based on mapping of emitting activities and corresponding emissions factors that are in line with IPCC guidelines. The EDGAR data provides emissions of GHGs and air pollutants for all anthropogenic emitting sectors, following the IPCC categories, namely 'energy-industry' (which includes the combustion in the power and non-power generation industries, fugitive emissions, fuel production, refineries and transformation industries), 'residential' (which includes small scale combustion), 'transport' (which includes both road and non-road transport), 'waste' (which includes solid waste disposal and waste water treatment) and 'other' (which includes all emissions not included in the other categories such as industrial process emissions (e.g. cement production, iron and steel production, non-metallic minerals production, non-ferrous metals production, chemicals production), solvent use, indirect emissions for N2O, etc.). EDGAR data provides Scope 1 emissions spatially across types of settlements. City emissions are aggregated overlaying information on urban settlements with the EDGAR data.
[94] Emission numbers correspond only to urban centers. Data from Emissions Database for Global Atmospheric Research (EDGAR), Crippa et al., 2021. "Global Anthropogenic Emissions in Urban Areas: Patterns, Trends, and Challenges."

solid waste and wastewater management, among others. For example, the existing stock of 21 million residential and public buildings accounts for 17.42 $MtCO2e$[95] annually. Given that Egypt requires an additional 3.8-4.2 million housing units by 2030, along with non-residential buildings (such as offices, hospitals, schools, and hotels), decisions about where these new houses and buildings are placed and how they are built will have a bearing on future emissions.[96]

Urban heat island effects, air pollution and emissions further degrade cities' livability and productivity. The projected temperature increase will result in the increased severity, frequency, and duration of heat waves.[97] Across the 14 major Egyptian cities, nearly 90% of the total urban population lives in areas where surface temperatures can reach extremely high levels of more than 40°C, exacerbating existing urban heat island (UHI) effects.[98] For several cities in Egypt pollution levels measured through particle matter remain at high level, contributing to reducing quality of life and worsening heat-related climate change impacts.[99] Further, the evidence of links between air pollution and health costs in Egypt is strong, with recent work suggesting that the a 10 μg/m3 increase in PM10 causes a roughly 2% percent higher hospital admission rate for respiratory diseases in Egypt, implying important increases in health expenditures and GDP loss.[100,101]

Unplanned and unregulated spatial urban expansion is leading to both increased desertification and an associated rapid decline in arable land as well as urban sprawl, increased congestion, and rising transport emissions. Weak spatial planning systems, resource-efficient territorial planning and land governance challenges, together with the need for land readjustment laws are resulting in significant desertification effects in Egypt. Arable land, a key resource constraint for Egypt, is shrinking at the rate of ~2% per decade as desertification intensifies, especially around urban areas. As a result of urban expansion, the rate at which arable land is being lost has accelerated between 2000 and 2015, with an overall decrease of ~8.6% (43,000 hectares) and decreases as high as 30% in Asyut and Aswan. According to modeling done for this report, continued urban growth and expansion following current patterns would lead to an additional loss of 138 km^2 of natural land is projected by 2030. An additional loss of 251.24 km^2 of agricultural land will result from urban expansion. Similarly, Egyptian cities suffer from fragmented spatial and mobility planning, insufficient public transport systems, heavy congestion, and heavy reliance on fossil fuel-based vehicles. By 2030 in 12 of the 14 large cities in Egypt, density is expected to drop from 316 to 273 inhabitants per hectare, leading to increased dependency on private vehicles, vehicle kilometers traveled (VKT), emissions, and costs. Access to public transportation, green public spaces, and social infrastructure (hospitals, schools, etc.) remains a challenge in all cities, as less than 8% of city residents live within walking distance of a bus stop.[102]

Limited solid waste and wastewater recycling in cities puts additional strain on scarce resources. While wastewater recycling can significantly reduce water security risks from climate change, only 1.7% of generated wastewater[103] in Egypt is treated to tertiary standards, recycled, and reused, suggesting very limited progress on building the basis for a circular economy in cities.[104] Mismanaged wastewater contributes to water pollution, deepens risks of urban flooding, and degrades fertile land. As population

---

[95] Including both embedded carbon and energy consumption. WRI's climate watch data tool https://www.climatewatchdata.org/ (lasted accessed September 30, 2022)
[96] *Resilient Cities and Coastal Economies*. Egypt CCDR Background Note. World Bank (2021).
[97] Calculations using Wet Bulb Globe Temperature, Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021).
[98] *Resilient Cities and Coastal Economies*. Egypt CCDR Background Note. World Bank (2021).
[99] *Resilient Cities and Coastal Economies*. Egypt CCDR Background Note. World Bank (2021).
[100] Heger, Martin; Zens, Gregor and Meisner, Craig. 2019. Particulate matter ambient air pollution and respiratory disease in Egypt. The World Bank
[101] See "Chemical characteristics of atmospheric $PM_{2.5}$ loads during air pollution episodes in Giza, Egypt. Atmospheric Environment, 2017; 150 346e355" funded by Ministry of Higher Education & Scientific Research, for additional detail on the study sources of air pollution, chemical characteristics of $PM_{2.5}$ and health importance.
[102] *Resilient Cities and Coastal Economies*. Egypt CCDR Background Note. World Bank (2021).
[103] Hany F. Abd-Elhamid et. al. "Safe Reuse of Treated Wastewater for agriculture in Egypt", (2018).
[104] Several studies funded by the Ministry of Higher Education & Scientific Research focus on the improvement of solid waste and wastewater recycling, including Polishing of secondary treated wastewater using nano-ceramic hybrid PET waste plastic sheets. Desalination and water treatment, 2021; 217: 214–220, Three-dimensional, flow-through silver-magnetite nanocomposite–modified reactive electrochemical system with slow silver ions release for efficient bacterial disinfection of sewage. Journal of Environmental Chemical Engineering, 2022; 10, 106985., and combining chemical coagulation processes and innovative aerobic reactor for the treatment of de-hairing wastewater, Waste and Biomass Valorization, (2021); 12:2557–2564.

and income increase, so will the volume of waste. In 2018, only 62% of municipal solid waste was collected, leading to illegal landfills and open burning of waste on the street, impacting public health and contributing to ~8% of GHG emissions in 2019.[105,106] Estimates suggest that around 135 million tons of mismanaged waste will be produced in cities between 2021 and 2030. Mismanaged waste with high plastic content (~13%), is expected to continue to contribute to Egypt's enormous share of marine litter, impacting health and coastal economies.[107] Egypt contributes to 0.25 million tons per year of marine plastic waste to the Mediterranean Sea, only followed by Turkey (0.11million tons per year).[108] Egypt is projected to contribute about 0.5 million tons of plastic waste to the Mediterranean Sea by 2025.[109] Growing evidence suggests that plastic pollution (and microplastics) interferes with the absorptive carbon capacity of soils and the world's oceans.

Vulnerability to pluvial flooding and coastal risks (from SLR, subsidence, saltwater-intrusion, coastal storms and urban flooding) will impact the livability and economic productivity of cities. Currently, the resilience of cities even against low-intensity rainfalls is limited due to inadequacy of urban drainage infrastructure and weaknesses in planning, operation and maintenance (for example, there is no separate stormwater management system; all water goes through the sewage network) and limitations in existing early warning systems, which must be improved and enhanced. Coastal cities such as Alexandria, Port-Said, Ismailia, and Suez face the highest level of climate and economic risks.

Coastal and blue economy exposure to climate change is significant and expected to grow. The coastal and blue economies are driven by diverse economic activities of fisheries and aquaculture, tourism, ports and marine transport, and critical ecosystems such as mangroves and coral reefs. All are subject to long-term risks from climate change. Fisheries and aquaculture valued at about US$3.7 billion are a pillar for food security (they contribute to 25% of households' protein intake) and a source of jobs to more than one million people directly and indirectly.[110] Marine capture fisheries have seen a decline in catch volumes over the years even despite the expansion of the fishing fleet.[111] Overfishing, pollution, habitat destruction and climate change have contributed to capture fisheries' declining productivity. On the tourism front, the Red Sea, home to 209 types of coral and over 5% of the world's coral reefs, is a major contributor. Coastal tourism, in particular, has been estimated to account for about half of Egypt's tourism, attracting a total of 13.6 million visitors and contributing about 12% to Egypt's GDP in 2019. The economic benefits of coastal tourism to local communities are projected to be adversely impacted due to coral reef bleaching, retreat of mangrove areas in the Red Sea, and coastal erosion on the Mediterranean coast. Estimates from the High Level Panel for a Sustainable Ocean Economy presented at COP25 suggest that by 2100, Egypt could lose US$5.6 billion in revenue compared to 2019 under RCP 8,5.[112] Coral bleaching has been observed in the Red Sea as far north as Hurghada, although recent studies show that corals of the Red Sea's Gulf of Aqaba have a high bleaching threshold of 32°C, making the Gulf a "coral refuge" of sorts.[113,114] However overfishing and unsustainable practices at local

---

105 Official estimates from the First Biennial Updated Report (BUR), indicate that in 2015, the waste sector contributed also to 8% of the total GHG emissions.

106 2019 data from Climate Watch Historical GHG Emissions. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org/ghg-emissions.

107 Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021).

108 Losses from plastic pollution are estimated at €641 million per year for the Mediterranean, including up to €268 million in tourism, €235 million in the maritime industry, and €138 million in fisheries. Dalberg (2019). "Stop the Plastic Flood: How Mediterranean Countries Can Save their Sea." Report for the World Wide Fund for Nature (WWF), Gland, Switzerland.

109 Dalberg (2019). "Stop the Plastic Flood: How Mediterranean Countries Can Save their Sea." Report for the World Wide Fund for Nature (WWF), Gland, Switzerland.

110 *Capturing Value from the Egyptian Blue Economy: Aquaculture and Fish Supply Chains*. World Fish (2019). Report prepared with support of World Bank and UK Government.

111 *GAFRD, Fish Statistics Year Book (27th Edn.), 27th ed. (General Authority for Fish Resources Development (GAFRD), Ministry of Agriculture and Land Reclamation, Egypt, 2017).*

112 *High Level Panel for a Sustainable Ocean Economy. Summary for Decision-makers: The Expected Impacts of Climate Change on the Ocean Economy. Available at: http://www.oceanpanel.org/sites/default/files/2019-12/expected-impacts-climate-change-on-the-ocean-economy-executive-summary.pdf*

113 Fine, M., Gildor, H., and Genin, A. (2013). A coral reef refuge in the red sea. *Glob. Chang. Biol.* 19, 3640–3647. doi: 10.1111/gcb.12356

114 Fine, M., Cinar, M., Voolstra, C. R., Safa, A., Rinkevich, B., Laffoley, D., et al. (2019). Coral reefs of the Red Sea — Challenges and Potential Solutions. *Reg. Stud Mar. Sci.* 25:100498. doi: 10.1016/j.rsma.2018.100498.

level may put these natural assets at risk even if Red Sea corals are able to adapt to warming water temperatures.

Egypt's geographical location lends significance to ports and maritime transport in both the Mediterranean and Red Seas, linked by the Suez Canal. The Suez Canal is the main trade route between Europe and Asia, accounting for roughly 12% of world sea trade. Approximately 90% of Egypt's international trade is seaborne, with strong reliance on over 60 seaports (15 commercial ports; six mining ports; six fishing ports; five marinas; and 10 oil shipping ports). This seaborne trade is a major pillar of the Egyptian economy and employment. Central to achieving Egypt's plan to become a global trading hub is the role of ports and logistics to enhance capacity, efficiency, and resilience. Climate change is projected to cause disruptions in port infrastructure and operations stemming from coastal flooding and overtopping due to sea level rise, as well as heat stress impacts that may affect both infrastructure and operations leading to subsequent economic losses.[115,116]

[115] *Resilient Cities and Coastal Economies*. Egypt CCDR Background Note. World Bank (2021).
[116] Izaguirre, C., Losada, I.J., Camus, P. et al. Climate change risk to global port operations. Nat. Clim. Chang. 11, 14–20 (2021). https://doi.org/10.1038/s41558-020-00937-z

2. Climate Change Policy, Institutions and Regulatory Framework

Main Messages

- The National Climate Change Strategy 2050 (NCCS) and the First Updated National Determined Contributions mark important steps for Egypt's climate policy, laying down priorities for action in mitigation and adaptation and supported by enabling goals on regulations, financing, technology, and capacity. The strategy builds on various other national articulations, which have contributed to significant progress in climate change adaptation and mitigation action.
- The National Council on Climate Change (NCCC) headed by the prime minister is the main body responsible for climate change, ensuring enhanced coordination and integration of climate change aspect within the national plans and strategies. Dedicated climate units are currently being established in various sectors to enhance coordination and address challenges that stem from overlapping responsibilities between and within sectoral ministries
- Going forward and to achieve national ambitions on climate policy, mobilizing private sector financing on climate change priorities will be key. To provide the right enabling environment it will be important to strengthen regulatory frameworks, support the role of local governments and improve coordination from the center of government to support climate action across the government, public and private sector. Integrating climate-related risks and mitigation actions in budgeting and public investment management (PIM) and improving links between PIM and Private Public Partnerships will be key to ensuring that national budget and investment decisions are aligned with Egypt's climate goals. Further, including climate considerations in SOEs' governance frameworks and improving monitoring, reporting, and verification (MRV) will be conducive to climate action.

2.1. An ambitious climate change policy

Egypt's COP27 presidency provides a unique opportunity to strengthen its role on climate policy and action. The country has already taken important steps and built a strong institutional basis for climate action. But tackling the challenges at the intersection of climate and development described in Chapter 1 will require clear commitments, strong institutions and national regulations, and effective coordination. This chapter presents an overview of Egypt's climate policies, including its National Strategy for Climate Change and related decrees. It also describes the institutional layout for climate action and discusses some opportunities to strengthen it.

Egypt's climate change policy has evolved from adhering to specific international commitments to defining a long-term strategy in line with the country's ambition to become a regional leader on climate change. Since the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, Egypt has developed national strategies, made commitments, and established national steering mechanisms on climate change. As further discussed below, in June 2022, the country launched its First Updated Nationally Determined Contributions (NDC) covering the period between 2015 and 2030. Moreover, Egypt aims to be a regional leader on climate change and has stated its commitment to a sustainable future and a just transition.

The most recent national articulation of climate policy is reflected in Egypt's National Climate Change Strategy 2050 (NCCS), launched in May 2022. The NCCS provides a comprehensive institutional framework for the articulation of climate action to 2050 with two goals on mitigation and adaptation priorities and three enabling goals intended to overcome the governance, financing and technology, and awareness constraints.[117] The NCCS reflects continuity with other national articulations, such as Egypt's Sustainable Development Strategy (Vision 2030). The NCCS lays down clear objectives and targets for Egypt to transition towards a low-carbon development pathway and enhance resilience, and includes the establishment in all the ministries of specialized units in charge of climate change issues (intended to foster institutional coordination at the sector and overall level). The NCCS includes 26 high-priority projects to be completed by 2030. As stressed in Chapter 1, interlinkages across sectoral challenges call for cross-sectoral actions.

In an effort to tackle the compounded risks on energy, water and food, the GOE has put forward the Country Platform for the Nexus of Water, Food, and Energy (NWFE) Program. The platform will facilitate the design, structuring and preparation of concrete and implementable climate action projects. NWFE integrates nine high-priority projects for adaptation and mitigation, bundled around the nexus of Water, Food, and Energy, and selected through a prioritization process led by the GOE. These climate action projects are to be implemented under a programmatic approach and include projects that would replace existing inefficient thermal power plants with renewable energy, enhance small farmers' adaptation to climate risks, increase crop yields and irrigation efficiency, build resilience of vulnerable regions, develop water desalination capacity, establish early warning systems, and modernize on-farm practices.

Implementation of climate policies remains a challenge despite important advances under Vision 2030. Egypt has taken important steps to achieve adaptation and mitigation goals under Vision 2030. While not comprehensive, Table 1 highlights the Egyptian government's key recent achievements in reducing GHG emissions and protecting its population from the impacts of climate change. However, while strategies have been put in place, in many cases their implementation remains a challenge and limited monitoring and evaluation prevents a clear assessment of such advances.

Table 1. Selected Examples of Egypt's Mitigation and Adaptation Achievements Across Sectors

Mitigation Measures	Adaptation Measures
Renewable energy The non-Hydro Renewable energy capacities have been increased form 687 MW in 2014 to 3016 MW in 2021. The most prominent recent renewable energy accomplishments were the launch of Benban Solar Park (total of 1,465 MW), Assuit hydropower plant (32 MW), Kom Ombo Solar PV Plant (26 MW), Zafarana Wind Power Plant (542 MW), Ras Ghareb Wind Power Plant (250 MW), and Gabal El-Zeit Wind Power Plant (580 MW).	**Water resource management** *Irrigation Canals:* Extending/rehabilitating of canals to reduce irrigation water losses. *Protection structures*: Building protection structures to harvest and store additional water. *Wastewater:* Inauguration of the Bahr Al-Baqar, the largest WWTP in the world (5.6 million m3/day) and construction of Al-Hammam WWTP which will be every bigger (6.5 million m3/day). *Desalination plants:* 76 plants are in operation, with capacity expanded from 140,000 m3/day in 2014 to 750,000 m3/day in 2021. Final capacity of 6.4 m m3/day renewable energy-based desalination plants is expected by 2050.

[117] Specifically, the NCCS 2050 goals are 1) Achieving Sustainable Economic Growth and Low-Emission development in the Different Sectors, 2) Enhancing Resilience and Adaptive Capacity to Climate Change and Alleviating the Associate Negative Impacts, 3) Enhancing Climate Change Action Governance and Management, 4) Enhancing Climate Financing Infrastructure, and 5) Enhancing Scientific Research, Technology Transfer, Knowledge Management and Awareness to Combat Climate Change.

Energy efficiency Prominent programs include Improving the Energy Efficiency of Lighting and Building Appliances (2010–2017), Industrial Energy Efficiency (IEE) Project (2013-2018), Solar Heating in Industrial Processes (SHIP) (2014-2022) and Motor Efficiency Improvement (Phase I: 2015 – 2018, Phase II: 2018 – 2022). *Public:* Large-scale transition to energy-efficient lighting systems in Egypt resulted in a 12.8% nationwide reduction in fuel consumption by power stations since 2015. *Industry:* The Environment Pollution Abatement Project Phase III (2017-2022), a mechanism for the adoption of resource-efficient technologies and management. *Policy:* Structural reform of the sector and programs for gradual removal of energy subsidies. Fuel switching programs to substitute lower-efficiency fuels (gasoline, diesel) with cleaner fuels such as Natural Gas and renewable sources.	**Agriculture and livelihoods** *Irrigation modernization program*: The areas that use modern irrigation systems in Egypt account for 4.6 million feddans[118], of which 3.7 million are in the new lands, out of the total 9.7 million feddans cultivated in Egypt.[119] *Canal rehabilitation:* To date, 4,447 km of canals have been lined and rehabilitated and 4,185 km are currently undergoing rehabilitation.[120] The goal is to rehabilitate 20,000 km of branch canals for improved irrigation and drainage service delivery. *Improved techniques and land consolidation*: To support the adaptation of smallholders in Upper Egypt to climate change, the government introduced early warning systems, heat tolerant varieties of common crops, techniques for improving farmland productivity and income, education on efficiency measures such as switching to drip irrigation, and land consolidation. *Policy:* Restrictions on the cultivation of crops with high water content such as rice, sugar cane, and banana, changing sowing dates and management practices, and land reclamation projects for 4 million acres. *Land management:* Reclaimed 4 million feddan (irrigated land for agriculture). *Research:* Establishment of several specialized research institutes, including the Agricultural Research Center, to explore innovative technologies for climate resilient agriculture.
Oil and Gas[121] MOPMR has developed an institutional framework for EE in the petroleum sector including the establishment of:[122] - Higher Energy Committee to promote EE & Climate in the petroleum sector - Energy Efficiency & Climate Department at the MOPMR MOPMR has established an EE policy in line with ISO 50001 requirements, with the main goal of improving energy efficiency for petroleum sector activities to minimize energy consumption, GHG emissions and operating costs. -Recovery and utilization of associated gases generated from the crude oil fields, which is an ongoing program with 19 projects.[123] -Egypt's signing in 2017 of the World Bank Zero Routine Flaring Initiative by 2030.	
Transportation *Railway*: Expansion of the Cairo underground metro system network included the opening of Stage 4 (length 11.5 km – Phase I: 2019, Phase II: 2020) of the third Cairo metro line. Additionally, it includes the expansion and development of electric railway networks. *Buses*: Introduction of a high-quality bus system and electric buses in Alexandria.	

[118] A feddan is an Egyptian unit of area equal to 1.038 acres
[119] Information provided by the Ministry of Water Resources and Irrigation in July 2022.
[120] As informed by the Ministry of Water Resources and Irrigation on July 3, 2022
[121] The following policies were developed with the following objectives: i)Develop energy efficiency departments in all companies: ii) Increase awareness for the importance of reducing energy consumption; iii) Establish energy consumption database and monitoring systems; iv)Implement low cost/ no cost and housekeeping energy efficiency measures; v)Introduce EE New/Oriented technologies to reduce cost and improve yield; vi) Identify KPI and set EE targets for all the petroleum sector companies to minimize the energy consumption and to be reported and reviewed annually during company's general assembly meeting. Information provided by the MOPMR.
[122] Objectives included among others increasing awareness of the need to reduce energy consumption, establishing information and monitoring systems, and identifying indicators and targets for companies in the oil and gas sector to minimize energy consumption.
[123] Information provided by the Ministry of Petroleum.

Electric Vehicles (EV): Developing EV infrastructure and issuance of an EV charging tariff.	
Industry Launch of eco-industrial park pilot projects to catalyze improved environmental and economic performance of industries, according to a framework jointly developed by the World Bank, UNIDO and GIZ.[124]	**Cities and coastal resilience** *Aquaculture:* Investing in establishing large sea aquaculture systems in coastal governorates. *Coastal protection:* Enhancing adaptation of the hot spots on the Mediterranean coast under a GCF-funded project in the North Coast and the Nile Delta regions. *Sea-level rise*: Preparing for sea-level rise by linking land use planning for coastal protection along 100km of coastline, and including shore protection along 40 km. *Municipal wastewater reuse*: Egypt has developed some of the largest wastewater treatment plants in the world (Bahr Al-Baqar, Al-Mahsama, Al-Hammam) as part of a strategy to reuse treated wastewater in agriculture *Municipal solid waste management*: Investments in collection and transportation systems, waste-to-energy and recycling facilities, and landfill development including methane capture.
Solid Waste Management Investments in establishing solid waste management infrastructure in the four pilot governorates (Kafr El-Sheikh – Assuit – Qena – Al Gharbiya) under the Egyptian National Solid Waste Management Programme. In Greater Cairo, the Air Pollution Management and Climate Change Project (2020 – 2026) focuses on reducing vehicle emissions, improving the management of solid waste, and strengthening the air and climate decision-making system.	
	Education Universities are including climate change in their education curriculum to help build needed skills and increase awareness.[125]
Sources: EEAA (2021) Sowing seeds for Future generations: http://mdgfund.org/content/climatechangeriskmanagementegypt; Mahmoud, S. H., & Gan, T. Y. (2018). Urbanization and climate change implications in flood risk management: Developing an efficient decision support system for flood susceptibility mapping. Science of the Total Environment, 636, 152-167. Egypt First Updated Nationally Determined Contributions, June 2022.	

2.2. Coordination, capacity and robust MRV to enable effective climate action

Egypt has made significant institutional changes to address climate challenges, nonetheless climate action remains fragmented. Recognizing that climate change will have implications across all sectors of Egypt's economy, the GOE revamped the institutional framework for climate action. The national climate change committee, established in 1997, was restructured in 2015 and then elevated in 2019 to be headed by the Prime Minister, ensuring that climate change issues receive the highest consideration in the GOE's decision-making. The NCCC is supported by a high-level committee to oversee strategic issues related to climate action in Egypt, an executive bureau to supervise the implemented policies or actions, and specialized technical working groups responsible for tracking the progress on policies and actions. In 2020, the Government took two important climate-related actions: first, it mandated all ministries to focus on the shift toward the Green Economy and increase public investments directed to green projects from 15% in the 2020-2021 plan to 30% in the 2021-2022 plan, and second, it required all ministries to apply the sustainability standards, including climate change, in the national Sustainable Development Plan. Although the NCCC is the main body responsible for climate change policy, policies are formulated and implemented by many ministries, leading to fragmentation and coordination difficulties.[126] In May 2022, Egypt adopted the NCCS 2050 through Prime Ministerial Decree (No.1860 of 2022) and all concerned ministries are required to develop action plans in coordination with the NCCC. Climate change is by definition cross-sectoral, leading to an

[124] United Nations Industrial Development Organization "UNIDO and Switzerland to support Egypt with the development of eco-industrial parks (17 January 2022) https://www.unido.org/news/unido-and-switzerland-support-egypt-development-eco-industrial-parks
[125] Information provided by Ministry of Higher Education and Scientific Research.
[126] *Human Development Report: Egypt,* UNDP (2021); Abdel Monem, M. A., & Lewis, P. (2020). "Governance and Institutional Structure of Climate Change in Egypt" in *Climate Change Impacts on Agriculture and Food Security in Egypt* (pp. 45-57). Springer, Cham.

inevitable overlap of ministerial responsibilities.[127] For example, the Ministry of Environment's area of responsibility has been expanded to include topics such as industrial pollution, waste management and water quality, which had historically been under the jurisdiction of other line ministries. Better coordination and clarity of roles are needed to reduce overlap in responsibilities and inconsistency in the formulation and implementation of climate change policy. Given Egypt's dual executive system,[128] national fragmentation challenges on climate action and planning are replicated at the local level.

Strengthening the regulatory framework can help engage a wide range of stakeholders, including the private sector. The major environmental protection laws enacted across the period mentioned above to address gaps related to water pollution, hazardous substances, and waste management,[129] also advance climate change priorities. Decrees as executive orders have also been published on the climate agenda. For instance, Presidential Decree 566 of 2016 mandates that all agencies comply with the Paris Agreement. However, additional steps are needed to transform such decrees into regulations that are more comprehensive and have wide-ranging applicability. Adopting regulations that improve compliance with and participation in climate-sensitive and green management practices by a wide range of stakeholders, including the private sector, facilitates awareness for climate action. The revised Environmental Protection Law (Law no. 105, adopted in 1994 and amended in 2015) with a chapter on climate change, improves the scope for compliance and contributes to increasing awareness of climate action.

Strengthening sector-level, climate change-related capacity at the national and local levels is a priority for strong interagency cooperation and will require both a national strategy and coordination to build human capital capacity for climate change. The institutional capacity at the sector level is concentrated in a few institutions, such as the climate change central department at the Ministry of Environment, the climate change and energy efficiency units at the Ministry of Electricity and Renewable Energy, and the energy efficiency unit at the Ministry of Petroleum. To address this gap, the first systemic capacity development initiatives have been set up and carried out within key institutions.

Putting in place climate-sensitive governance and institutional frameworks to mainstream climate change in core government and broader public sector operations will be critical for supporting climate action. Integrating climate in planning and public financial management to establish a coordinated approach across government (central and sectoral ministries at the national level as well as subnational governments) and the broader public sector will be key. Under the Green Financing Framework, Egypt determined that by 2025, 50% of public investment projects should be green. While this is a step in the right direction, work remains to further strengthen public investment management by government and public sector entities. Additionally, coordination of the capital and recurrent budget processes to support the allocation of limited public funds to climate-responsive projects should be improved. Including climate objectives in a governance framework for state-owned enterprises will be equally important given the large number of SOEs that are present in most sectors of the economy, affecting competition and market contestability. Egypt should continue ongoing efforts to ensure that public assets and investments comply with climate change requirements, including disaster and risk assessments.

The NCCS 2050 affirms the role of the private sector in climate action. For example, under the broad goal of enhancing climate change action governance (Goal 3), the NCCS sets out an objective (3.c) for

---

[127] Institutions involved in climate change policy include the Ministry of Environment, the EEAA, the Ministry of Trade and Industry, the Ministry of Health and Population, the Ministry of Petroleum, the Ministry of Electricity and Renewable Energy, the Ministry of Education and Technical Education, the Ministry of Higher Education and Scientific Research, the Ministry of Agriculture and Land Reclamation, and the Ministry of Water Resources and Irrigation, among others.

[128] In this system, national ministries have sectoral directorates, with sectoral budgets at the governorate level,

[129] For example, the recently enacted Decree 113 of 2022 defines fee schedules for waste management licenses and approval, a step toward implementation of the Waste Management Law no. 202 of 2020

sectoral policy reform to capture the required climate change mitigation and adaptation interventions and specifies that the necessary sectoral policies should be developed and reformed to ensure the involvement of the private sector and all relevant groups. This provides a means to anchor the private sector's role in climate action in existing economic policy programs, such as the National Structural Reform Program. On the finance side, mobilizing private sector financing on climate change priorities will be key in the coming years.

Empowering local-level institutions and strengthening their institutional capacity and systems is vital for Egypt to advance action against climate change at the local level, both for building resilience to climate hazards and chronic stresses, as well as for decarbonizing its economy. Egypt's climate change governance at the local level remains limited. It is essential that the local administration system is functional and capable of, first, assessing the climate risks and their impacts in a spatially focused and integrated manner, and second, identifying, prioritizing, planning, and implementing actions to ensure that communities and citizens are protected from the disastrous effects—and accompanying economic losses—of climate risks. However, at the subnational level, decision-making power relating to planning and budgeting is limited.[130] Local administration units in Egypt have a relatively narrow scope for public investments, with local governments being highly dependent on national transfers. The result is a lack of sufficient local-level autonomy and financial capacity for successful climate change action, especially for adaptation measures

Climate sensitivity needs to be integrated into city and local government planning and management (covering spatial, land-use, infrastructure, economic development, and investment/financial management dimensions). While local service delivery plans and local sectoral investment plans are prepared through a bottom-up approach, limited decision-making power at the subnational level, as mentioned previously. Further, the investment planning process is fragmented, resulting in weak linkages between the national socioeconomic plan and sub-national plans. The socioeconomic development plan is, therefore, implemented with limited synergies between different sectors from a spatial/regional perspective. It also lacks a climate resilience and low-carbon focus. These gaps, if left unaddressed, will impact the implementation of climate resilient pathways for cities, and limit their capacity to engage into public-private partnerships for green investments in infrastructure and utilities. It is vital that the planning process at the sub-national level be integrated, climate-risk informed, emission-sensitive, and well-resourced to ensure the identification and implementation of priorities to drive sustainable, resilient, and inclusive development.[131]

2.3. Egypt's Updated Nationally Determined Contributions (NDC)

In June 2022, Egypt submitted its First Updated Nationally Determined Contributions (NDC) setting quantitative targets for reducing harmful emissions. Egypt's first NDC was submitted in 2015 and highlighted priorities for climate change, including qualitative goals for mitigation and adaptation. The updated NDC features clearly defined targets and measurements, as well as mechanisms to ensure the monitoring of progress. Such quantifiable targets include mitigating 33% of emissions from the electricity sector, 65% from the associated gases subsector of the oil and gas sector, and 7% of emissions from the transportation sector by 2030, against a business-as-usual (BAU) scenario (with 2016 as the starting year of projections). The estimated cost of implementing the proposed mitigation interventions provided in the updated NDC is US$196 billion by 2030, while implementation of

[130] The majority of local administration funding (both for recurrent services as well as local investments) is provided by central transfers due to the limited ability of the local government to create taxes, with only vehicles tax and local fees being collected at the local level.
[131] Initial steps have been taken to localize SDGs and improve the institutional and service delivery performance of governorates, with an initial focus on the Upper Nile. The Egyptian government has recently promulgated a new planning law for governorates that requires all the spatial, economic and investment plans at the local level to be climate-risk informed and to incorporate green development solutions/models. Ongoing flagship government programs such as "*Haya Karima*" and the Waste Management Law no. 202 of 2020 could also help the pivot toward climate-resilient and green development approaches for long-term sustainability.

adaptation interventions is estimated to require US$50 billion. The updated NDC is based on the goals and objectives presented in Egypt's 2050 National Climate Change Strategy (NCCS). The BAU scenario in the updated NDC reflects continuation of the same development trends and practices that were followed by the country before 2016.

Between 2015-2021, in efforts to transition towards clean energy, Egypt successfully implemented a number of electricity sector reforms which bore fruit. Most notably a phased removal of energy subsidies (both electricity and fuel subsidies) and improved power plant and demand-side energy efficiency. These reforms were accompanied by efforts to scale up the share of renewable energy, particularly utility-scale solar and wind (such as the Benban solar park and Jabal Al-Zit wind farm), as well as the discovery of large commercial-scale gas reserves that resulted in the deployment of new more energy-efficient combined cycle gas-fired power plants. This electricity sector transformation led to a considerable reduction in the growth of energy demand, improvement in generation efficiency, and a sectoral shift away from plans to construct high emitting coal-fired power plants (with no coal projects developed or currently under development). These developments suggest that future capacity additions for electricity supply over the next two decades can complement the energy-efficient combined cycle gas-fired power plants with renewable energy and demand-side energy efficiency improvements across various end-use sectors.

Importantly, the update to the NDCs also puts forward key adaptation actions and the need to strengthen MRV systems. In terms of adaptation, the updated NDC provides a set of policy actions and measures across Water Resources and Irrigation, Agriculture, Coastal Zones, Urban Development and Tourism and other adaptation actions such as early warning systems and resilience measures in the most vulnerable regions.

Building appropriate MRV systems to track improvements is an important step in strengthening Egypt's climate commitments and enhancing implementation of existing policies. As outlined in the updated NDC, measurement, reporting and verification (MRV) systems would be fundamental to enhance national and international climate action. Egypt has drafted a proposed national climate MRV structure, coordinated by the Climate Change Central Department. The MRV pathways for data flow consist of four tracks: (i) GHG Inventory MRV, (ii) Mitigation Policies and Actions MRV, (iii) Support Received MRV, and (iv) Adaptation Policies and Actions MRV. While the proposed MRV framework has been formally adopted by the NCCS, it has not yet been institutionalized, and funding and other capacity building and technology resources are pending for its launch. In addition to the current MRV targets, the national system could also examine the social impacts of projects, including the social impacts related to climate change. Currently the country is implementing the second phase of the Interactive Vulnerability Map for the Risk of Climate Change that links mathematical models to a geo-climatic database to assist policymakers in identifying areas exposed to potential risks and strategically mobilize resources.

3. Pathway Toward Resilience and Low Carbon Development

Main Messages

- Egypt should focus on managing risks stemming from uncertain water availability and on enhancing the resilience of people and firms in cities and coastal areas. The high contribution of the energy, transport and industry sectors to Egypt's total emissions suggests that focusing on these sectors will allow Egypt to accelerate its transition to a low carbon development path, building on the current efforts undertaken by the government.
- There are two courses of action to address climate challenges and deliver on national strategies and visions, including the NCCS 2050:
    - Strengthen resilience and adaptation to prepare for an uncertain future by (i) Enhancing efficiency in how resources are used and allocated; (ii) providing better information and information systems and increasing awareness about climate change impacts for collective action; and (iii) enhancing resilience and reducing the risk of stranded assets through complementary actions.
    - Move to a low carbon trajectory to strengthen export competitiveness, leverage co-benefits of emission reductions, and avoid the lock-in of carbon-intensive capital, by (i) accelerating the transition to renewable energy ; (ii) reducing emissions in the oil and gas sectors and lower intensity of the energy supply mix; (iii) reducing inefficiencies in the production and use of energy for electricity and industry; (iv) reducing the carbon intensity of the transport; and (v) taking synergistic actions across adaptation and mitigation.

3.1. Strengthening resilience and adaptation

Climate change creates increased uncertainties in water availability and amplifies risks from natural hazards, with large impacts concentrated in cities and coastal areas. As stressed in Chapter 1, climate change increases rainfall variability, resulting in high uncertainty of water availability for people and productive activities, in particular agriculture. The spatial concentration of people and economic activities in coastal areas suggests that the exposure of people and the economy to climate change is high today and is set to increase in the future. Importantly, as highlighted in the diagnostic presented in Chapter 1, climate change risks are not isolated but intertwined across sectors. While these sectoral interlinkages are not the only ones that represent opportunities for strengthening resilience to climate change in Egypt, these areas of focus were selected through the review of climate and development challenges discussed in Chapter 1, and a consultative process with stakeholders. In the face of these challenges, this section builds upon modeling and qualitative analysis focusing on (i) the intersection of challenges between water and agriculture and (ii) the risks and opportunities present in cities and coastal economies.[132] The impacts of future water variability and policy measures at the intersection of water, agriculture, and energy challenges are explored through a combination of two modeling exercises: (i) an irrigation study combining the Agricultural Sector Model for Egypt (ASME) model (to test policy and investment options to determine potential damages due to reduced water availability or insufficient adaptation investments) with an institutional assessment to identify more suitable policy options/investments for irrigation modernization; and (ii) financial modeling and technical calculations to quantify investment needs and energy/GHG savings related to investments in desalination, biogas capture, non-revenue water reduction and water use rationalization. To understand the challenges in urban and coastal areas and to identify opportunities for strengthening the resilience of people and firms, this section leverages analysis focused on the city of Alexandria to illustrate flood risks, and urban growth modeling in Egypt's 14 largest cities paired with a qualitative analysis of cities and coastal

[132] Background notes: Climate Change and the Water-Food-Energy Nexus Note, and three background notes on cities: Resilient Cities and Coastal Economies Note, Climate Change and Future Flood Impacts in Alexandria Note, and Coastal and Marine Economy in Advancing Climate Change Priorities of Egypt Note. All World Bank, various dates.

economies to identify opportunities to enhance resilience (and opportunities for emission reduction, as discussed in the following section).

A focus on improving information, reducing inefficiencies and strengthening resilience of infrastructure can help Egypt cope with an uncertain future. Managing risks by providing the information and tools that governments, people, and firms need to cope with uncertainty is the first step toward strengthening resilience and adaptation. Investments in information to manage risks, produce early warnings and incentivize favorable behavior changes are also cost effective, with an estimated cost benefit ratio of 1 to 9.[133] Reducing inefficiencies can help minimize the losses from climate hazards as well as contribute to slowing climate-related impacts (e.g., water scarcity, heat, floods, etc.) on productive sectors. Finally, efforts are needed to expand infrastructure that protects households and firms from climate-related hazards. Laying the foundations for the private sector to increase its contribution to adaptation through innovation and financing will be important.

3.1.1. Enhance efficiency in how resources are used and allocated based on their true value

To minimize losses from climate change risks, it will be key to reduce inefficiencies in how resources are used, allocated and valued. Inefficiencies can arise from the waste of resources (natural or built capital), lack of coordination between the institutions in charge of implementing policies, overlapping functions, or a misallocation of subsidies, leading to resource waste. Reducing inefficiencies can help reduce waste and effectively increase the availability of resources.

Reducing losses of scarce resources

Without additional measures to increase water efficiency in agriculture, water scarcity will increase net virtual water[134] imports by 15% by 2030, reaching 45% in drought periods. The transition to a sustainable development model requires reducing waste and losses and improving the way scarce resources are used, especially water. Given Egypt's unique arid climate, agriculture in the country relies almost entirely on irrigation systems, but a large portion of farms are likely to face severe water and agricultural production risks if traditional irrigation practices are not modernized. With its drainage reuse policy, the GOE has already taken steps to augment irrigation supplies. This has raised the system's efficiency up to 78%. When fully operational, Al-Mahsama, Al-Hammam and Bahr Al-Baqar WWTPs, can recycle over 13 MCM of treated wastewater for agriculture. When completed, the Irrigation Modernization Program is expected to increase the productivity of water use in agriculture by an estimated 15%, while also enhancing the resilience of the food and agriculture systems to water-related risks and limited water availability (drought). ASME model analyses suggest that irrigation modernization will result in a 6% increase in gross agricultural production value, due primarily to a 10% increase in irrigation efficiency at branch canal and farm levels, and a 7% increase in cropping intensity (shifting towards less thirsty, high-value seasonal crops). Notably, intensification of the food systems is expected to raise agricultural employment by 5% and reduce food imports by 12% compared to the reference scenario. These measures are remarkable, but still not fully adequate given the water shortages Egypt faces. Given current levels of efficiency, without further action it is expected that water scarcity will increase net virtual water imports by 15% by 2030, with this figure jumping above 45% during periods of drought.[135] Additional water efficiency measures in agriculture and improvements in irrigation service delivery systems are needed to maintain productivity and improve value given a changing climate. Irrigation modernization is not expected to deliver substantial water savings at the Nile system level, although farm-level savings provide an opportunity for intra-system resource re-

---

[133] "Adapt Now: A Global Call for Leadership on Climate Resilience," Global Commission on Adaptation (2019). https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/
[134] Virtual water refers to the water "hidden" in the products, services and processes people buy and use every day.
[135] *Irrigation Modernization Policy Dialogue*. World Bank (2021).

allocation. Drip irrigation and sprinklers operate at high efficiency and apply less water more uniformly to fields, allowing farmers to produce a more diversified crop mix of higher value with less water.

Institutional reforms are needed to align cross-sectoral priorities and actions that impact water use and allocation. Multiplicity of institutions in the water sector and limited coordination between water and agriculture institutions also lead to inefficiencies in water use and allocation, arising from duplicated efforts or missed opportunities from uncoordinated actions. Implementation of water-related climate adaptation actions is currently tasked to eight different agencies,[136] with each agency pursuing adaptations aligned with its own priorities and timeline. Coordinated planning and implementation based on a shared set of development and adaptation goals can instead reduce the risk of over- or under-investment, duplication of efforts, and high transaction costs. One recommendation to address this problem is institutional reforms that align food security and water security objectives through the balancing of domestic production for food self-sufficiency with food trade policies. Egypt exports high-value fruits and vegetables such as citrus, potatoes, onions, and grapes, with horticulture only generating over US$ 2 billion in export earnings in 2020.[137] Egypt imports about 40% of its food needs annually (it is the largest importer of wheat in the world), with imports representing US$6.3 billion in 2019.[138] Model analyses suggest that to produce an additional 5 million tons of domestic wheat, Egypt would require almost 5.5 BCM of water—the equivalent of 10% of its primary supplies from the High Aswan Dam. Efforts to scale up the delivery of treated wastewater for use in agriculture will supplement water availability for specific types of crops such as forage and fiber crops[139], but must be advanced in coordination with improved land use planning, efforts to modernize irrigation practices, appropriate crop choices, and the scaling up of implementation of on-farm, climate-smart agriculture practices that ensure that crops and on-farm practices align with the salinity levels of the reclaimed water. Economic and financial analyses of the investments that would be needed to scale up use of these adaptation tools would help the GoE choose among alternatives and maximize the cost-benefit ratio of investment in adaptation. Synchronized planning would ensure that opportunities for increased yields are maximized, while increased coordination and better understanding of tradeoffs would help to ensure that operating and maintaining these more efficient systems will be financially sustainable.

In cities, rationalizing urban water use, enhancing the efficiency of urban water service delivery systems and reducing non-revenue water[140] could help Egypt save over 2 BCM of water annually.[141] Egypt's Sustainable Development Strategy 2030 has targeted a reduction of water losses from 29% to 15%. There is a significant opportunity for Egypt to rationalize urban water usage and improve efficiency in operations—increasing its ambition for reducing water loss—by reviewing current norms and targeting investments that help reduce technical and commercial losses. The NWRP 2037 targets a per capita allocation of 242 lpcd by 2037, but this would still lead to an increase in demand from 11.5 BCM to 13 BCM by 2037. Bringing down water losses to 20% and revising water supply norms to 80% of current levels (which would still be a high value), could help Egypt save an additional 2.2 BCM of water annually by 2050 (over a third of estimated water production in 2050 for domestic consumption)—over and above the NWRP target—through reduced demand and improved efficiency, thus making water available for other uses. Today, water supply for some areas in Egypt remain as high as 400 lpcd.[142] While industrial water use was not studied extensively as part of this report, some of the industries

[136] The NWRP 2037 defined the following ministries as coordinating public entities for different outcomes: Ministry of Water Resources and Irrigation, Ministry of Environment, Ministry of Housing, Utilities and Urban Communities, Ministry of Local Development, Ministry of Agriculture and Land Reclamation, Ministry of Trade and Industry, Ministry of Foreign Affairs, and Ministry of international Cooperation.
[137] FAO (2021). FAOSTAT Food and agriculture data. Food and Agriculture Organization of the United Nations (FAO)
[138] Ibid
[139] Regulatory control is exercised to ensure that the water quality of treated wastewater reuse is acceptable for the crops where it is practiced, in particular for non-food crops such as forage and fiber crops.
[140] Non-revenue water (refers to volume of water that is lost due to physical losses such as leaks in the distribution system, reservoirs, household service connections, etc. and commercial losses such as pilferage, illegal connections, metering inaccuracies etc.)
[141] Egypt plans for an average annual water availability of 55.5 BCM for all water uses, of which approximately 24 percent or 13 BCM is allocated for drinking water while the actual production is 11.52 bcm. The bulk of the remaining water is used for agriculture and a small proportion for industries. (CAPMAS 2021).
[142] This is over twice as much as water supply in Jordan, Morocco, and Tunisia (168, 155, and 159 lpcd). Global Water Intelligence (GWI) WaterData Indicators database, 2016.

prioritized as growth industries by the authorities are water-intensive, such as textiles and apparel. It will therefore be important for water resource efficiency and water treatment to become an integral part of forthcoming export competitiveness strategies.

Ensuring food security will require focused, short- and medium-term actions in rural areas to reduce waste through investments in improved storage infrastructure for strategic grains. Further, such investments can help strengthen climate resilience and build competitiveness while reducing waste/losses along the agri-food value chain. Average losses in the wheat supply chain can account for up to 12% or around 1.2-2 million metric tons per year, with an estimated cost of around up to USD $1 billion at current prices. The highest losses in the wheat supply chain are seen in post-harvest handling and storage.[143] This is an area that the GOE is already actively trying to address, by rehabilitating existing storage facilities and building new ones, to reduce losses in the system. Open-air storage facilities (*shona*), for example, do not provide protection from birds, rodents, weather changes, and insect infestation. Extreme temperatures and increases in atmospheric humidity due to climate change increase the risk of insect infestation, a source of wheat loss and health risks. Safe wheat storage is considered a measure to adapt to climate change and contributes to food security, particularly in the context of the expected drop in domestic wheat production due to climate change.[144]

Allocation of resources according to their value

Agricultural water allocation reform that recognizes the economic and social value of water could help incentivize the adoption of climate-smart technologies in agriculture. A policy on water allocation is evolving. The current policy, the Logical Framework of the National Water Resources Plan 2017-2037 contains specific policy objectives focused on the supply of water for domestic use, industry and irrigation purposes, but these policies do not include a water allocation policy that would use economic efficiency allocation considerations to guide the distribution of water. Rather, water is allocated to the urban system based on demand (which is highly variable between cities, without efforts to curb higher demand) and to various parts of the agricultural system based on land area irrigated in combination with crop-specific norms. Water-intensive crops such as rice and sugar cane have a higher irrigation water requirement compared to wheat or barley, but do not have a higher value per cubic meter of water used. By reforming the allocation policy to consciously maximize social and economic gains from water allocations, including through the reduction of allocations to areas that have modern irrigation systems,[145] the GOE will incentivize farmers to adjust their cropping systems and on-farm water management practices to improve productivity and value from agriculture. Closer examination of allocation among and within sectors is needed to improve the efficient use of resources by recognizing their true social and economic value; an allocation policy among agricultural users is needed to meet the goals of the Irrigation Modernization Program.

Rationalizing urban residential water tariffs will also support improved water use and help ensure financial sustainability of desalinization plans. The sector overall is highly subsidized, and all revenue streams should be reviewed to improve financial sustainability, particularly in light of plans to scale up desalination. Expanding desalination is a strategic priority for Egypt, as it is expected to alleviate the pressure on Nile water for supplying urban and tourism demand in coastal areas. The incremental capex requirement over the next 10 years is expected to be US$3.45 billion, in addition to the operation and maintenance outflow of US$390 million per annum by 2032.[146] However, given the high costs of desalinated water, user tariffs are unlikely to cover the full costs of planned adaptation measures. Egypt

---

[143] Yigezu, Yigezu A., et al. "Food Losses and Wastage along the Wheat Value Chain in Egypt and Their Implications on Food and Energy Security, Natural Resources, and the Environment," *Sustainability* 13.18 (2021): 10011.
[144] Exchange rate at 1 USD = 18.4790 EGP calculated on April 20, 2022 (www.xe.com)
[145] It is important to ensure alignment of incentives and communication of benefits as systems are modernized to ensure continued adoption of modern systems Reductions in allocation would need to reflect changes in on-farm needs arising from higher field application efficiency. Reduced allocations in more efficient areas are a way to effectively use and reallocate water within the system and to fill existing and emerging gaps in a context of water scarcity.
[146] Based on financial projections by the World Bank team.

should therefore consider a combination of financial options including viability gap funding, annuity models, and guarantees for scaling-up desalination within an affordable fiscal envelope. The need to focus on diversifying financial options and attracting private sector financing further underscores the need to focus on tariff reform to underpin the financial viability of the sector as capital and operational expenditures rise. Reforming tariffs would have the additional benefit of better reflecting the value of water and would be an important factor in reducing the per capita demand.

Better management of spatial urban growth would also help increase efficiency in the use and allocation of land and water resources, preserving nearly 39,000 hectares of green areas, including very scarce agricultural land. Guiding urban growth away from high-risk areas (such as flood-prone areas) can help minimize future damage. Estimates suggest that better management of urban expansion in Egypt's 14 major cities could result in the conservation of nearly 39,000 hectares of green areas (for further details on this analysis see Chapter 4, Box 4). These actions would result in the conservation of permeable surfaces, which are key for flood management, contribute to food safety by preserving prime agricultural land, and mitigate heat stresses. Compact urban growth will also require prioritizing infill development against urban expansion, to increase densities in cities. To support this, updated city-level, long-term detailed plans and strategic plans and strengthening legal frameworks for land registration will be needed.

Mainstreaming digital information systems that bring together information on land use, buildings, and provided services can improve efficiency in resource allocation, land as well as financial. Digital building platforms improve the management and collection of own-source revenues, such as monetizing land assets, implementing land value capture instruments for adaptation, and scaling up nature-based solutions. Similarly, smart digital solutions (e.g., water quality monitoring systems) can increase efficiency of service delivery while enhancing the local resource governance. The growing use of digital technologies in the energy, transport and industry sectors requires appropriate cybersecurity and data privacy measures. Additionally, considering that food, water and energy security cannot be easily achieved without some level of digitalization and the appropriate digital resilience, it is important that Egypt be prepared to respond to different types of cyber risks.

3.1.2. Provide better information and information systems and increase awareness about climate change impacts for collective action

To enable more effective and timely early warnings and response actions to floods and droughts, continued efforts to strengthen information services that leverage innovative technologies are needed to better predict seasonal and daily changes in rainfall and flows in the Nile Basin and in Egypt's coastal areas. The storage capacity of Lake Nasser is used as the primary system for flood control and drought risk mitigation, as it can store nearly twice the expected annual inflow of the Nile. As flow variability increases, however, it will be necessary to enhance the tools that predict changes in precipitation and runoff in the entire Nile Basin. Seasonal forecasting to better understand the severity and extent of both dry years and extremely wet years will be critical to the optimal operation of Lake Nasser and the appropriate allocation of available water in any given year. Near-real-time forecasting of precipitation and runoff in the Nile Basin during the rainy season can usefully inform emergency releases and avoid spilling water, which is fundamentally wasteful, as the frequency of riverine flood events in the basin increases. Real-time forecasting for coastal and other flash flood-prone areas is an essential tool as flash-flood events increase in frequency and intensity over the coming century. The costs of ignoring these risks and not adapting can be high (Box 1 below provides details on estimated costs from flooding and SLR in Alexandria). To adapt to increasing variability in precipitation, continued efforts to deploy advanced technology tools will be critical (innovative earth observation technology, advances in numerical weather prediction, and other remote sensing technologies) and cooperation with Nile Basin riparians will be needed to collect real-world observations that can then be used to increase the accuracy and lead times of early warning and response systems (by using that real-world data to calibrate predictive models).

Strengthening the way that hydro-meteorological (hydromet) information systems are used will help boost the resilience of many to disasters such as drought and flood. This can be done by improving the systems that share climate- and hydrology-related information with affected stakeholders and by grounding investment planning, operation of climate and hydrological risks-affected systems, and governance measures in precise assessments of climate change impacts. Predictive information on flood and drought hazards is only useful if relevant stakeholders have access to the information in a format and frequency that facilitates informed decision-making and triggers response actions by end users. The GoE can deepen its effort to pair their information generation and forecasting with improved information dissemination to relevant users in the agricultural, industrial, transport, and financial sectors and with awareness raising efforts at all levels.[147] These needs are also recognized in the update NDCs. Preparedness plans at multiple levels that reflect the evolving risks of climate change will improve stakeholder access to information needed to act within the relevant timeframe. Deepening consultations with stakeholders such as farmers, urban and peri-urban dwellers, tourism companies, industry, pastoralists, and other vulnerable groups will support a renewed approach to building resilience to disaster risks and mobilizing information to support responses that safeguard the common good.

A comprehensive, multisectoral drought risk management system is needed to link hydro-meteorological information services to the appropriate dissemination channels and emergency response actions in cities and rural areas, in order to improve resilience through better prevention, preparedness and response. Actions along three pillars will be important: (i) strengthening the GOE's forecasting and early warning systems as the anchor points for predicting and tracking the location and intensity of droughts, with the end goal of informing decision making and triggering preparedness and contingency responses; (ii) developing a modern Operational Response Plan (ORP) that is based on a vulnerability assessment and a strong contingency plan, with well-defined metrics when a drought hits; and (iii) establishing disaster risk financing avenues that are available at multiple levels, including insurance, risk-layering strategies, and social safety net programs that can support stakeholders in the event of impacts that are not mitigated by the drought program. A truly multisectoral and modern drought ORP would consider responses and protocols for all water uses, including satisfying basic water needs for household consumption, setting the priority levels for industrial and agricultural allocations, and preserving groundwater quality in the Nile Delta. Most importantly, while ORP development would be led by the government, it would need to follow a participatory approach, including strong stakeholder engagement and ensuring ownership by civil society and the private sector. The ORP should include details on how the Lake Nasser storage is operated during drought situations so that reserve water is available to meet basic needs, evaporative losses are minimized, and there are incentives for water users to reduce or halt water use during drought periods. Measures for the agriculture sector should specify water allocations during times of low availability to comply with water rights, preserve medium-term productivity and critical agricultural functions, and avoid saline intrusion and contamination of groundwater systems in the Nile Delta. Finally, the development of the mitigation and response measure in the ORP should stem from a well-informed dialogue with key stakeholders, to ensure that the multisectoral risk management system underpins resilience and financial risk mitigation for diverse stakeholders.

[147] The GoE investments in early warning infrastructure include the developed three weather radars to improve weather prediction and installed 24 devices used to measure the amount of evaporation, which allows for the determination of the quantities of irrigation water required. Projects related to early warning systems in the agriculture sector have been implemented in cooperation with the Ministry of Agriculture and the Meteorological Authority (which carries out the weather forecast using numerical models). and funded by the United Nations World Food Program (WFP). For instance, the Food Security in Egypt to Adapt to Climate Change project provides an early warning service to farmers through the use of smart phone applications.

Box 1. Alexandria faces multiple flash flood risks from coastal rainfall, coastal flooding storm surges and sea level rise, threatening populations and economic activity

Alexandria is the second-largest city in Egypt, with 5.18 million residents, and is a key tourist and economic activity center along the Mediterranean. Analysis suggests that the total exposure-at-risk (expressed as a percent of the total replacement value for Alexandria's buildings—estimated at US$46.6 billion),[148] by flooding from coastal rainfall could be as high as 10.9% in case of extreme events. The exposure-at-risk from coastal flooding risk ranges from 22.7% to 30.1% of the total building stock. Economic losses from disruption to services, mobility, industrial productivity, socio-economic costs, and flooding of heritage buildings and socio-economic infrastructure (e.g., schools, hospitals) add to the cost of flooding in Alexandria city.[149]

Analysis of Climate Change and Future Flood Impacts in Alexandria, Egypt CCDR. Background Note. *(*World Bank, 2021)

3.1.3. Enhance resilience and reduce the risk of stranded assets through complementary actions

Strengthening the resilience of ongoing and projected investments is the only way to ensure long-term sustainability and avoid stranded assets. Complementary actions to foster innovation, strengthen capacity and improve institutions in key adaptation sectors—water, agriculture, urban development, and environmental management—are needed to ensure that planned and ongoing investments contribute to strengthening resilience to climate change and help manage uncertainty. The goal is to reduce the likelihood that resources are wasted on large infrastructure investments with the potential to become stranded assets. A focus on resilience also aligns with the NCCS, which includes a sub-goal on resilient infrastructure and services. The returns on early action to increase infrastructure resilience can be high. Global evidence suggests that the cost-benefit ratio for investments in more resilient infrastructure is about 1 to 5.[150]

Irrigation and Agriculture

The Irrigation Modernization Program requires complementary policies and investment actions to strengthen sustainability and resilience to shocks. Egypt's goal is to improve agriculture productivity by 30% while reducing water consumption by 10%. While current irrigation investments, such as the NWRP, are well aligned with adaptation needs, the country needs to further adapt its irrigation investments given the high uncertainty of water availability and to ensure that improvements in agriculture do not result in an increased demand for water. Based on international experience, investments in irrigation modernization must be combined with institutional systems designed to manage, allocate and distribute water savings. These include (i) agricultural water allocation reform to incentivize the adoption of climate-smart irrigated agriculture and to reduce crop consumptive water use and non-beneficial atmospheric losses; (ii) improved groundwater governance to slow over-draft of the resource and retain the productivity of land and water in the Delta; and (iii) a policy shift toward the holistic management of irrigation and drainage systems and services, in a way that is responsive to modernized farm irrigation needs. Without the requisite policy and institutional reform measures, the risk is high that investments in irrigation modernization will not meet the goal of doubling agricultural

[148] The assessment of the scale of flood risk hazard and the subsequent EAR (Exposure-at-risk) for Alexandria has been conducted based on global flood layers such as Climate Central dataset (2020) and Fathom dataset. Buildings' built-up floor area exposure and replacement value has been estimated based on the 2019 WSF-3D Structure raster layers with 90 m cell resolution. The scenarios are based on the Fathom scenario that model the impact of each of the varying return periods of 5, 10, 20, 75, 100, 250, 500, 1000 years. *Analysis of Climate Change and Future Flood Impacts in Alexandria, Egypt CCDR Background Note, (*World Bank, 2021).

[149] The assessment was conducted based on global flood layers such as Climate Central dataset (2020) and Fathom dataset. Fluvial and Pluvial scenarios from Fathom dataset, consider climate current change trends, while coastal risk considers RCP8.5 scenario, in 50th and 95th percentile. Source: Analysis of Climate Change and Future Flood Impacts in Alexandria. Egypt CCDR Background Note. World Bank (2021).

[150] "Adapt Now: A Global Call for Leadership on Climate Resilience," Global Commission on Adaptation (2019). https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/

water productivity within 10 years (which is equivalent to a linear water productivity growth rate of 7.4%, NWRP 2037). Specifically, policy reform should (i) enable farm investment in modern irrigation systems and (ii) ensure that improved irrigation service delivery from canals is fully compatible with the needs of modern irrigation systems. With the passage of new water resource and irrigation legislation in 2020, water user organizations, in conjunction with agriculture cooperatives, will play a greater role in the interface between off- and on-farm investment facilitation, improving irrigation service delivery and cost recovery.

Complementary policy reform measures and institutional changes are needed. Otherwise, the risk is high that investments will not improve agricultural productivity and may even be detrimental to the sustainability of agriculture systems. Policy reform that enables the holistic management of irrigation systems and improved allocation within these systems is necessary to avoid the distributional impacts anticipated if no action is taken. For example, for many farm holdings that rely on irrigation supplies from drainage reuse and Nile waters, policies need to be in place to ensure reliability of supplies at times when reusable drainage return flow is reduced. An irrigation pilot study conducted by the International Water Management Institute in 2015 (IWMI 2015) identified inequitable distribution of water across the head and tail end reaches of branch canals, which created long-term water shortages. A typical response from farmers is to file a complaint at the office of the district engineer; if outcome of the complaint is not favorable, they adapt to water shortages by seeking other sources of water such as groundwater or drainage water, with the latter often of poor quality. The ongoing branch canal rehabilitation program of the Ministry of Water Resources and Irrigation (MWRI) addresses distributional deficiencies of the irrigation delivery network across the head and tail end reaches of branch canals, leading to fewer complaints being filed.[151] Coupling these efforts with an improved and institutionalized service delivery approach that is tailored to the needs of modernized irrigation systems can help improve effectiveness of the irrigation modernization program. With improved irrigation services farmers are likely to consolidate their farm unit and collectively invest in farm irrigation modernization. The process is likely to see many smallholders exiting from farming to take advantage of the much-increased land rents and/or higher land sale prices and hence complementary actions - including transparent policy and institutional reforms, will be needed to support a fair transition into non-agricultural jobs.

Fostering innovation in the agricultural sector through targeted spending and incentives can be a cost-effective way to strengthen economic resilience and improve livelihoods. Greater spending on crop research and development (R&D), better provision of extension services, and the introduction of smart subsidies for the construction of greenhouse infrastructure have been identified as the most cost-effective policies to increase GDP growth and employment, increase poor households' consumption, and diversify diets to improve nutrition.[152] For instance, it is estimated that each US$1 of public spending on crop R&D raises consumption levels for poor households throughout the country by US$1.50 and generates US$10 in agri-food GDP, improving livelihoods while contributing to economic growth. Likewise, combined investments that complement each other in climate-resilient seed technology, soil fertility improvement, crop protection (e.g., from disease and insects), and irrigation can increase overall yields for different crops by up to 6.6%, in most cases counteracting or reducing the effects of climate change.[153]

[151] Personal communication MWRI 2022.

[152] Thurlow, James; Holtemeyer, Brian; Kassim, Yumna; Kurdi, Sikandra; Randriamamonjy, Josée; Raouf, Mariam; Elsabbagh, Dalia; Wiebelt, Manfred; and Breisinger, Clemens. 2020. Investing in the agri-food system for post-COVID-19 recovery: An economywide evaluation of public investments in Egypt. MENA Policy Note 7. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.133773

[153] For fruits and vegetables, potatoes, rice, and wheat these measures can counteract the adverse impacts of climate change, and even for some crops such as maize, oilseeds, pulses, and sugar that will not return to the pre-climate change productivity level, these investments provide the largest returns. Perez, Nicostrato D.; Kassim, Yumna; Ringler, Claudia; Thomas, Timothy S.; and ElDidi, Hagar. 2021. Climate change adaptation strategies for Egypt's agricultural sector: A 'suite of technologies' approach. MENA Policy Note 18. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134321

Ensuring food security will require that investments to improve productivity and reduce waste are complemented by a shift in agricultural policy to realign incentives with climate objectives. Further, a shift in policy will be needed to move resources away from subsidizing water-thirsty crops considered important for food security (wheat, rice, and sugar beets),[154] and provide incentives to grow crops that are better suited to local conditions. Such a shift in policy would require a reassessment of Egypt's strategic crops and varieties, as well as its production practices, a revision of the costly subsidy-supported strategy for wheat self-sufficiency,[155] and a rethinking of the agri-food trade balance. In the medium term, it will also be important to tackle agricultural land fragmentation through modernization of the land and property registry, the development of a robust geospatial information system, enhancement of the state land allocation and expropriation procedures, and the regulation of urban expansion over privately-owned land (mostly agricultural).

Coastal Resilience

Complementary actions to strengthen the resilience of coastal areas and the coastal economy could help avoid high costs and are therefore an urgent priority. For example, estimates suggest that by 2050, climate change may bring about *daily* losses to tourism revenue in the Red Sea's Sahl Hasheesh and Makadi Bay in excess of US$350,000. Beach tourism infrastructure will need to be protected from flooding to prevent these losses.[156] Complementary public and private investment in nature-based solutions (NbS) could promote cost-effective green infrastructure and ecosystem-based adaptation (EbA) of the tourism infrastructure. Such tactics include natural barriers against SLR storm surges, the reduction of coastal erosion, carbon capture, and mangrove ecosystem services. The Egyptian government's mangrove planting efforts in the Red Sea Governorate, along with the private initiative led by HSBC Bank, WRI, WWF and a network of local partners through the Climate Solutions Partnership, could be scaled up as public private partnerships to promote investment in NbS throughout Egypt's coastal zone. The cost benefit ratio of combining dikes and mangroves has been estimated to be 1.5 times higher than the ratio of dike-only protection,[157] which highlights the potential of NbS as an investment option to protect tourism infrastructure and urban areas on the Red Sea and Mediterranean coasts. In addition, efforts to support a transition toward a diversified approach to tourism will be important, including efforts to address structural weaknesses (e.g. unregulated development contributing to irreparable damage to fragile coral reef ecosystems in the Red Sea; and poor waste management and regulation contributing to large coastal and marine pollution load as reflected in Egypt ranking third in plastic pollution (167 kg/km) in the Mediterranean region).[158], encourage digital and low carbon technologies, promote sustainable coastal tourism models that integrate recreation and conservation, and develop other complementary ecotourism options that offer long-term stability to coastal tourism.

Coordinated coastal zone management and marine spatial planning can help amplify the benefits of investments in protective infrastructure. Various localized Integrated Coastal Zone Management (ICZM) initiatives have been undertaken by the GOE to improve preparedness, build capacity, and enhance coastal resilience, but actions remain fragmented. Early ICZM efforts have facilitated localized coastal protection (e.g., coast of the Nile Delta), and rationalized land use (e.g., Fuka-Matruh coast). However,

---

[154] Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update. World Bank (2021)

[155] Shinan N Kassam and Boubaker Dhehibi. 2016. "Mechanization to Drive a Process for Fertilizer Subsidy Reform in Egypt." Economic Research Forum Policy Brief No. 22, December 2016.

[156] Sharaan, M., C. Somphog, and K. Udo. 2020, "Impact of SLR on Beach-Tourism Resort Revenue at Sahl Hasheesh and Makadi Bay, Red Sea, Egypt: A Hedonic Pricing Approach," *Journal of Marine Science and Engineering* 8 (6): 1–13.

[157] Naoko Kumano, Makoto Tamura, Tomomi Inoue, and Hiromune Yokoki, 2021. "Estimating the cost of coastal adaptation using mangrove forests against sea level rise", Coastal Engineering Journal, 63 (3) 263-74.

[158] Heger, Martin Philipp, Lukas Vashold, Anabella Palacios, Mala Alahmadi, Marjory-Anne Bromhead, and Marcelo Acerbi. 2022. Blue Skies, Blue Seas: Air Pollution, Marine Plastics, and Coastal Erosion in the Middle East and North Africa. Middle East and North Africa Development Report. Washington, DC: World Bank. doi:10.1596/978-1-4648-1812-7. License: Creative Commons Attribution CC BY 3.0 IGO

ICZM remains fragmented and primarily focused on coastal protection infrastructure through hard measures (e.g., sea walls, dikes, groins) and soft measures (e.g., dune stabilization) implemented by Shore Protection Authority under the Ministry of Water Resources and Irrigation (MWRI). In the absence of ICZM, the cost of addressing coastal risks could be significant. For example, coastal flooding in Alexandria, which supports 40% of Egypt's industrial capacity, is projected to result in annual losses of between US$504 and $580 million by 2050.[159] Coastal flood risk in Alexandria highlights the need for a comprehensive ICZM to institutionalize coordination among national ministries, governorate- and city-level agencies in 36 cities and urban bodies in the coastal zone. A comprehensive ICZM would contribute to coordinated planning and management, budgetary savings, and the enhanced resilience of coastal infrastructure to climate risk. This policy action would be in line with the updated NDC adaptation ambitions, which include the development of a climate resilient Integrated Coastal Zone Management Plan for the North Coast of Egypt linking land use development plans with coastal protection works over the next 10-15 years.[160] Coordination of marine activities using key marine spatial planning (MSP) mechanisms is needed to conserve coral reefs, mangroves, and other marine ecosystems through marine protected areas (MPAs).[161] As part of the national blue economy strategy, a coordinated MSP is also a priority in the Suez Gulf to coordinate multiple activities such as oil extraction, coastal tourism, maritime transport and port infrastructure through effective planning, coordination and sustainable use of marine resources.

Regulation can improve the resilience of the coastal economy while strengthening food security and enhancing economic diversification. Fish production is projected to reach 5 million tons and provide employment to over 1 million persons by 2030, and 7.6 million tons and 1.6 million persons by 2050, driven strongly by aquaculture.[162] Additionally, mariculture can enhance the resilience of capture fisheries and strengthen the nutritional security and incomes of households. Mariculture of non-traditional species such as bivalves, oysters, clams, seaweeds and multi-trophic culture systems could be upscaled for habitat restoration as well as for targeting export markets.[163,164] Analysis of the fisheries of 156 countries, including Egypt, shows that maximum sustainable yield of fish stocks from 2012-2100 is forecast to decline by 2.0% to 18.5%[165] respectively, under the climate change impact.[166] Full adaptation, in contrast, could increase profit, harvest, and biomass by 27%, 16%, and 29%, respectively, as compared to what the oceans provide today[167] In the context of coastal tourism, Egypt's reef tourism revenue of about US$7 billion per year represents half of Egypt's tourism revenue[168] but is projected to lose US$5.6 billion (about 80% of coastal tourism revenue) by 2100 due to the projected loss of coral reefs to ocean warming and acidification[169] The latest research demonstrates that Red Sea coral reefs are less sensitive to thermal anomalies and have the capacity for rapid recovery after bleaching events if no further stresses are imposed[170] To prevent the loss of reef ecosystems, Egypt

---

159 Stephane Hallegatte, Colin Green, Robert J Nicholls, Jan Corfee Morlot, 2013, "Future Flood Losses in Major Coastal Cities, Nature Climate Change", 18 August 2013

160 Egypt First Updated Nationally Determined Contributions, June 2022.

161 Egypt Environmental Affairs Agency, 2017. Egypt State of the Environment 2017 (in Arabic), 2018; Egypt Ministry of Planning and Economic Development Egypt's 2021 Voluntary National Review.

162 Chin Yee Chan, Nhuong Tran, Kai Ching Cheong, Timothy B. Sulser, Philippa J. Cohen , Keith Wiebe , Ahmed Mohamed Nasr-Allah, 2021. Future of Fish in Africa: Employment and Investment opportunities, PLoS ONE 16(12): e0261615.

163 Harrison Charo Karisa, Ahmed Nasr-Allah, Diaa Al-Kenawy, Nabil Ahmed Ibrahim, Jeleel Opeyemi, Walid, Elsawy Aly, Alaa El Far, Seamus Murphy and Michael Phillips, 2019. "Capturing value from Egyptian Blue Economy: Aquaculture and Fish Supply Chains," World Fish.

164 Mariculture has been demonstrated through over 40 offshore tuna farms in the Mediterranean Sea and similar offshore marine cages for Cobia and grouper (a native fish species) could be adopted for the Red Sea to protect the fragile environment.

165 While long-term GHG emissions in the RCP8.5 are considered overly pessimistic, the CMIP5 climate change scenarios with RCP8.5 provide useful (and not implausible) high-warming scenario, which would be consistent with continued GHG emissions and high climate change sensitivity or positive feedback from the carbon cycle.

166 Christopher M. Free, Tracey Mangin, Jorge García Molinos, Elena Ojea, Christopher Costello, Steven D. Gaines, 2019, "Realistic fisheries management reforms could mitigate the impacts of climate change in most countries".

167 Steven D. Gaines, Christopher Costello, Brandon Owashi, Tracey Mangin, Jennifer Bone, Jorge García Molinos, Merrick Burden, Heather Dennis, Benjamin S. Halpern, Carrie V. Kappel, Kristin M. Kleisner, Daniel Ovando, 2018. "Improved fisheries management could offset many negative effects of climate change," Science Advances, 4: eaao1378.

168 Egypt Environmental Affairs Agency, 2016. Egypt Third National Communication submitted to UN Framework Convention on Climate Change.

169 Under RCP8.6 climate scenario. High Level Panel for a Sustainable Ocean Economy. *Summary for Decision-makers: The Expected Impacts of Climate Change on the Ocean Economy.*

170 Monroe, A.A., Ziegler, M., Roik, A., Röthig, T., Hardenstine, R.S., Emms, M.A., Jensen, T., Voolstra, C.R., Berumen, M.L., 2018, "In situ observations of coral bleaching in the central Saudi Arabian Red Sea during the 2015/2016 global coral bleaching event," PLoS ONE 13, e019581. http://dx.doi.org/10.1371/journal.pone.0195814.

should prioritize measures to protect and conserve coral reef systems (which would stabilize and enhance tourism revenue), as well as regulation to prevent overfishing, illegal harvests and unsustainable coastal and beach infrastructure development. Integrating the latest research into adaptive planning of the Marine Spatial Planning and Marine Protected Areas of the Red Sea supported by continuous monitoring offers scope for analyzing the risks of and opportunities for adopting measures that enhance marine ecosystem resilience.

Complementary investments in the resilience of ports and logistics—with hazard monitoring and modelling—can help avoid lock-ins of designs and operating models that cannot adapt to future risks. Port infrastructure and operations are also sensitive to climate change impacts such as SLR, storm surges and high-speed winds, which affect port performance through disruptions or damage to port infrastructure. Analysis of port disruptions across 74 ports in 12 countries found that an increase in storm surge of 1 meter or wind speed of 10 meters/second resulted in a 2-day increase in port disruptions, with cascading impacts on supply chains.[171,] About 90% of Egypt's trade is seaborne, with large reliance on 15 commercial ports (out of over 60 ports with 197 terminals). Alexandria Port is the largest port, through which 65% of the country's trade passes. The capacity of seaports under Egypt Vision 2030 is projected to grow. [172] Longer dwell times and inefficiencies in the unloading process contribute not only to the cost of trade, but also to GHG emissions. Adaptive planning and investments to improve the resilience of port infrastructure along with continuous monitoring and modelling to assess climate risks are priorities. Adaptation also includes the use of technologies to enhance resilience of port infrastructure. The GOE has taken steps in this area through efforts to establish[173]sand dune dikes along five vulnerable hotspots within the Nile Delta and the Sectoral Strategy for Ports Development Sector that focuses on deploying green port principles and reducing pollutants. Moreover, the Advanced Cargo Information System—a blockchain-based technology launched by Egypt on May 2022—improved processing times by over 50% through its automation of the customs process and integration with the digital trade portal, Nafeza, which links the import and export operations all of Egypt's ports.

Cities

In cities, a focus on enhancing the resilience of infrastructure and services will require combining ongoing investments with better planning to guide development away from the most high-risk areas and to complement nature-based solutions. Egyptian cities are growing in unsustainable ways, as soil surfaces are sealed over, green spaces are removed, and biomass and diversity are diminished. If well-implemented, nature-based solutions have significant potential to enhance urban cooling and livability, decrease air pollution levels, increase carbon absorption (GHG sinks), mitigate the destructive effects of floodwaters, and manage sea level rise. Urban areas can be cooled effectively through increased vegetation for shade and evaporative cooling and the use of more reflective materials. In newly built areas, streets and buildings can be oriented to maximize shade and airflow. Lowering temperatures in the cities can also bring savings in energy costs and prevent heat-related illnesses. Better land management to restore protected areas is essential, especially in the context of desertification. In cities that receive little rainfall, natural approaches to preserve vegetation can help manage water flows. Nature-based solutions can assist with stormwater management, water treatment, rainwater harvesting, thermal regulation, the enhancement of local biodiversity, and much more. Guiding urban growth away from high-risk areas (such as flood-prone areas) can help minimize future damages and preserving natural land can help implement the nature-based solutions highlighted above. If no action

[171] Verschuur, J., Koks, E.E., and Hall, J.W. (2020). "Port disruptions due to natural disasters: Insights into port and logistics resilience," T*ransportation Research Part D: Transport and Environment*, 85, 102393.
[172] McCarron, B., Giunti, A. and Tan, S. (2018), *Climate Costs for Asia Pacific Ports*. HBC.
[173] Enhancing Climate Change Adaptation in North Coast and Nile Delta in Egypt, UNDP Project. https://www.undp.org/egypt/projects/enhancing-climate-change-adaptation-north-coast-and-nile-delta-egypt

is taken in cities, the costs from higher exposure to risks and the losses of arable and natural land will be high. Urban growth modelling reveals that in the absence of a resilient and compact growth focus (reference scenario), the results will be (i) a 35% increase in population exposed to a 1 in 100 years return period pluvial flooding event by 2030, with an additional 1.1 million people living in flood-prone areas, (ii) ~900 Km^2 of additional land requirement, doubling the current built-up footprint of the 14 main cities, which today stands at 923 Km^2, (iii) loss of 138 Km^2 of natural land that is critical for cities' adaptive capacity against climate change variability and change (flooding, emissions, pollution, heat stresses), and (iv) loss of agricultural land, to the tune of 251.24 Km^2, resulting in a decrease in agricultural productivity and further reduction of an already scarce resource. The results for the reference scenario of continued urban growth patterns by 2030 suggest that challenges will vary by city; of the 14 cities studied, two will lose more than 30% of their natural land area, four cities more than 60%, and six cities more than 90%.

Transport

Complementary actions to improve asset management, operation and maintenance can help improve the resilience of connective infrastructure and the management of strategically important infrastructure assets. Under the MiNTS Master Plan for Nationwide Transport System,[174] Egypt is implementing an ambitious infrastructure investment program, including highways, railways, and dry ports. These projects represent an opportunity to build resilient infrastructure assets through better risk assessments and improved design and risk-mitigating engineering measures such as adequate drainage facilities and heat-resistant materials, among others. The operational continuity and resilience of transportation network infrastructure in the event of climate and disaster events requires adequate maintenance of the assets. Infrastructure asset owners (e.g., governorates, transport sector authorities) can benefit from climate-aware asset management systems that enable the optimization of the lifecycle costs of operating and maintaining infrastructure assets, to account for the risks of increasing and intensifying climate events.

A focus on reforms that strengthen transparency and build regulatory authority capacity in railway transport can improve resilience while fostering multimodality. Reforms that are already underway, including the introduction of Public Service Obligation contracts and Multi-Annual Infrastructure contracts, will improve the accountability of passenger rail operations and help improve financial sustainability. Improved accountability and financial sustainability are necessary to ensure railways remain available as an affordable means of transport for accessing economic opportunities and services, especially for vulnerable groups including women, youth, and rural populations. Further, a focus on improving the railway system can promote multimodality and avoid redundancy in logistics and freight networks, both needed to build resilience in the face of increased weather disruptions due to climate change. Improved railways will also help reduce the GHG emissions of the transport sector by shifting freight transport from carbon-intensive trucks to lower-emission trains. The competitiveness of railways has decreased across the last 15 years, due to the poor condition of railway infrastructure and the Egyptian National Railways' (ENR) lackluster attitude toward commercial freight transport. Building on policy actions that have already been implemented, and to strengthen resilience and mitigation, it is essential for the government to reform its relationship with ENR to facilitate private sector participation in the railway sector. One clear recommendation is the establishment of an Infrastructure Access Charging (IAC) regime so that private operators can access ENR's railway network, which will provide transparency and visibility for private investors to enter the market. The GOE should assess the opportunities and hurdles for increasing the use of inland waterways for transport and build the regulatory and planning capacity of the relevant authorities.

[174] JICA, Almec Corporation, Katahira & Engineers International, & Oriental Consultants Co., Ltd., 2012. MiNTS – *Misr national Transport Study – The Comprehensive Study on the Master Plan for Nationwide Transport System in the Arab Republic of Egypt – Final Report.*

3.2. Transitioning to low carbon development

In 2019, energy, transport, and industry (ETI) together accounted for about 80% of GHG emissions in Egypt.[175] Likewise, official data estimates that for 2015, the Energy sector, which includes transport and industry emissions (65%), and Industrial Processes and Product Use (IPPU) (12%), together represented 77% of emissions.[176] Industry and transport also represent a high percentage of final energy consumption, accounting for about 28% and 30%, respectively in 2019. In addition to reducing the carbon intensity of energy supply and electricity production, the fastest path to a low-emissions transition will require congruent and effective actions concerning these two major demand-side sectors, along with the buildings sector. To highlight how actions in these sectors can contribute to putting Egypt on a low carbon development path, this section builds upon results from both modeling and qualitative analysis, with a focus on interventions in the energy, industry and transport sectors. The decarbonization of Egypt's power system was simulated using the World Bank's in-house Electricity Planning Model (EPM) tool, and a national transport emissions model based on the World Bank's ongoing analytical engagements for the transport sector (see Box 2 and Box 3 for additional details on the modeling scenarios). Possibilities for reducing emissions in the industry sector were explored following a bottom-up qualitative assessment, given the fragmentation of the industrial sector.

A move toward low carbon development can help prepare Egypt for the uncertainty caused by changing markets, while also allowing it to take full advantage of the co-benefits of reduced emissions. The shifting of international markets toward greener, low carbon alternatives creates additional uncertainty for Egypt. As global markets move toward more stringent requirements in terms of carbon content and the use of sustainable production methods (e.g., the European Union's Carbon Border Adjustment Mechanism (CBAM), and consumer preferences also begin to favor greener alternatives, preparing for an uncertain future will require reducing emissions to strengthen the competitiveness of Egyptian products and help manage the risks of increasingly "green" markets. Reduced emissions can also help leverage new opportunities. Actions to reduce inefficiencies in electricity use in the industry, transport, and logistics sectors in the short-term, and a move toward cleaner energy sources in the medium and long term, can help local firms leverage opportunities in greener international markets and improve their links to green global value chains by reducing the carbon content of products. But actions to reduce emissions have benefits that go beyond strengthening competitiveness. For example, cleaner transport in cities can deliver air quality improvements, leading to better quality of life and important economic savings: in 2017, the cost of air pollution on health in the Greater Cairo area alone was estimated to be about 1.4% of Egypt's GDP.[177]

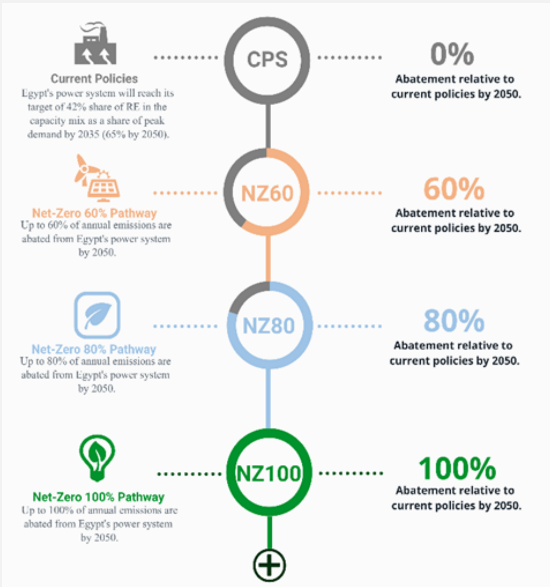
[175] In 2019, CAIT data estimates that the contribution of these sectors to emission reached over 80%, with 74% of emissions coming from Energy (incl. electricity & heat (32%), transportation (16%), manufacturing (11%), fugitive and other fugitive emissions (10%), building (5%)), and 8% from industrial processes. Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.
[176] Egypt's First Biennial Updated Report (BUR), 2018.
[177] Larsen, Bjorn. 2019, "Egypt: Cost of Environmental Degradation: Air and Water Pollution," The World Bank.

Box 2. Energy Decarbonization Policy Scenarios

The World Bank reference scenario, referred to as the *"Current Policies Scenario"* (CPS), was designed to reflect the electricity sector's 2015-2021 transformation towards a clean energy pathway, described in Section 2.3, and to continue the same trajectory to 2050. The sectoral reforms and efficiencies gained through the reduction of growth in energy demand and shift towards a combination of gas and renewables for supply has negated the need for coal-fired power plants as a technology option for development in the CPS. The CPS also includes the GOE's target of reaching a 42% share of renewable energy in the generation capacity mix as a proportion of peak demand by 2035, which was then extrapolated out to 2050. Importantly, mitigation actions already implemented between 2015-2020 have been taken into account in the CPS scenario.

A CCDR Net-Zero (NZ100) pathway-based scenario was then modeled to enforce a scaling constraint to abate 100% of annual power sector emissions by 2050 relative to the World Bank reference (CPS) scenario, starting in 2030. Two intermediate *"towards-zero"* pathways scenarios were modeled, considering the abatement of 60% (NZ60) and 80% (NZ80) by 2050, relative to the CPS scenario. These decarbonization scenarios analyze alternative clean energy development pathways for Egypt, including their associated benefits for emission reduction, and impacts to system costs and investment requirements. Figure summarizes the four scenarios modelled for the development of Egypt's power sector.

Figure 12. Summary of Scenario Design



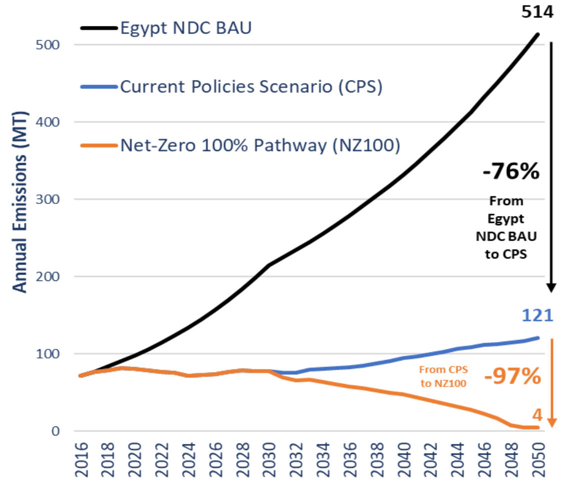
Source: World Bank Team elaboration

The growth of electricity demand in Egypt was modeled for this CCDR using a linear model that considers the relationship between GDP growth rates, electricity prices, and elasticity factors of price and income. Applying projected GDP growth rates, the rise in energy demand was extrapolated from a 2021 base year that incorporated recent trends in energy efficiency improvements, ongoing reduction of transmission and distribution (T&D) network losses, future adjustments for increased electrification from electric vehicles (EVs) in the transport sector, and the production of Low Carbon Hydrogen (LCH), which needs electricity for water electrolysis. The former two trends contribute to reducing the growth in electricity demand, while the latter two increase demand growth, together ensuring that recent policies announced by the government are considered and reflected in the electricity demand projections used in the scenarios here presented.

The World Bank's CCDR analysis suggests that the trajectory of current policies is not entirely conducive toward low carbon development by 2050. Under current policies, Egypt will still meet its NDC commitments by 2030, but after that, a gradual increase in annual power sector emissions would follow, reaching 121 MT in 2050 (up from around 78 MT today), due to the growth in demand compounded by a CPS energy mix. Achieving a low carbon trajectory requires greater ambition for decarbonization than that stipulated by current policies. Figure 14 shows the growth of annual power sector emissions under the CPS and NZ100 scenarios. Starting in 2030, the NZ100 pathway leads to a 97% reduction in emissions, relative to the CPS, by 2050. Figure 14 also shows the GOE's BAU scenario power sector emissions per its updated NDC. As mentioned in Chapter 2, the GOE's BAU considers 2016 as a starting year of projections. As mentioned in Chapter 2, the BAU scenario hence reflects continuation of the same development trends and practices that were followed by the country before 2016 and does not consider actions taken between 2016 and 2022. Such actions are considered by the Egyptian government as mitigation actions. As Figure 13 suggests, such a trajectory would have led to considerably higher emissions today and into the future. Instead, the CPS scenario considers important adaptation and mitigation actions taken between 2016 and 2022. This CPS trajectory provides a reduction of 76% in emissions compared to the BAU presented in the recently updated NDCs (Figure 13).

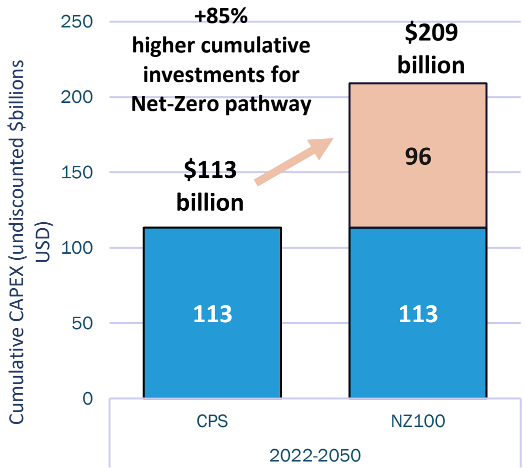
Egypt can be more ambitious over the next decade through a *"no-regret"* approach to decarbonization efforts, given the overlap in investment needs between the CPS and NZ100 scenarios through 2030. After 2030, Egypt can re-evaluate the path to follow, to identify the most suitable long-term low carbon development pathway from 2030 onwards. Beyond 2030, the CPS requires up to US$113 billion in cumulative investments by 2050. Achieving the NZ100 pathway requires US$96 billion (+85%) of additional investment in electricity generation supply and storage over the 2030-2050 horizon (see Figure 14). These results suggest that Egypt has significant flexibility to take immediate action now and re-evaluate an optimal long-term decarbonization pathway beyond 2030.

Figure **13**. Annual Power sector emissions 2016-2050



Source: World Bank Team calculations.

Figure **14**. Cumulative Investments Requirements by scenario

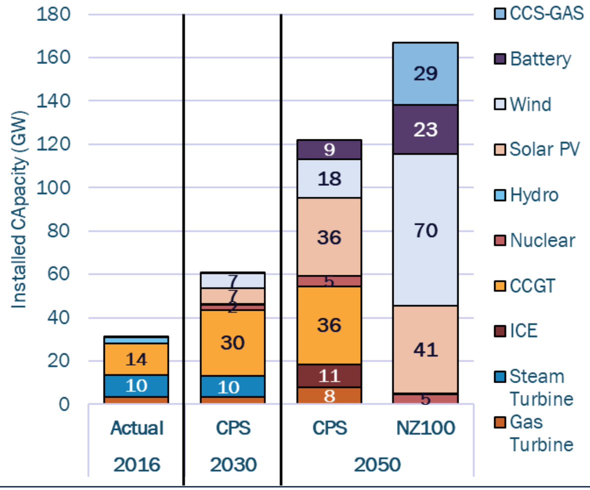


Source: World Bank Team calculations

The CPS scenario results indicate that there is no requirement to build new sources of carbon-emitting generators from 2022 to 2030. By 2030, Egypt's electricity generation mix in the CPS is dominated by gas (79%) and supplemented by wind (8%), solar (5%), and nuclear (7%) energy. In 2050, continuing to follow the current policies trajectory in the CCDR modeling shows there will be a small decline in the share of gas to comprise 66% of the energy generation mix, coupled by a modest growth of renewables to a 27% share. Achieving a low carbon development pathway by 2050 in the NZ100 scenario indicates the need to deploy a significant share of Wind (43%) and Carbon Capture and Storage (CCS) Gas (35%) to the energy generation mix, supplemented by Solar PV (15%) and 23 GW / 136 GWh of battery energy storage system (BESS) capacity.[178] Figures 15 and 16 chart the change in installed capacity and energy generation mix by scenario.

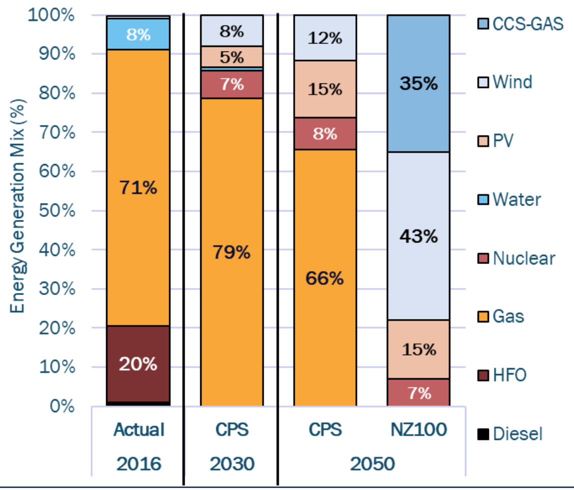
[178] Uncertainties in prices and technological feasibility of CCS and battery capacity are already included in the modeling exercise and result in these investments appearing only after 2035.

Figure 15. Power system installed capacity by scenario, 2050



Source: World Bank Team calculations

Figure 16. Energy generation mix by scenario in 2050



Source: World Bank Team calculations

Achieving a deeper decarbonization pathway toward 100% (NZ100) in the electricity sector will require the deployment of Carbon Capture Utilization and Storage (CCUS) and Battery Energy Storage System (BESS) technologies, beginning in 2035, along with the early retirement of older plants. Egypt's power system will undertake carbon reduction efforts under the backdrop of excess existing thermal capacity in the system, increasing the marginal costs of abatement for each unit of emissions. The power sector model used for this CCDR, considers an early retirement on an economic basis starting in 2026. Given the context of Egypt's current excess thermal capacity in the system, this is essential for the move toward a lower carbon path when pursuing pathways of NZ60 and beyond.[179,180] The NZ100 scenario modeled an early economic retirement of up to 7-10 GW of older Combined Cycle Gas Turbines (CCGT) starting in 2031, due to the need to displace generation from emitting sources with no-carbon alternatives.[181] Achieving deeper decarbonization targets will begin to deploy CCUS technology on a least-cost basis[182] in 2035, which is expected to then play a significant role in marginal abatement efforts as a run up to full decarbonization by 2050.[183]

Achieving the level of required investment in Egypt's electricity sector will only be possible with more robust policies to catalyze private investment, improvement of the regulatory framework and strategic planning of public finance. To mobilize more private capital, the government needs to provide a clear and predictable regulatory framework such as cascading down the emission reduction targets to specific sectors and subsectors designing necessary policy actions to achieve them, and to leverage public finance, including climate finance, to provide the needed incentives and strategically de-risk and catalyze private investment. This can offer confidence to private sector developers and "crowd in" financing from the private sector and new international sources.

To support the transition to this new path, a long-term vision complemented by short-term actions in the three high-emission sectors (energy, transport, and industry) can help maximize the short-term benefits of emission reductions and build a solid base for a fast transition to low carbon development. The full transition to clean energy in Egypt is in progress and will take time. A combination of actions to

[179] The NZ100 scenario requires significant early economic retirements of combined-cycle gas turbine (CCGT plants), starting with 8GW in 2026, up to 13 GW by 2030, and 17 GW by 2040. In the NZ100 scenario, is assumed that not only can these plants not produce electricity at a competitive cost – they are also essential to decommission early to meet abatement targets in the system. It is important to keep in mind that this exercise is based on least-cost optimization and does not take into account economic or social costs of the transition.
[180] NWFE program recently launched suggest the government is considering decommissioning of 5 GW of twelve inefficient thermal power plants by 2025.
[181] The EPM least-cost planning tool findings suggests some older thermal plants in Egypt's power system are inefficient and not economical to continue operating. The model has the option to retire those plants on an economic basis starting in 2030, in all scenarios, including the CPS.
[182] Capital costs are assumed to fall from 2,800 USD/kW in 2020 to 2,350 by 2030, and 2,050 by 2050.
[183] CCUS technology is assumed to capture 90% of the emissions from CCGT generation.

lay the foundation for such a transition and to help Egypt realize short-term benefits is needed. Such portfolio interventions would require (i) accelerating the renewable energy transition to strengthen competitiveness in the long-term; (ii) reducing emissions in the oil and gas sectors for immediate emission reduction; (iii) tackling inefficiencies in the production and use of energy for electricity and industry; (iv) reducing emissions in the transport sector to strengthen competitiveness and livability, and (v) taking synergistic actions across adaptation and mitigation efforts and increasing the use of digital technologies.

Often termed as the "first fuel," energy efficiency is one of the largest and cost-effective options to mitigate climate change. However, due to the financial and other barriers that the energy efficiency market transformation faces, the scale of uptake and implementation of energy-efficient measures remains considerably low in Egypt even though targets have been well laid out through the Second National Energy Efficiency Action Plan NEEAP-II. Across the last few decades, the focus of energy efficiency development has been on addressing some of the barriers—technical, awareness, capacity, regulatory, policy, institutional, and market-based—through policies and regulations. It is of course vital for the government to facilitate the implementation element of energy efficiency by establishing systems and infrastructure, based on robust institutions and governance frameworks, to strengthen the enforcement of these policies and regulations. That said, the challenges to the energy efficiency market transformation remains the financial constraint associated with the higher or incremental upfront costs of the measures, coupled with higher transaction costs and larger risk perception. More creative financing tools like introducing the Energy service Companies (ESCO) model might help overcome this upfront cost barrier, provided that appropriate regulatory schemes, incentives, and business models are put in place.

3.2.1. Accelerate the transition to renewable energy

A significant scale-up of Renewable Energy (RE) in the medium- to long term is needed for Egypt to move to a low carbon path. This should include efforts to expand the energy storage systems like battery storage and hydro storage. Considering the high contribution of the energy sector to Egypt's emissions (64.5%),[184] and the current surplus of gas-based generation capacity (21 GW), a transition to clean energy sources in the medium- to long term will be at the core of the country's move to a low carbon path of development. The benefits of accelerating action beyond the Egypt Integrated Sustainable Energy Strategy (ISES) 2035 target in renewable energy electricity generation capacity are not limited to the move toward a low carbon path and the opportunity to leverage Egypt's natural advantages. It will constitute an important transformation to enhance energy security, to lower domestic demand for natural gas, by diversifying the generation mix currently dominated by natural gas. Scaling up RE will be feasible -and contingent- on a plan for the gradual decommissioning of thermal power plants based on efficiency, O&M costs and lifetime expiration considerations.

Despite important advances, RE integration for electricity generation remains behind. The GOE has taken decisive action to reduce emissions from electricity generation. Emission intensity for generation dropped by 13% between 2016 and 2020 (the grid emission intensity declined from 0.528 in FY16/17 to 0.458 in FY19/20)[185], thanks to an increased share of RE, the incorporation of new thermal powerplants, and the introduction of energy pricing reforms that broadly encouraged energy efficiency in downstream sectors.[186] Emissions reductions were significantly driven by an increase in the use of natural gas. Egypt has doubled its overall electricity generation capacity (from 32 GW in 2014 to 58.8 GW in 2021), as it shifted from a net importer of natural gas to a net exporter in 2018 (LNG exports

[184] Egypt's First Biennial Updated Report (BUR), 2018.
[185] Government of Egypt estimates
[186] It should be noted that electricity system optimization analysis to reach various GHG reduction targets was carried out based on estimated average heat rates for gas and fuel oil thermal generation plants considering their average age and benchmark rates from publicly available sources

reached 6.8 million tons in 2021) and rose its power exchange to 1,591 GWh in FY21/22 through interconnections with neighboring countries. While these actions are in line with the objective to transition into a regional energy export and trading hub, Egypt's energy strategy has not explicitly incorporated increasingly pertinent clean energy transition elements or the strategic role of the smart grid (with the opportunity to increase penetration of digital technologies in the energy system). The opportunities missed by not driving RE integration more vigorously include more significant decreases in the carbon intensity of its energy mix, enhanced system resilience and energy security, and a strengthening of its position as a clean energy hub.

Price distortions remain an important constraint to the acceleration of RE in energy generation. The GOE has carried out significant adjustments to natural gas prices for residential and industrial users across the past five years. Nevertheless, power generation from natural gas still benefits from gas supplied at a cross-subsidized price of US$3.25 per MMBTu, compared to US$5.75 per MMBTu for industrial uses.[187] The artificially low price of gas for energy generation could act as a disincentive for the integration of RE. Although RE integration has accelerated in the last decade, the share of non-hydro RE in the total energy mix is just 5% (10,202 GWh generated from wind and solar compared to total generation of 204,794 GWh), still well below its potential.

The integration of RE provides opportunities to reduce exposure to external price shocks, shift domestic use of surplus gas production to value chains with higher value added, and potentially expand exports. In FY19, local consumption of natural gas reached 2,181.7 billion standard cubic feet (Bscf), mostly used in electricity generation and industry (electricity - 62.3%; industry - 22.5%; petroleum, gas derivatives and petrochemicals - 10.1%; residential and CNG - 5.1%). As of 2021, consumption remained stable (2,185.2 Bscf). Domestic production, however, which reached a peak of 2,394 Bscf in 2021, is expected to decline starting in 2023 and into the medium term, temporarily returning Egypt to a net-importer status before once again picking up its upward trend. Subject to domestic natural gas priority needs and essential power generation system resilience and optimization considerations, the integration of RE into Egypt's energy mix could deliver significant climate transition and adaptation benefits, while potentially reducing power sector, balance of payments and fiscal exposure to international gas price shocks. Subject to domestic production and internal power generation and other demand trends, it may also eventually allow for the shifting of surplus domestic natural gas use to higher value-added products (e.g., petrochemicals and fertilizers) and increased exports as part of Egypt's strategy to become a key player in the regional energy trade.

Table 2. Investment Needs and Economic Costs: Net-Zero 100% Pathway, 2022-2050
NPV, deviation between CPS and NZ100

	$ billion	Change
Capital costs for new generation and storage	+34	+77%
Gas	-10	N/A
Solar	+1	+10%
Wind	+24	+234%
Nuclear	0	N/A
Storage	+5	+347%
CCS-Gas	+15	N/A
Variable operational and maintenance costs	+4	+36%
fixed operational and maintenance costs	+6	+23%
Total System Costs	+44	+54%

[187] In October 2021, the gas price to industrial customers was raised to US$5.75 /MMBTU from US$4.5 (28% increase), those prices were reduced earlier to help the industry sector face the COVID19 pandemic challenges.

Minus fuel cost savings	-16	-12%
Net total system costs	+29	+10%

Source: World Bank staff analysis based on power sector modeling.

To scale up RE, Egypt needs to enable private sector investment by laying the groundwork for competition in the energy sector. Egypt has successfully mobilized private sector investments in the power sector, but majority of investments are still channeled through public financing, whether through government bond offerings or loans/grants from bilateral and multilateral development financing institutions.[188] The full transition toward clean energy would need to be driven by the private sector because the scale of investments—even for a NZ60 scenario, let alone the NZ100 scenario—are several times the CPS anticipated investments. As mentioned above, the electricity sector will require the deployment of CCS and Battery Energy Storage System technologies after 2035 and this effort will need to be led by the private sector. The private sector can respond to the needs, but the foundations for increased private investment have to be in place through enabling policy reforms and incentives. Total system costs of the NZ100 scenario amount to US$44 billion between 2022 and 2040 (See Table 2 above). Taking into account the fuel cost savings, the net investment needs are estimated at US$29 billion. To ensure that the sector is attractive to the private sector, Egypt needs to introduce key reforms, ensure rational cost-based energy tariffs, and improve the efficiency and financial viability of the electricity distribution companies. A first step to reform the sector is the full implementation of the new Electricity and Renewable Energy Laws. Reviewing the tariff system is important to ensure financial confidence and sustainability for private investments, while protecting affordability of the service. Today, current average end-user tariffs are only about a third of the real cost of energy generation.

3.2.2. Reduce emissions in the oil and gas value chain and lower carbon intensity of the energy supply mix

Given the contribution of oil and gas to Egypt's overall emissions, and the availability of cost-effective short- to medium-term solutions, decarbonization of oil and gas value chain operations is a national priority for energy transition and adaptation, not only from a climate perspective but also from a strategic, economic and development standpoint. Egypt's oil and gas sector operations are estimated to have generated more than 1 Mt of methane emissions in 2021[189], roughly equivalent to 25 $MtCO_2e$, of which vented methane accounted for 60%, fugitive emissions for 26%, and incomplete flaring of natural gas for 12%, with the balance represented by other, smaller sources. These are estimated to have increased to 15-20 $MtCO_2e$ in 2021, of which 5.5 $MtCO_2e$ were derived from gas flares.[190,191] Likewise, in 2015 official data estimated that oil and gas sector operations generated 0.8 Mt of methane emissions.[192,193] Implementing a transformative program to modernize the oil and gas sector is included among the mitigation pathways outlined in Egypt's updated NDC.[194] Absent a detailed, asset-by-asset detection and measurement campaign of GHG emissions from the full oil and gas value chain including upstream, midstream and downstream, and integral satellite, aerial and ground level measurements the sector's contribution to Egypt's CO2 and methane emissions inevitably relies so far on informed estimates. The abatement of CO2 and CH4 (methane) emissions and other decarbonization measures in oil and gas production can contribute to lowering the carbon intensity of energy supply and provide an early lever to help meet NDC commitments.

---

[188] *Enabling Private Investment and Commercial Financing in Infrastructure*. World Bank Group (2021).
[189] According to Egypt's First Biennial Updated Report (BUR) oil and gas sector operations were estimated to have generated 0.8 Mt of methane emissions in 2015.
[190] Figures for 2021 obtained from the WB Global Gas Flaring Reduction Partnership (GGFR) and the IEA Global Methane Tracker
[191] *According to official sources, 6Mt of CO2 emissions (3% of the energy sector emissions) were estimated to derive from gas flaring and other combustion uses in production, treatment, processing, storage, compression, transport and refining operations in 2015.* World Bank calculations based on data from the Annex C table of the First Biennial Updated Report (BUR).
[192] Egypt's First Biennial Updated Report (BUR), 2018
[193] Egypt First Updated Nationally Determined Contributions, June 2022.
[194] Ibid.

As compared to the uncertainties surrounding fuel-switching, leveraging opportunities to reduce the carbon footprint and carbon intensity of the oil and gas, and gas-to-power value chains could bring significant emission reductions in the short- to medium-term, would be cost effective and could result in significant environmental co-benefits. Such efforts can also contribute to lowering the carbon intensity of energy production (oil, gas and power) and the carbon competitiveness of energy-intensive exports in anticipation of the adoption of carbon taxes and CBAM mechanisms in export markets. Based on average natural gas prices from 2017-2021, the IEA estimates that almost 45% of global oil and gas sector methane emissions could be avoided at zero or negative net cost, as the cost of mitigation is often lower than the market value of the gas that is captured. The IEA also estimates that it is possible to avoid more than 70% of methane emissions using existing technologies. Methane abatement actions tend to fall on the lower end of the decarbonization cost curve. International benchmarks indicate that energy efficiency, gas recovery and asset integrity improvements have an average abatement cost of US$10 – US$20 per ton of CO2e over the estimated lifespan of the investment due to the incremental revenues and savings from lower energy consumption. There are several levers available to address the carbon footprint of sector value chain operations, including energy efficiency (EE) measures; electrification and integration of RE energy; gas flaring reduction; abatement of CO2 and methane venting and leakage along the oil and gas value chain; development of carbon capture and storage (CCS) projects; and Demand Side Management (DSM), including the implementation of digital solutions. Such measures can also improve service reliability and resilience and optimize the operation of energy systems.

Egypt has significant carbon capture and storage (CCS) potential for emission reduction in the oil and gas, power generation and industrial sectors, including the development of low carbon blue hydrogen.[195,196] The existence of potential CO2 sinks in depleted natural gas reservoirs located close to oil and gas production operations and industrial sites with significant concentrations of CO2 emissions offer an opportunity for the development of CCS hubs. Three potential CCS hubs that will merit further assessment for their technical, economic and commercial viability have been recently identified: Cairo, Ain Sokhna/Suez, Damietta and Alexandria[197]. The Ain Sokhna/Suez hub alone has the potential to capture almost 20 MtCO2 per year at cost of US$35 to US$120 per ton. The economic and commercial feasibility of CCS projects is normally dependent on the adoption of supporting mechanisms like carbon taxes and green finance facilities, CCS associated with the production and processing of natural gas, where naturally occurring reservoir CO2 is produced and separated, is the lowest-cost application of CCS today, costing between US$15 and US$25 per ton of CO2.[198] According to the Global CCS Readiness Index, Egypt's readiness to deploy CCS is still low[199] with only oil and gas sector-specific regulations currently in place.[200] Further assessment of the potential for CCS development and the supporting policy and regulatory framework, financing mechanisms and capacity development needed for implementation is therefore required to determine the technical, economic, and commercial feasibility of CCS prospects.

Reducing emissions in the oil and gas sector value chain through private sector investment will require a clear policy and regulatory framework and close consultation and coordination with private operators to establish decarbonization and carbon-intensity targets, measurement standards, and reporting requirements. Policy development should begin with a granular inventory of decarbonization opportunities in the sector's upstream, midstream, and downstream operations and a determination of

[195] Decarbonizing Natural Gas using CCUS Technology, World Bank, fothcoming.
[196] Global CCS Institute https://co2re.co/FacilityData
[197] High-level CCUS Hubs Screening Assessment for Algeria and Egypt, World Bank, April - June 2022
[198] Naturally occurring CO_2 dissolved under pressure in underground oil and gas reservoirs tends to separate (evaporate) under lower pressures above ground during production and processing. The proximity of depleted natural gas reservoirs to still active oil & gas operations presents cost-competitive opportunities for reinjection of captured CO_2.
[199] https://www.iea.org/commentaries/is-carbon-capture-too-expensive.
[200] Decarbonizing Natural Gas using CCUS Technology, World Bank, forthcoming.

the location, volume, intensity and concentration of CO2 and methane emissions, including an assessment of energy efficiency gaps, power, heat and combustion processes in operations, gas flaring reduction, and emissions from venting and leakages of methane. The subsequent development of a Marginal Abatement Cost Curve (MACC) and the development of a short- to medium-term action plan, can inform the prioritization and sequencing of low-hanging fruit interventions and practical measures to lower the carbon intensity of operations, including the selection of optimal technologies, identification of costs, and the assessment of the commercial feasibility of applicable efficiency, mitigation and/or abatement options and of CCS opportunities. The MACC would also provide an indication of the needs and space for required state and private sector investment. Complementary actions will be needed to comply with high environmental standards for planned investments in decarbonization and to properly ensure the readiness of the policy options to address and manage associated risks.

3.2.3. Reduce inefficiencies in the use of energy for electricity and industry

Actions are needed to reduce inefficiencies in the use of energy in the electricity and industry sectors through technology, innovation, and regulatory reforms.

Energy

Inefficiencies in the use of energy in electricity generation come from a combination of subsidies and technical challenges. The GOE launched a comprehensive energy policy reform including energy subsidy phase-out and reforms for the electricity and oil and gas sectors that were initiated in July 2014 and expected to be completed in FY2024/25. Completing the move initiated during the last decade to fully remove energy subsidies is a crucial step to address inefficiencies.[201] In the long term, energy subsidy cuts are likely to improve growth perspectives and household welfare.[202] In the short term, targeted response of cash transfers should be continued and scaled up in parallel with the phase-out of energy subsidies.[203] The reduction of transmission and distribution (T&D) losses also presents an opportunity for decarbonization and can be supported by digital technologies in the energy system. T&D losses have increased over the past years and were estimated to be responsible for about 23 Mt of CO2 emissions in 2019.[204] While Egypt's transmission system losses are comparable to those of many EU countries, distribution losses[205] are very high, primarily driven by a sharp increase in commercial losses. Reducing T&D can lead to important energy savings and emission reductions. However further understanding of the main reasons and volumes commercial losses is still needed. A focus on deployment of smart meters can improve the control over the distribution network and contribute to enhancing the understanding of the challenges. Even simple pre-paid meters can help improve the collection rates and thus enhance the financial sustainability of the sector while also contributing to manage demand.

Remaining subsidies in the energy sector suggest that the real value of the negative externalities from fossil fuels, such as the health impacts of air pollution, is not being recognized. For Egypt, sizable explicit subsidies remain in the electricity sector and in diesel for transport. The order of magnitude of these subsidies is large: electricity subsidies for industrial and residential users are around US$8 billion, while diesel subsidies are around US$4 billion. This US$12 billion total (about 3% of GDP) would alone finance most of the annualized adaptation investment needs for cities (see Chapter 4). The magnitude of implicit subsidies is even larger, notably for diesel and other oils (e.g., jet fuel, heavy fuel oil). The

[201] Before this program, energy subsidies constituted 6% of Egypt's GDP in 2012/13. Between 2014 and FY2017/18, energy subsidies dropped to 3.4 percent of Egypt's total GDP and by FY2019/2020 they account for only 0.3% of total GDP. Egypt First Updated Nationally Determined Contributions, June 2022.
[202] Clemens Breisinger, Askar Mukashov, Mariam Raouf, Manfred Wiebelt (2019), "Energy subsidy reform for growth and equity in Egypt: The approach matters," Energy Policy, Volume 129.
[203] As a reference, the percentage of cash-transfers (Takaful and Karama) in total income was 6% of income for the poorest decile and 1% on average in FY21 (FIA tool). World Bank (2022) Poverty, Jobs and Climate Change. Egypt's CCDR Background Note.
[204] Assuming grid emission factor of 0.53 t CO2/MWh.
[205] Distribution Companies (DCs) losses include commercial losses and technical losses.

externality cost of local air pollution represents the lion's share of the implicit subsidies granted to fossil fuels. Climate change accounts for 4% of GDP in terms of implicit subsidies.

Industry

Improving energy efficiency across the industrial sector can help make headway in decarbonizing the sector while strengthening its export competitiveness. Global markets are increasingly demanding greener and lower carbon content products. Egypt needs to be ready to respond to such changes. In 2020, while only 4.3% of firms in Egypt reported that their end consumers require environmental certificates or adherence to environmental standards as a requirement for doing business with those firms, the percentage is higher for large firms[206] and exporting firms, at 16% and 12% respectively. There is still little awareness among the industrial sector: one third of firms report that they monitor CO2 emissions, 18% monitor energy consumption, and 16.8% have adopted measures to enhance energy efficiency.[207] These data suggest that most firms do not see energy efficiency as a priority compared to other investments. Egypt is already taking steps to increase awareness about the importance and impact of energy efficiency, and is moving toward decarbonization of the industrial sector through energy efficiency measures ranging from stronger minimum energy performance standards for motors and drives to requiring the adoption of waste heat recovery systems in industries. The Ministry of Trade and Industry (MTI) is working on an integrated approach to support market reforms through consumer awareness campaigns, finance and financial delivery mechanisms that ease the upfront costs of energy efficient motors, and capacity building, including through the establishment of 13 technological centers.

Energy service companies (ESCOs) can play a critical role in implementing energy efficiency in industries. To achieve even more ambitious outcomes, energy efficiency will need to be coupled with additional efficiency measures and energy use optimization in water, material use and waste management. In the initial stages, private ESCOs can implement energy efficiency through energy savings performance contracting that takes the form of either shared or guaranteed savings models across industry, Micro, Small, and Medium Enterprises (MSME), building, and public sectors (municipal street lighting, water pumping, etc.). To trigger a longer term, more fundamental market transformation toward large-scale implementation of energy efficiency projects across sectors, the creation of a public Super Energy Service Company (Super ESCO) will be required. International good practices in establishing Super ESCOs could inform practices and determination of the best model for moving forward.[208] A Super ESCO approach could further enhance the use of non-financial policy measures such as green certificates for industrial plants that implement EE/RE projects.

Accelerating the uptake of energy efficient motors through awareness and enforcement of decree 463/2020[209] could strengthen competitiveness while reducing emissions. Effective implementation of high efficiency motor standards (such as the "IE3" efficiency class on the International Electrotechnical Commission's (IEC) international performance rating scale) could help save the industry sector nearly US$560 million[210] and has the potential to mitigate up to 9 million tons of CO2 in cumulative emissions by 2031.[211] But as mentioned above, there is little awareness across the industry sector. Improving

---

[206] Large firms refer to firms with over 100 employees. Egypt Enterprise Survey (2019-2020)
[207] Egypt Enterprise Survey: Green Module, World Bank (2019-2020).
[208] Super ESCOs are typically governmental entities created to serve the public sector, develop the capacity of private ESCOs, and facilitate project financing. For nascent energy services markets, Super ESCOs help aggregate projects and drive down transaction costs through standardization. For an overview of ESCO and Super ESCO issues, see World Bank (2018) Transforming Energy Efficiency Markets in Developing Countries: The Emerging Possibilities of Super ESCOs https://openknowledge.worldbank.org/handle/10986/30385
[209] Decree 463/2020 was supported by the IFC's Smart Technology and Energy Efficiency Production Program (STEP)
[210] The USD$560 million is the cumulative net present value of savings and takes account equipment and operating costs over the equipment lifetime and a 5% discount rate. The calculations were conducted at the onset of the Smart Technology and Energy Efficiency Production Program (STEP), using the Lawrence Berkeley National Laboratory Policy Analysis Model System (PAMS) impact analysis model, and were based on 2016 energy prices and tariffs and quote savings at 2031.
[211] *Ibid.*

awareness of the potential savings and ensuring that the standards supported by the decree are enforced, could help accelerate the sector's EE transition.

Further, to enable industry carbon competitiveness it will be necessary to reduce non-tariff barriers. Current import tariffs seem to support the move toward greener trade, as tariffs on environmental goods and services are comparatively low. However, non-tariff barriers are extensive, with price controls and technical barriers to trade affecting most environmental goods. This challenge is particularly pronounced for imports of renewable energy products, products related to the management of solid and hazardous waste, and recycling systems.[212] Reducing these barriers will be important to support the private sector as a domestic and international solution provider that is able to offer innovative products and services, while also reducing the environmental footprint of economic activity in Egypt and strengthening private sector resilience to climate events.

Egypt has an extensive network of industrial and investment zones that can be leveraged to facilitate greater resource efficiency and reduce emissions in the industrial sectors. Investment in common infrastructure to support cleaner energy, water treatment and re-use, and waste reduction and re-purposing will help achieve economies of scale for such solutions and also raise awareness in industry about the business case for investing in cleaner technologies.

3.2.4. Reduce emissions in the transport sector

Progress toward a low carbon transition of the transport sector can enhance livability and productivity, while strengthening the competitiveness of goods. Carbon emissions from the transport sector have been rising and are projected to continue to increase. Well-designed, low carbon public transport systems can improve safety and security, increase access to employment opportunities and services, and build the economic and social resilience of women and vulnerable groups. Associated reductions in congestion and air pollution can also increase labor productivity in cities. A low carbon transition in the freight and logistics sector could help strengthen competitiveness by improving the sector's efficiency and lowering costs for shipping goods, including agricultural products. Improving railways to make them competitive for freight transport, including through connectivity improvements to ports and neighboring countries, will be a cornerstone of strengthened regional integration in a region characterized by market fragmentation, while also delivering climate co-benefits. Finally, reducing emissions in the transport sector can contribute to lowering the carbon content of final goods, increasing competitiveness in carbon-conscious markets.

Priority actions to achieve the transformational scenario would include adopting pricing interventions and awareness-raising programs to manage demand; integrating multimodal transport systems; and improving the fleet composition, in addition to continuing investment in low carbon infrastructure. The analysis conducted for this report suggests that several policy actions are important to help reduce emissions in the transport sector. First, to realize the climate benefits of ongoing investment projects, the GOE can build the capacity of transport authorities, with an initial focus on developing and then implementing a national transport sector strategy that coordinates government-wide transport programs for a low carbon transition of the sector, and increasing its resilience. Second, to deliver wider social benefits, the GOE could adopt soft measures that influence behavior, in parallel with the hard investments already underway.[213] See Box 3 below for additional details on the transport analysis and a description of the scenarios considered.

---

[212] Among the 1,924 non-tariff measures on EGs, imports of renewable energy (REP) and management of solid and hazardous waste and recycling systems (MSHW) face 614 NTM and 394 NTMs, which cover more than half of total NTMs.
[213] Hegazy, M., 2022. *Egypt transport policies 2014-2021.* Arab Reform Initiative. Available at: https://www.arab-reform.net/publication/egypt-transport-policies-14-21/

Box 3. The World Bank's Transport Emissions Analysis

The World Bank's transport sector emissions analysis emphasizes policy and regulatory opportunities to reduce sector emissions toward 2050. The analysis complements Egypt's First Updated Nationally Determined Contributions (NDC),[214] which focus on investment projects that drive a low carbon modal shift from private passenger and freight vehicles to mass transit. The World Bank reference "Current Policies Scenario (CPS)" reflects the GOE's low carbon transport vision, including the ambitious sustainable transport investment projects listed under Egypt's First Updated NDC. The CPS further accounts for policies and strategies, such as Zero/Low Emission Vehicles transitions (the CNG fleet size reflects the GOE target of 620,000 CNG cars by 2024; Cairo Transport Authority target of 2,269 CNG vehicles by 2025; and 50% of new cars to be EV by 2050). The CPS also includes retirement of aged vehicles, such that no imports of secondhand passenger vehicles are allowed by 2030, and the vehicle survival curve is adjusted to reflect the removal of 80% of 20-year-old vehicles by 2040. Finally, the CPS modeled urban public transport investment (rail, bus, BRT) assuming a 2% mode shift from cars to public transport by 2040 as a result of the investment projects. [215]

Our analysis includes a High Ambition scenario to assess the potential carbon emissions abatement of transport policy and regulatory options. This scenario includes more ambitious transitions compared to the CPS, in terms of the transition to Zero/Low Emissions Vehicles (earlier shift to EVs, with all new cars, motorcycles, buses, and minibuses being EV by 2045, and a lower uptake of CNG because EVs would dominate the fleet). With respect to the retirement of aged vehicles, the High Ambition scenario included no imports of secondhand motorcycles, vans, trucks, cars, buses, or minibuses by 2030, a 15% reduction in energy consumption for new cars and vans, and a 10% reduction for buses and trucks by 2030. Further, the High Ambition scenario accounted for complementary policy options including urban congestion charging, traffic management and drivers' training for eco-driving, rural and intercity bus development, railways electrification, and logistics consolidation. Finally, the High Ambition scenario modeled urban public transport investments such as those required to achieve the replacement of 80% of urban microbuses with buses by 2050, and a 4% mode shift from cars to public transport by 2045.

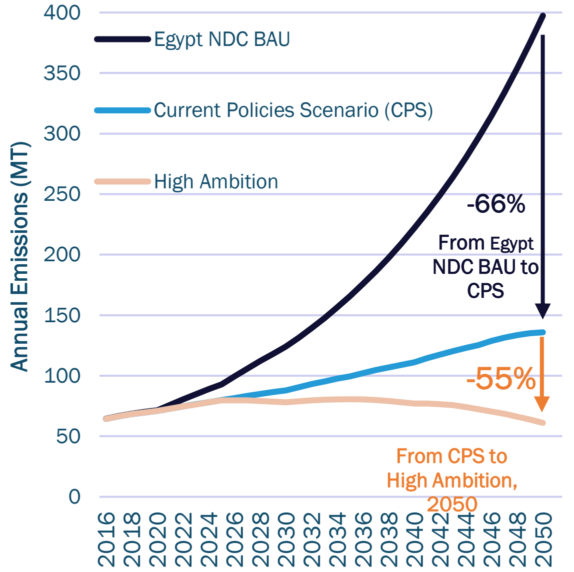
The World Bank CCDR Transport Analysis modeled the sector's carbon footprint based on passenger and freight transport activities in road, rail, waterborne and air travel modes. The model projects travel demand and emissions through 2050, based on socio-economic and sectoral trends in population, GDP, vehicle stock, motorization, location of demand (urban, rural, and intercity), fleet capacity and occupancy, mileage, and changes in vehicle efficiency, among others. Taking into account both direct and indirect emissions for urban, non-urban, and highway locations, the model accounts for different power train and fuel options as appropriate to each mode (e.g., diesel, CNG, and electric for buses; and gasoline, CNG, and electric for private cars) as well as age (or vintage), for different vehicle classes, energy consumption, and emission factors for different fuels.

With full implementation of the current policy and regulatory framework (Current Policy Scenario), carbon emissions from transport and related sectors are projected to reach 88 MtCO2e in 2030 and 136 MtCO2e in 2050. The update NDCs projects under the Business As Usual (BAU) scenario the transport sector's carbon emissions[216] to exceed 124 MtCO2e in 2030. The World Bank's transport emissions analysis suggests that the full implementation and enforcement of current policies and strategies would lead to an emission trajectory that is considerably lower than that provided by the BAU in the update NDCs, with emission levels that are 29% and 66% percent lower in 2030 and 2050 respectively. As shown in Figure 17, the CPS emission projection for 2050 would still lead to an increase of 111% as compared from the 2016 emission levels. Electrifying 50%[217] of new vehicles of all classes is ambitious in light of technological, macroeconomic, market, and other risks. However, the benefits of this move can be high, representing about 73% of carbon emission abatement[218] under the Current Policy Scenario (Figure 18) by 2050. Regarding the public transport sector, the aggregate capital

[214] Egypt First Updated Nationally Determined Contributions, June 2022
[215] The World Bank. Greater Cairo Mobility Assessment and Public Transport Improvement Study, *forthcoming*.
[216] The Government of Egypt NDC, transport sector includes domestic navigation, rail, and road.
[217] Launched in 2019, Egypt E-Mobility Strategy which emphasizes strengthening local manufacturing set a target of increasing market share of private EVs in Egypt to 50% by 2040.
[218] CPS assumed electricity generation GHG intensity of 0.147 kgCO2e/MJ in 2020 and annual change of -2.8% through 2050 to align with the CCDR energy analysis.

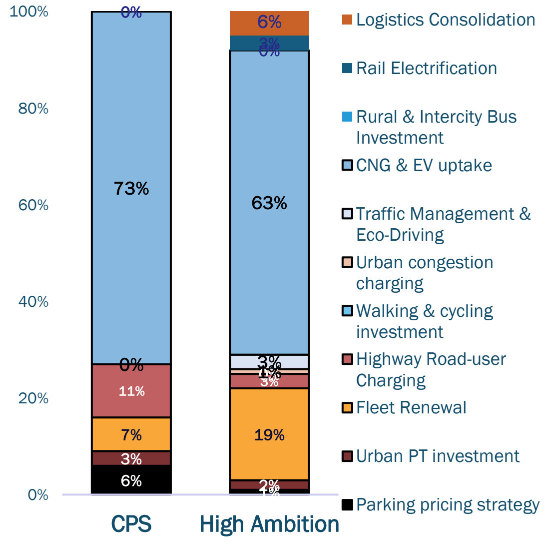
investment needed to meet government ambitions for CNG buses and electric bus uptakes is estimated at US$5.4 billion and US$12.6 billion, respectively, by 2050.[219]

Figure 17. Transport Sector Emission Projections by Scenario, 2016-2050



Source: World Bank Team calculations

Figure 18. Carbon Emission Abatement by Transport Policy Options, CPS and High Ambition Scenarios



Source: World Bank Team calculations

Through additional investments, increased uptake of new technologies, and demand-side interventions (High Ambition Scenario, or HAS), Egypt could achieve further reductions in transport sector emissions, down to 61 MtCO2e in 2050 or abatement of 55% from the Current Policy Scenario (Figure 17). Figure 18 shows the carbon emission impact of policy options assessed under the HAS. Renewal of the old fleet is projected to contribute to 19% of the carbon emissions abatement impact of the HAS but would require building the capacity of regulatory institutions to strengthen monitoring and enforcement of laws and regulations mandating the retirement of aged vehicles. Egypt can also accelerate the renewal of the old fleet by extending its successful carbon financing program to scrap and replace high-mileage commercial vehicles. Strategic street parking pricing, traffic management (Intelligent Transport Systems, traffic signaling, etc.), and well as eco-driving training programs for divers can in aggregate contribute 4% of the High Ambition Scenario's carbon emissions reduction impact (Figure 18), while also delivering road safety co-benefits that protect human capital.

Regulatory interventions to promote sustainable logistics (e.g., logistics coordination, freight consolidation, accelerated investment in and operation of intermodal facilities, and charges to push freight from road to rail) can have lasting impacts. Freight transport regulatory authorities can also be strengthened to deploy logistics transport solutions that would incentivize the consolidation of carbon-intense truck traffic, which represent 6% of the HAS emissions reduction potential (Figure 18). Introducing Highway Road User Charging linked to the carbon footprint of each respective vehicle class

[219] See Egypt CCDR National Transport Emission Analysis background paper (The World Bank, 2022) for details. CPS assumed the current trajectory of CNG and electric vehicles will continue, i.e., 50,000 new CNG cars added per year, and no substantial addition of EVs. CPS accords with the government target of 620,000 CNG cars by 2024 and extrapolate thereafter until 2050. For buses, the analysis extrapolated CTA target of 2,269 CNG buses by 2025 and extrapolated thereafter until 2050. Further, the Current Policy scenario reflects the GoE's target of 50% of new cars to be EV by 2040, for buses, minibuses and vans. EV uptake of medium and heavy trucks was assumed to delay other vehicle classes. The analysis also assumed that by 2050, the shares of EVs in new vehicles will be maximum 50%. The estimates assumed capital cost of CNG buses at US$179,200/vehicle, and Battery Electric Bus at US$ 236,200, both of which include exercise tax and remain constant until 2050. The analysis assumed additional fleet to be acquired to meet projected travel demand to be served by the bus sector, unconstrained, and discounted at 6%. CNG fueling stations are excluded from the analysis. E-Bus investments include fleet and import tariff. The analysis focuses on capital investment needs, and the lifecycle feasibility and Total Cost of Ownership assessment is beyond the scope of this study.

can would contribute 3% of the HAS carbon abatement impact. These interventions are cost effective and can mobilize private capital, especially if they leverage emerging technologies such as mobile app-based management solutions and digital payment systems. To achieve policy objectives, the GOE's focus should be on building the capacity of authorities to design adequate schemes and regulate private operators effectively. Where suitable, it is essential to ensure that privately operated transport services can collect commercial fees, as opposed to being viewed as Public Service Obligations. Essential next steps to attract private investment for this transformation include simplifying the sector's complex institutional structure, introducing transparent regulations, and designing both an integrated multimodal freight transport strategy and an integrated mass transit strategy.[220]

Egypt can facilitate the transition of public transport vehicles to low/no emission alternatives by focusing on building the capacity of regulatory institutions to fully realize development benefits and increase private sector participation. Figure 18 shows that a more ambitious uptake of electric vehicles of all classes, complemented by a transition to CNG, represents 63% of the High Ambition Scenario's carbon emissions abatement impact.[221] Affordability and the need for motorization management present important challenges for private vehicles. An initial focus on moving toward a low/no emission bus fleet can bring important co-benefits including air pollution reduction, improved access for vulnerable populations, and job creation (if coupled successfully with policy and regulatory interventions to create a sound domestic industry). Therefore, public transport is an appropriate focus for policy interventions. The aggregate capital investments needed to switch the public transport (bus) fleet to CNG and electric buses under the HAS would total US$5.4 billion and US$48.7 billion, respectively, by 2050.[222] Achieving a modal shift from cars to low carbon transport modes will be essential in parallel with the uptake of a low/no emission fleet. The magnitude of the needed investment suggests that the government should focus on mobilizing private investments by mitigating investors' perceived policy, regulatory, and technical risks. Policy priorities in this regard should include strengthening institutions to effectively manage E-Mobility transitions and the consolidation and more effective regulation of informal public transport operators, which otherwise may compete with and hinder the financial viability of a CNG and electric bus fleet.

The transition toward low emission vehicles needs to go hand in hand with the RE transition and capacity building of regulatory institutions to fully realize the development benefits of a low carbon transition. Low carbon transition of the transport sector and acceleration of the RE transition are processes that should happen in tandem and can be mutually reinforcing, in terms of benefits. The GOE has active initiatives to partner with, among others, private entities to establish green hydrogen plants from renewable sources. Researching and piloting hydrogen fuels, for example for long-haul trucks, trains and ships, and supporting the roll-out of fueling networks in Egypt's unique context would be a sensible approach to prepare for future uptakes. For Egypt to be prepared for the transition, it will be important to for the GOE to assess potential opportunities for policy instruments such as taxation and incentive schemes.

3.2.5. Take synergistic actions across adaptation and mitigation

While mitigation and adaptation may sometimes appear as divergent paths toward greener development, there are many adaptation actions that can make headway toward mitigation goals while

[220] Enabling Private Investment and Commercial Financing in Infrastructure, World Bank Group (2018).

[221] High Ambition Scenario assumes electricity generation GHG intensity of 0.147 kgCO2e/MJ in 2020 and annual change of -6.5% through 2050, as per Abdallah, L., El-Shennawy, T. Evaluation of CO2 emission from Egypt's future power plants. Euro-Mediterr J Environ Integr 5, 49 (2020). https://doi.org/10.1007/s41207-020-00184-w.

[222] See background paper on *National Transport Emission Analysis* background paper for details. The high ambition scenario assumes earlier shift to EVs with cars, motorcycle, bus and minibus being EV by 2045, which accords with nearly all cars on the road being electric by 2060. This scenario sees a lower uptake of CNG vehicles in later years, as EVs dominate. All new medium and heavy trucks are electric by 2050. The estimates assumed capital cost of CNG buses at US$179,200/vehicle, and Battery Electric Bus at US$236,200, both of which include exercise tax and remain constant until 2050. The analysis assumed additional fleet to be acquired to meet projected travel demand to be served by the bus sector, unconstrained, and discounted at 6%. The assessment assumed away operation and maintenance costs.

also better preparing Egypt for an uncertain future. Actions at this intersection in agri-food, water and urban development provide a no-regret pathway toward a low carbon future. Egypt should not miss the opportunity to achieve the potential mitigation co-benefits of adaptation actions that can strengthen the country's position in international markets and global dialogues, and prepare for when carbon markets provide new possibilities.

A focus on food and water systems is needed to strengthen climate adaptation, but it can also play a significant role in supporting a low emission path. Climate-smart technologies in agriculture can strengthen long-term resilience by preserving water and increasing agricultural productivity. For instance, the introduction of drought-tolerant maize varieties in 13 Sub-Saharan African countries has led to farmers reporting yields that are 20% to 30% higher than those of traditional varieties.[223] Desalination is one of Egypt's adaptation strategies being considered, with expansion plans to reach a capacity of 6.4 million m^3/day by 2050. This translates to a contribution of 2.33 BCM annually by 2050. While this amount represents only 4% of the current 55.5 BCM Egypt relies on for total water available coming into the country, it would be an important source of water for drinking, industry and tourism that would be available regardless of climate impacts, droughts or man-made changes in Nile runoff.[224] But Egypt will require approximately 600 MW of incremental energy generation capacity to meet the needs of desalination.[225] Meeting this energy demand will require corresponding developments in the generation, transmission and storage infrastructure feeding the desalination plants. To mitigate the impact of additional energy requirements, Egypt should consider using excess capacity in the system wherever feasible, creating transmission infrastructure and wheeling mechanisms to ensure that RE supplies can be used for operations. This may also involve building bulk water storage capacity in conjunction with desalination plants to allow flexibility in operations during times of day when RE is available.

Energy generation from wastewater treatment (WWT) could be a triple win for Egypt and attractive for private sector investment. According to plans from Egypt's Holding Company for Water and Wastewater, between 2020 and 2030, the capacity for secondary treatment and tertiary treatment is expected to be doubled from 5 BCM (secondary treatment) and 0.3 BCM (tertiary treatment) to 10 BCM and 0.58 BCM, respectively.[226] As Egypt expands its wastewater treatment capacity, it has an opportunity to achieve a triple win. First, the treated wastewater can be reused in agriculture or other sectors, thereby expanding the available water from a non-conventional source. Second, the process helps capture methane, one of the most harmful GHGs, which accounts for 85% of the emissions from wastewater treatment.[227] Third, there is significant potential to generate energy from biogas produced during WWT, which could help meet a sizeable share of the energy required for wastewater treatment. Wastewater Treatment Plants (WWTPs) serving more than 10,000 people may be financially viable for energy generation. Further, research shows that the cost of power from biogas tends to be lower than grid-supplied power, which makes an even stronger case for such investments and increases financial viability for the private sector.[228]

Despite the complex interplay between water and energy challenges, the goal of increasing water availability is achievable, and can be reached while also reducing emissions by over 5 million tons of CO2. Table 1 illustrates the effects on GHG reduction and increased water availability through the implementation of different wastewater treatment, water supply and renewable energy use policies, as

[223] CGIAR Research Program on Climate Change, Agriculture and Food Security, "CCAFS Big Facts - Drought-tolerant maize boosting food security in 13 African countries," https://ccafs.cgiar.org/bigfacts/#theme=evidence-of-success&subtheme=crops&casestudy=cropsCs2
[224] Global Water Intelligence (2020), "Egypt outlines $15 billion desalination programme". Vol 21, Issue 10. https://www.globalwaterintel.com/global-water-intelligence-magazine/21/10/general/egypt-outlines-15-billion-desalination-programme
[225] Based on financial projections by the World Bank.
[226] Based on discussions with HCWW and the MHUUC.
[227] Egypt's First Biannual Update Report for the UNFCCC, 2018.
[228] Vazquez Alvarez,Victor; Buchauer,Konrad. (2015)

well as their effect on decreasing desalinization needs. The ambitious scenario, which considers the implementation of additional policies that shift investments towards better demand management and efficiency improvements, can result in an emissions reduction of over 5 million tons of CO2 compared to the BAU scenario.[229] Water savings from these measures could be used to meet organic growth demands for energy in existing cities and minimize the need for expensive investments in desalination. The High Ambition scenario focuses on improved demand management, better energy efficiency, and a reduction in the amount of non-revenue water (NRW, which would reduce the need for investments in water treatment (including desalination and WWT). Savings from avoided investments in water and WWT are prioritized for NRW reduction, improved demand management and energy generation from WWT with a lower investment envelope than what is required for current policies.

Table 3. Proposed actions and emissions in the water-energy sector under different scenarios for 2050

Policy Scenarios	WB Reference Scenario		Current Policy		High Ambition	
	Current levels		Measures aligned with Water Strategy 2037		Additional policy measures	
	Quantity (MtCO2 (2050))	**Cost (USD billion)**	**Quantity** (MtCO2 (2050))	**Cost (USD billion)**	**Quantity** (MtCO2 (2050))	**Cost (USD billion)**
Emissions	5.67	$25	1.51	$19.1	0.43 - 0.53	$14.30 - $23.30
Water policies of the three scenarios						
Drinking water production	Present per capita levels for water supply & current Non-Revenue Water (NRW) until 2050		• Introduction of water supply norms that range between 150 lpcd and 400 lpcd for different categories of rural and urban settlements with a target to bring average allocation to 242 lpcd by 2037 • NRW comes down to 20%		• Drinking water production per person is reduced by 20% of the applicable norms • NRW reduced to 20%	
Desalination	6.4 million m³/day by 2050		Current norms lead to savings in water production: 1/3 of the water savings could be used to replace desalination		EE measures are implemented in WWTPs, leading to a 25% reduction in energy consumption per m³ of water treated. 1/3 of the water savings could be used to replace desalination	
Wastewater	• 100% of wastewater is treated before discharging • Very few WWTPs are retrofitted with equipment for generating energy from sludge		• 100% of wastewater is treated before discharging • Very few WWTPs are retrofitted with equipment for generating energy from sludge		• 100% population with access to water and sanitation • 100% of wastewater is treated before discharging • About half of WWTPs are retrofitted with equipment for generating energy from sludge; potentially generating between 15%-45% of the WWTP's energy requirement	
Energy grid (MtCO2/MWh)	0.3		0.1		0.05	
Methodological Note: *The figures used for WB Reference scenario calculations are: (i) Water Production from CAPMAS 2021; (ii) NRW from EWRA 2017-18; (iii) Wastewater generation from CAPMAS 2021; (iv) Desalination capacity considered at 6.4 million*						

[229] See methodological note in Table 3.

m3/day by 2050 as per national plans; (v) Energy demand for desalination: 3.75 kwh/m3, 3 kwh/me (after 5 yrs); 2.25 kwh/m3 (after 20 years). Energy grid assumptions are consistent with WB energy model. Calculations for the Current Policy Scenario and the High Ambition Scenario use the same data sources, but are modified by efficiency factors listed in the "water policies in three scenarios" portion of the table. Costs are listed for each scenario and are not cumulative across scenarios.

An initial focus on low carbon cities can help accelerate progress toward ambitious GHG mitigation goals and support adaptation while enhancing livability and productivity. Cities contribute about 80% of Egypt's direct GHG emissions[230], while Greater Cairo contributes almost 50% of GDP. Interventions in cities to manage urban form, improve connectivity and enhance the sustainability of service delivery not only provide a path for adaptation and improved resilience, but also a way to strengthen Egypt's contribution to reducing emissions. These actions would go in line with Egypt's updated NDC and its ambition to promote sustainability in existing and new buildings and urban developments, and also increase resilience in cities. Moreover, low carbon cities also deliver significant co-benefits, including health gains and job creation.[231] A focus on green and resource-efficient buildings can ensure that the expected 4.4 - 4.5 million additional residential units and the 23 - 24 million m^2 of commercial buildings (offices, hotels, retail establishments, etc.) that will be required by 2030 do not create additional emission burdens. A focus on establishing and updating standards and leveraging existing certifications (such as the EDGE certification), to reduce energy and water consumption as well as GHG emissions, can foster private sector participation in this sector while contributing to emission reduction and more efficient use of water and energy in cities.[232]

Sustainable waste management practices focusing on resource recovery maximization and circularity can build resilience and accelerate the transition to low carbon. Given that waste generation is coupled with Egypt's population, economic and per capita income growth trajectories, the waste generation in major Egyptian cities is anticipated to increase by 68% between 2021 and 2030, from ~12 million tons annually to ~21 million tons. Waste generation is anticipated to grow at a faster rate due to the combined effect of urban population increases in cities as well as the coupling of per capita waste generation rates with rising incomes. Given existing service delivery levels, increasing waste generation will result in a significant volume of mismanaged waste, to the tune of 135 million tons between 2021 and 2030 in the BAU scenario. Egypt's updated NDC also identifies as one of its ambitions an increase in the efficiency of the waste system and valorization of waste through materials and energy recovery.[233] The organic content (56%) in the mismanaged waste has a bio-energy resource potential of ~650 million Nm^3/annum of biogas, which is currently unrecovered. This is a lost opportunity, especially considering the increasing energy demands of urbanization. Similarly, ~51 million tons of mismanaged plastic will be produced between 2022 and 2030 because of poor municipal waste management systems, which can further increase Egypt's contribution to marine litter. Moving up the waste hierarchy[234] implies both a reduction in waste generation and re-introduction of material resources into

---

[230] World Bank staff calculations using EDGAR emissions data combined with information on urban extents. Crippa et al., 2021. "Global Anthropogenic Emissions in Urban Areas: Patterns, Trends, and Challenges. EDGAR data is a global dataset and is based on based on mapping of emitting activities and corresponding emissions factors that are in line with IPCC guidelines. The EDGAR data provides emissions of GHGs and air pollutants for all anthropogenic emitting sectors, following the IPCC categories, namely 'energy-industry' (which includes the combustion in the power and non-power generation industries, fugitive emissions, fuel production, refineries and transformation industries), 'residential' (which includes small scale combustion), 'transport' (which includes both road and non-road transport), 'waste' (which includes solid waste disposal and waste water treatment) and 'other' (which includes all emissions not included in the other categories such as industrial process emissions (e.g. cement production, iron and steel production, non-metallic minerals production, non-ferrous metals productions, chemicals production), solvent use, indirect emissions for N2O, etc.). EDGAR data provides Scope 1 emissions spatially across types of settlements. City emissions are aggregated overlaying information on urban settlements with the EDGAR data.

[231] The co-benefits from moving toward a low carbon path has been recognized globally with more than 700 cities having signed a pledge to 'implement immediate actions to cut emissions in half within the next decade and reach net zero carbon emissions globally by 2050'https://www.c40.org/news/cities-committed-race-to-zero/. For more examples on co-benefits from investments in cities see https://www.c40knowledgehub.org/s/article/Climate-Opportunity-More-jobs-better-health-liveable-cities?language=en_US.

[232] EDGE, a green building certification system for emerging markets created by the IFC. EDGE is a measurable way for builders to optimize their designs, leading to a more investment-worthy and marketable product. The EDGE software shows within minutes how committing to a few practical energy and water-saving options improves building performance at little or no cost. The numbers are brought to the forefront to reveal the most economically viable path to building green. EDGE focuses the certification process on technical aspects that yield meaningful results. This makes it easier for developers to build a portfolio of innovation that attracts new customers and boosts brand equity.

[233] Egypt First Updated Nationally Determined Contributions, June 2022.

[234] The Waste Management Hierarchy principle has been widely adopted internationally to guide sustainable waste management practices. It is founded on a principle of not discarding waste, unsafely, in the environment, but rather trying to reduce the amount of waste ultimately disposed.

the economy. The Circular Economy concept[235] focuses on enhancing recycling and resource recovery while also providing livelihood and economic opportunities to leverage local supply chains. But making headway in this direction will require a comprehensive reform of the solid waste management (SWM) sector to: (i) strengthen the institutions that regulate, manage and enforce the provision of SWM services; (ii) build the infrastructure and systems needed to provide adequate local services in an environmentally, climate change mitigation conducive, and socially sustainable manner; (iii) set up funding mechanisms that will allow financially sustainable systems to operate; and (iv) raise awareness and support from the public at large to expect and demand adequate services. A transformation of the sector is possible in the medium term but will require strong leadership at the national, sub-national (Governorate) and local government levels and clear, achievable targets. The 2020 ratification of the Waste Management Law[236] by the GOE is an initial step toward sustainable waste management but will require measures to ensure enforcement and efforts to establish a supporting integrated policy landscape.

Attention to how cities grow can help save time and improve livability through decreased travel times, limited congestion, and reduced pollution. A BAU city expansion scenario suggests an expected 24% increase in per capita daily travel distances between 2020 and 2030, from 13.6 km/capita/day to ~17 km/capita/day, increasing by a total of 15,480 billion VKTs. Increased travel distances hinder accessibility to and inclusivity in key services and jobs, and increase emissions. ILO estimates suggest that in African countries, a reduction in worked hours due to heat stress will result in productivity losses of about 2.3%, the equivalent of 14 million full time jobs.[237] Empirical evidence from global studies further suggests a significant drop (~30%) in productivity as temperatures increase from 26C to 31C[238], while the productivity of heavy outdoor work could decline by 26.1% from current levels under the RCP 8.5[239] climate scenario.[240] Nature-based solutions have been shown to be cost effective. For example, in the United States, across 52 coastal defense projects, nature-based solutions were estimated to be two to five times more cost-effective at lowering wave heights and increasing water depths compared to engineered structures.[241] In cities, nature-based solutions serve as GHG sinks while also enhancing resilience to climate change hazards such as heat stress and flooding, contributing to clean air and delivering as much as five times cost effectiveness when compared to engineered solutions.[242] Similarly, integrating low carbon and energy efficiency levers such as energy efficient technologies, pumping systems, and efficient processes into infrastructure and service delivery choices across public transport, water supply, wastewater management, and street lighting can result in dramatic GHG reductions while also lowering the fiscal burden on governments and citizens through reduced electricity bills.

---

[235] It is an expression of an economic model that highlights business opportunities in the management of wastes and promotes incentives to reduce the amounts of waste disposed. It aims to maintain and prolong the life of products/materials, and to extract maximum value from them for as long as possible to avoid ultimate disposal.
[236] Waste Management Law No.202 of 2020.
[237] *Working on a warmer planet: the impact of heat stress on labor productivity and decent work*, ILO (2019).
[238] Wyndham CH (1969), “Adaptation to heat and cold,”. Env Res 2, 442-469.
[239] While long-term GHG emissions in the RCP8.5 are considered overly pessimistic, the CMIP5 climate change scenarios with RCP8.5 a provide useful (and not implausible) high-warming scenario, which would be consistent with continued GHG emissions and high climate change sensitivity or positive feedback from the carbon cycle.
[240] Seung-Wook Lee et. al (2018). Effects of climate change-related heat stress on labor productivity in South Korea
[241] Seddon Nathalie; Chausson Alexandre; Berry Pam; Girardin Cécile A. J.; Smith Alison and Turner Beth. 2020, “Understanding the value and limits of nature-based solutions to climate change and other global challenges,” *Phil. Trans. R. Soc. B*3752019012020190120 http://doi.org/10.1098/rstb.2019.0120
[242] Gregg et, al (2021): “Benefit Accounting of Nature-Based Solutions for Watersheds: Guide.”

4. Growth, Equity, and Financial Implications

Main messages

- Policy and institutional framework changes will be essential to facilitate investments in climate action. A mix of policy instruments, including carbon pricing, regulation and taxation, can reduce the amount of additional investment required, but a sizable flow of investments is still needed.
- The growth impact of climate-related investment can be positive, but financing should be carefully managed by balancing sources (taxes, debt, reprioritization), spreading investments out over time, and tapping relevant markets.
- A fiscal framework with integrated climate policy options would create a path to remove current carbon subsidies and price distortions, which could finance some adaptation investments and incentivize decarbonization.
- Enabling the transition toward a low carbon, climate-resilient economy will require:
  - Levelling the playing field for private sector participation, which would support a transition toward green, resilient and inclusive development. For climate action, the private sector has an essential role to play as a financier, innovator, and provider of services to reduce inefficiencies and foster innovation across sectors in water management, desalination, SWM, transport, and urban development. Private participation across sectors would be supported by leveling the playing field in infrastructure pricing, and international green markets, where the development of adaptation standards and tools would reduce investment risk and the introduction of incentives would speed the transition to greener productive processes and services. Public institutions must continue to play the strategic role they have in driving climate priorities and action, while also creating climate governance frameworks that include government, SOEs and other public sector entities.
  - Strengthening green finance, which is key to achieve Egypt's sustainable goals and is also recognized by the NCCS 2050. To boost green public investment, Egypt needs to enable coordination among the central government, different levels of government, and the broader public sector. Strengthening public investment management, developing a strategy for the use of public finance, public-private partnerships, and private finance for green investments defining a disaster risk financing strategy, establishing more transparency in emissions reporting, and leveraging innovative green financial instruments are key first steps.
  - Embracing a people-centered green transformation, which should ensure a focus on the most vulnerable through income support, reskilling and upskilling. Such a focus would provide these groups with mechanisms to adapt to the economic and natural shocks and transitions, supported by well-targeted and adaptive social protection systems, strategies to reskill and upskill human capital for current market needs and upcoming green jobs, and awareness-raising to encourage "green" behavior.

The current macroeconomic outlook illustrates the limited financing space available for climate action within the fiscal framework. The economic slowdown at the start of the pandemic put pressure on reserves and the current account.[243] Egypt has a complex debt structure, with large refinancing needs: 60% of the country's public debt is at maturity of one year or less.[244,245] Despite an improved government debt trajectory, the debt-to-GDP ratio remains high and is expected to have increased to 91% in June 2021.[246,247] Likewise, the overall country fiscal deficit is forecasted to widen to 7.9% of GDP in FY2021/2022 due to needed measures to mitigate the effects of global economic developments, including the Ukraine crisis, soaring international prices, and monetary tightening, all of which are driving up the cost of government purchases, subsidies, and interest payments.

---

[243] IMF Country Focus: Egypt: Overcoming the COVID Shock and Maintaining Growth (July 2021) https://www.imf.org/en/News/Articles/2021/07/14/na070621-egypt-overcoming-the-covid-shock-and-maintaining-growth
[244] African Development Bank (2021) African Economic Outlook. https://www.afdb.org/en/countries/north-africa/egypt/egypt-economic-outlook
[245] The domestic portion of debt remains predominantly short-term, making it subject to refinancing and interest rate risks. External debt on the other hand is mostly medium- to long-term and remains largely on concessional terms. However, the recent increase in the share of foreign currency-denominated debt (last estimated at 25.1 percent of total government debt at end-FY2020/21) is raising exchange rate risks. Financial Sector Development and Stability Policy Loan (P178324), Program Document. Forthcoming.
[246] World Bank. Egypt's Economic Update. October 2021.
[247] If fiscal consolidation resumes and growth remains firm over the medium-term, the government debt-to-GDP ratio is projected to decline to 91.5 percent by end-FY2022/23 and further to 87.2 percent by end-FY2023/24. Financial Sector Development and Stability Policy Loan (P178324), Program Document. Forthcoming.

Adverse global economic developments are a significant new shock to Egypt's macroeconomic environment. Soaring international commodity prices and tightening global financial conditions have been aggravated by the war in Ukraine. These unfavorable developments have contributed to large-scale portfolio outflows from emerging markets, including Egypt. Egypt's trade and tourism relations with Russia and Ukraine compounded pre-existing weakness in external inflows.[248] The adverse global economic developments have also been fueling domestic inflation, causing the net export deficit to widen, and exerting pressures on fiscal accounts.

The government's initial adjustment to the shock focused on relieving pent-up stress on the exchange rate and real incomes, while over the longer-term, a more diverse export base will be needed. In March 2022, the CBE allowed the exchange rate to depreciate overnight by around 16% to stem the widening trade deficit and the increasing pressures on external accounts. It also raised policy rates by a cumulative 300 basis points between March and May 2022 to curb inflation and contain portfolio outflows. Simultaneously, the government announced an income support package to partially alleviate the impact of associated price increases, through hikes in public sector wages, pensions, tax measures, and expanding the coverage of cash transfer programs. It is worth noting that these macroeconomic policy adjustments also reflect the need to address structural weaknesses in the Egyptian economy that result in the below-potential performance of non-hydrocarbon exports of goods and services as well as foreign direct investments (FDI), which in turn contribute to the chronic trade deficit and render the country susceptible to such external shocks.[249]

Over the medium term, the government debt-to-GDP ratio is expected to resume its downward trajectory, but risks to debt sustainability will leave little room for debt-financed climate investments. Declining debt is expected under the reference scenario, which assumes continued fiscal consolidation that will sustain the primary surplus of at least 1.5% of GDP. In addition, debt reduction is expected to be supported by favorable debt dynamics (as the real GDP growth rate is projected to exceed the real interest rate—notably in light of the forecast uptick in inflation—at least through FY2022/23). The factors that will dilute debt reduction efforts include: (i) expected domestic monetary tightening[250] (in light of rising domestic inflation, as well as the tightening of global financial conditions as advanced economies unwind their accommodative monetary policies; thus, making it more difficult for emerging markets, including Egypt, to access international debt markets on favorable terms) and (ii) continued extra-budgetary transactions that will necessitate additional debt issuance (although these are expected to gradually decline over the medium term as a percent of GDP).

This CCDR takes an adverse primary balance shock scenario as the starting point for analysis of additional climate investments from a debt sustainability perspective, given the increased economic uncertainty driven by fears of a global recession. A complementary interpretation would be that the CCDR looks at the resilience of the debt to a primary balance shock if additional debt-financed climate investments are made following the recommendations in this report. The additional climate spending by Egypt as a result of the recommendations in this report is parameterized as a permanent increase of 1% of GDP in public spending, financed 50/50 between higher debt and revenue mobilization. A climate shock that comes on top of a primary balance shock assumes an additional increase in public investments by 0.5% of GDP annually, targeted to a combination of adaptation and mitigation actions against climate change. This is over and above a global recession adverse scenario primary balance shock, posting a deficit in FY2023/2024, before starting to balance again and then rebound to a surplus through FY2026/2027. In the modelling for this analysis, this combination of primary balance

[248] World Bank: Egypt Overview, Update March 16, 2022 https://www.worldbank.org/en/country/egypt/overview
[249] *Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update* World Bank (2021).
[250] The CBE has already raised key policy rates by 300 bps since March 21, 2022 and is expected to raise them further over the coming months. WB staff estimates indicate that the budget deficit widens by 0.1 percent of GDP for every 100 bps increase in interest rates.

and climate shocks results in a primary deficit worth 1.5% of GDP in FY2023/2034, and even as the primary balance reverses into a surplus, it remains at 0.5% of GDP throughout the forecast horizon.

The path of the debt after the primary balance shock and the additional 0.5% of climate-related spending pushed much closer to the point where it stabilizes but does not decline, increasing the risks to debt sustainability and market access. Under this augmented shock, the debt-to-GDP ratio initially stabilizes at 92.7% in FY2022/2023—24, and then declines over the forecast horizon, albeit at a slower rate compared to the reference scenario; reaching 87% by FY2026/2027, 9.7 percentage points higher than its ratio under the reference scenario.

Investment scenarios derived from Electricity Planning Model (EPM) have a relatively small macroeconomic impact relative to the benefits in terms of emission reductions. EPM's well-specified investment requirements are well suited to analysis of their macroeconomic impact in the Macroeconomic and Fiscal Model (MFMOD-CC). Analysis done for this report (detailed in a background paper) shows that external financing of EPM investments leads to a generally small negative effect on GDP relative to baseline, with the effect peaking at around 1% below baseline in 2050 and little variation across the scenarios (levels of emissions reduction) in the GDP impact: the decline is nearly the same for the 60, 80, and 100% emissions reduction scenarios. The very small GDP decline illustrates the standard crowding out channel and does to take account of the broader rationale to undertake these investments. The impact on GDP through this single channel is due to the macroeconomic equilibrium where higher capital inflows are mirrored in a trade balance adjustment which slightly reduces GDP; there is not a positive output effect because the EPM investments are generally replacing brown power with green, but not of themselves increasing output. If investments are tax-financed, there would be a more negative impact for households (because more of the investment will be financed via domestic savings) and for GDP due to the higher tax burden and higher costs of capital.

To realize the adaptation and mitigation benefits of climate action, policy and institutional change and investments will be needed. These will involve trade-offs between the present and the future and between different groups in society at various points in time. Policy changes can reduce the investment needs: for example, energy and water tariffs and/or regulation can reduce demand growth and thus future investment needs. Nonetheless, a sizable flow of investments is warranted given Egypt's circumstances (urbanization and poverty patterns, dependence on the Nile, role of natural gas). This will have macroeconomic implications in terms of fiscal and external balances and the time profile of consumption and debt; in general, higher investment will involve modestly lower consumption over the next 10 years. The macroeconomic impact of climate-related investment can be accommodated by spreading investments out over time and by tapping relevant markets. This will require a combination of fiscal space created by domestic revenue mobilization, improved quality of spending including reprioritization of investment, and an integrated financing strategy that blends public debt with other financing modalities including external and private finance. A carbon tax could be considered as an option emerging from the integration of climate change considerations into the macro-fiscal framework, including distributional considerations. This would lay out a path to remove current carbon subsidies and price distortions, which would incentivize decarbonization through market-driven improvements in allocative efficiency while adding to fiscal space.

Modelling of the agriculture sector within a macro-structural model of the overall economy shows that there are modest GDP reductions relative to the baseline in drought years, but significant negative drought impacts on the trade balance and employment. In a drought scenario (approximate 20% water reduction from High Aswan Dam, GDP falls by around 1% in the impact year, with the impact tapering off in subsequent years. However, with consideration of the additional effects of reduced water access on the broader agri-food sector, total exports could fall by around 5%, and imports would rise to offset lower domestic food production, compounding the deterioration in the trade balance. Perhaps most importantly, there would be a sizable impact on jobs, especially in Upper Egypt, given the importance of the agricultural sector for employment, especially of the vulnerable population. There is uncertainty about the range of impacts due to the sizeable role of the informal sector.[251]

The negative impacts of reduced water access on the macroeconomy via agriculture can be effectively addressed through specific adaptation investments. Model analyses project a reduction in net agricultural production value amounting to US$1.65 billion per year if water supplies from the High Aswan Dam are significantly reduced from 55.5 to 45.5 billion cubic meters per year. Investments in irrigation modernization amounting to US$2.01 billion would not only even out this potential damage, but add US$0.86 billion in value per year if water supplies can be restored to previous levels of 55.5 billion cubic meters. Annual investments already planned by the GOE amount to US$1.6 billion covering (i) canal rehabilitation, (ii) *mesqa* (tertiary canal) improvement, and (iii) field irrigation modernization targeting some 3.7 million feddans (1.5 million ha). Additional annual investment needs amount to US$0.37 billion for the installation of improved water level and flow control systems (SCADA), as well as the upgrading of groundwater monitoring and management systems. While significant in absolute terms, this annual investment is equivalent to just 6% of Egypt's total annual public expenditure of US$35 billion per year. Technical assistance and institutional strengthening are estimated at US$142 million. The payoff from these investments depends on the implementing of recommended major institutional and policy reforms also discussed in Chapter 3, such as a water allocation policy, to strengthen ongoing efforts under the NWRP.

While macro modelling of investments in cities was not included in this report, an assessment of investments needs in the 14 main cities suggests that while financing needs for transformative adaptation and mitigation actions in cities are estimated at US$11.7 billion, avoided costs could be four times that amount. A transformative scenario, including actions on information and information systems, investments, improvements in urban planning, water and waste management, and resilience of infrastructure, suggests that the financing cost of these actions is less than the expected costs of no action. The scenario integrates cross-sectoral analysis (e.g., urban expansion, city planning and basic service management), core climate change risk and GHG emissions of the 14 cities. Details of the policy levers and expected gains are further explained in
Box .

[251] Currently, the macroeconomic modelling of agriculture is pending a more precise parameterization of the economic cost of reduced water supply on sector and aggregate GDP. GTAP-BIO would show much larger economic impacts than a macro-structural model.

Box 4. A combination of policy and investment levers in cities can contribute to GHG mitigation; an approximately 18% reduction (~50.5 million tons) of annual GHG emissions by 2030, compared to following current urbanization trends

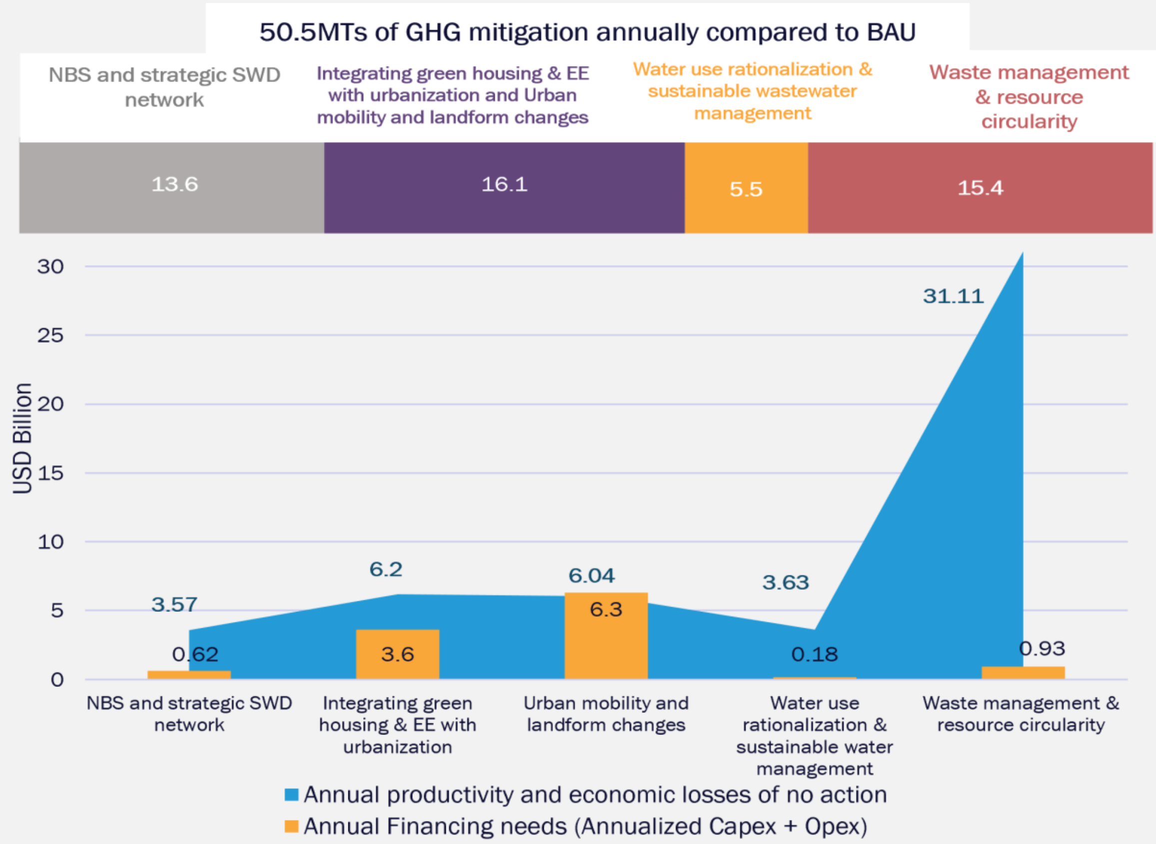
As discussed in Chapter 1, a large portion of emissions takes place in cities. Analysis done for this report assess the investment needs, costs avoided, and associated emission reductions from targeted interventions to strengthen climate resilience in cities. In particular, the impact of adaptation, efficiency and mitigation measures focused on cities and including infrastructure provision and service delivery options listed in the table below. For this analysis, the starting point assumes that urban growth trends continue with no significant changes made in urban policy. Also, the existing levels of service delivery gaps persist during the modelled time frame across each of the sectors. The policy levers considered in the transformation scenario are the following:

Nature-based solutions (NbS)	• Shift to sustainable nature-based solutions to enhance resilience against flood hazards and heat stresses (urban cooling systems through green spaces)
Green building & EE	• Mainstream levers for resilient and green buildings and housing in a calibrated manner • Promote EE retrofits for existing buildings and roof-top solar capacity additions
Spatial planning, land use & connectivity	• Compact city development with sustainable and efficient land-use • Climate-risk-informed spatial planning – urban densification and regeneration • Integrated spatial and mobility planning – Transit Oriented Development (TOD), modal shifts, and other instruments • Electric Vehicles (EV) penetration and Non-Motorized Transportation (NMT) solutions through integrated city planning
Urban water management	• Urban water use rationalization and improved demand-side management • NRW reduction and efficient systems • Resource efficient systems for wastewater management – circular approaches for industrial and agricultural usage
Solid waste management & resource circularity	• Adopt waste hierarchy principles to decouple waste generation from urbanization and economic growth – focus on resource recovery (including energy), recycling and reuse • Prevent open burning and dumping of waste – shift to safe disposal systems • Strengthen municipal waste management systems in an integrated manner • Promote plastics recycling and implement policy levers for upstream circularity
Mitigation & adaptation to SLR risks	• Adoption of ICZM plan with focus on planning, regulation and mitigation and adaptation priorities applicable to all urban and rural economic activities of the coastal zone • Protection of up to 38% of the high-risk, low-elevation coastal zone is a long-term priority to protect costal zones economic activities.

The total investment needs between 2022 and 2030, are estimated to be USD$105 billion (at 2022 real prices), of which

- US$5.6 bn is for NbS and Strategic Storm Water Drainage (SWD) network,
- US$32.4 bn for Integrating green housing & EE with urbanization,
- US$1.65 bn for urban water rationalization & sustainable wastewater management,
- US$57 bn for urban Mobility and landform changed,
- US$8.4 bn for waste management & resource circularity

An additional US$4.35 bn (at 2022 prices) is cumulatively needed to meet the O&M needs of the infrastructure created over the period 2022-30. The annual financing needs (annualized capex based on service life of assets), as shown in the figure below, of the transformation scenario are estimated at USD$11.7 billion, with annual economic benefits—considering economic costs avoided—reaching 4.3 times the financing needs. Action across waste management and resource circularity provides wider benefits in terms of avoided economic and productivity costs. In terms of mitigation, the transformative scenario anticipates a reduction of ~50.5 MT of GHG annually compared to the starting point (13.6 MT from NbS and strategic actions in the SWD network; 16.1 MT from actions integrating green housing & EE with urbanization, including better urban mobility and management of urban form; 5.5 from urban water rationalization and sustainable wastewater management; and 15.4 from waste management and resource circularity investments).



Source: Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021).

Efficient public spending on human development sectors will also be needed to enable the transition. The level of spending in these sectors is inarguably low. Social assistance spending, for instance, has remained unchanged at an average of 4% of GDP since the 2016 reforms and, while cash transfers are gaining more weight, they remain small. Moreover, in health and education, increased spending has corresponded to a decline in real terms. Financial allocations do not meet increasing needs brought by population growth, nor respond to other changes in population dynamics. These rigidities present a challenge given flexibility will be required for local services to adapt and respond under increased uncertainties brought by climate change. Public expenditure on the key social sectors reveals a longstanding paradox of high aggregate spending but low salaries, pensions, and transfers at the individual/household level. Taken together, these shortcomings have affected the quality of public social services, which are consequently not fully utilized. This leads to the paradoxical situation of the private sector responding to a gap in core public service provision, while the public sector is simultaneously active in commercial sectors.

4.1. Create the enabling environment needed to support the transition toward a low-carbon and climate resilient economy

Mainstreaming climate change in core public sector operations is critical to enable successful climate change adaptation and mitigation. Egypt's Green Financing Framework is an important step toward supporting climate investments, but further progress in allocating public spending toward climate-responsive projects depends on integrating climate in public financial management systems. Specifically, climate change impacts and the fiscal impacts of climate change policies must be integrated in fiscal plans and budgets (including both capital and recurrent budget processes), and coordination must be ensured across government at the central level and sub-central levels, as well as with the broader public sector receiving off-budget financing. The current dual budgeting system creates a disconnect between budget maintenance and the allocation of resources to investments in line with strategy documents (e.g., Vision 2030). The institutional and governance frameworks for public investment management should also be strengthened, through comprehensive and standardized requirements and methodologies for project preparation, selection, prioritization, and implementation. These requirements and methodologies should reflect climate objectives. Increased coordination between MoPED and MoF in the selection and allocation of financing is needed, including strengthening allocation at the subnational level to better reflect local priorities and ensure alignment with climate action. In addition, a strong public investment management system requires a focus on existing assets, not only on the flow of new projects. Egypt's public assets are prone to climate risks, underscoring the need to improve asset management to facilitate climate resilient capital assets and avoid stranded assets.

Further, government needs to play a steering role in identifying priorities for climate investments and attracting private sector participation. The government is best placed to identify the sectoral, spatial, and distributional trade-offs of climate investments and set priorities based on the country's climate change risks and adaptation and mitigation objectives. Sensitizing line ministries, local governments, and financial institutions to green financing is needed so they can also help promote public and private sector engagement on and investment in green infrastructure, technologies, and value chains that contribute to mitigation and adaptation solutions. The monitoring, reporting, and verification (MRV) systems highlighted in Chapter 2 can help assign emission reduction impacts to investment projects and through that, help leverage international markets for additional green financing.

Strengthening the governance framework for SOEs will facilitate climate action and private sector investment. The widespread presence of SOEs across the economy affects competition and market contestability. Based on publicly available OECD and Egyptian records, only China may have more SOEs than Egypt. The presence of SOEs in almost every sector in Egypt contributes to the private sector's perception that it is competing on an uneven playing field, which deters private domestic and foreign investment.[252] Recent amendments to the SOE law enhance governance, disclosure, transparency, and accountability for some SOEs. Nonetheless, the sustained growth of state-owned enterprises, and the complex framework in which they operate, feeds private sector uncertainty. To improve overall productivity but also to support climate action and foster private participation in the transition toward a sustainable and resilient growth model, the legal framework regarding SOEs should be reformed to (i) enhance the oversight and transparency of the financial operations of SOEs and Economic Authorities; (ii) clearly separate the state's role as owner from sector regulator, and (iii) bring the regulatory arrangements for these entities in line with those that govern their private sector competitors.[253] The pending publication of a state ownership policy will be an important opportunity to provide clarity in these areas.

Specific regulation can be introduced to include climate performance targets and ensure climate change ambition is included in SOEs corporate strategy. This would both complement Egypt's current initiatives to improve SOE governance and align with expectations as the government moves toward increasing private ownership in SOEs. SOEs should also follow through with the recommendations highlighted throughout Chapter 3. For example, industrial SOEs should pay water tariffs that are

[252] *Country Private Sector Diagnostic: Creating Markets in Egypt*, IFC, (December 2020).
[253] Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth. Egypt Systematic Country Diagnostic Update World Bank (2021).

reflective of water scarcity, and the government should ensure that they are compliant with standards, such as those regarding motor efficiency.

The private sector has an important role to play—as a financier, innovator, and provider of climate-friendly goods and services—but also as contributor to and affected party of climate impact. Egypt's fiscal space, while recovering from COVID-19, still faces high risks to the debt outlook arising from the level, maturity, and currency structure. These risks underscore the need to leverage private financing for adaptation and mitigation actions. It is key to engage private sector expertise, sophisticated technologies, and/or the establishment of private and public-private financing schemes to reduce inefficiencies in water management, scale up desalination, and increase energy generation from SWM. Likewise, the introduction of measures that enable private sector adoption of green technologies and that provide tools and services to help firms mitigate the risk of asset damages or supply chain disruption will be pivotal to meet changing demand patterns, alleviate pressure on natural resources, and build resiliency to climate hazards.

The private sector can help strengthen the climate resilience of infrastructure, including transport; initial actions focusing on urban areas can help reduce costs, advance mitigation, and maximize returns. Low carbon municipal waste and water management, energy-efficient retrofits of buildings, and green urban transport represent a minimum of US$38 billion in investment opportunity for the private sector in Egypt between 2020 and 2030, including green and resilient infrastructure and supporting decarbonization of diverse sectors.[254] In the transport sector, potential projects include fleet capacity, replacement with low/no emission fleets, non-motorized transport promotion, dry ports, cargo terminals, bus rapid transit, and light rail. Owners of incumbent transport infrastructure assets (e.g., railway and highway authorities) can also use innovative financing mechanisms such as asset recycling to modernize systems. To enable private investment in municipal Solid Waste Management (SWM), the Ministry of Environment and the Ministry of Local Development should explore ways to leverage the Waste Management Regulatory Authority's budgetary appropriation and develop tools for active private participation in SWM, particularly in treatment and disposal facilities for all types of waste. Finally, the significant potential to generate energy from biogas through WWT, as well the lower cost of power from biogas as compared to grid-supplied power makes wastewater treatment a strong and viable case for private sector participation.

Developing standards, as well as adaptation and resilience taxonomies, and making climate risk and vulnerability data widely available can help direct private sector investments towards adaptation and resilience. The government can guide and strengthen private investment toward building resilience by developing and enforcing standards, including building and water codes. For example, to take advantage of the economic and adaptation potential of green and resource-efficient buildings,[255] Egypt could complement existing standards and design-focused certifications with building performance rating systems and certificates such as the EU's Energy Performance Certificates, which help measure and monitor buildings' energy performance. Moreover, greater granularity in the mapping of climate risks and weather forecasts against key sectors and competitiveness assets, including the national databases of firms, would help firms improve resilience planning and insurance companies design appropriate insurance products. In agriculture, for instance, the development of information systems for investors, including information on water resource available, soil quality, and Information Communication and Technology or other services available, would reduce investment risk while ensuring sustainability. Finally, introducing financial products such as disaster risk insurance and loan

[254] US$38 billion represents the minimum investment. "A Green Reboot for Emerging Markets," IFC, Guidehouse Insights, 2020.
[255] Building green could range from savings of 0.5% to 12% in additional costs. Green buildings can decrease operational costs by up to 37%, achieve higher sale premiums of up to 31% and faster sale times, have up to 23% higher occupancy rates, and have higher rental income of up to 8%. *Green Buildings, A Finance and Policy Blueprint for Emerging Markets*, IFC, 2019.

assistance for recovery and rebuilding are needed to boost climate resilience while allowing firms and households to manage residual risk.

Reducing inefficiencies in how resources are valued, as mentioned in Chapter 3, is needed to ensure the attractiveness of key sectors to private investors, while also freeing up fiscal space for more climate action. Completing the transition away from fossil fuel subsidies and making headway on a new tariff model in the water sector, as discussed in Chapter 3, are essential to increase attractiveness for the private sector. For example, in desalinization, the incremental capex requirement over the next 10 years is expected to be US$3.45 billion, in addition to the operation and maintenance outflow of US$390 million per annum by 2032.[256] While private sector financing is one of the options for mobilizing the required investments, the current water tariffs are not sufficient to cover regular operation and maintenance costs, increasing the risk for investors.[257] To mobilize the private sector, Egypt should consider a combination of financing options including viability gap funding, annuity models, and guarantees for scaling-up desalination within an affordable fiscal envelope. The same holds true for the transport sector (as also mentioned in Chapter 3).

Public-private partnerships are one mechanism to mobilize the private sector in such public investments. Egypt's PPP Law No. 67 of 2010 permits authorities to enter into PPP contracts for all infrastructure and public services projects, to include the construction, financing, and maintenance of such projects.[258] However, according to Egypt's 2020 Country Private Sector Diagnostic, very few PPP transactions closed in Egypt over the past few years. Amendments approved in 2021 to the 2010 law help to integrate PPP screening into the public investment management process. Once the inter-ministerial committee contemplated in the amended law is established, the government will need to develop and publish the executive regulations, particularly those related to unsolicited proposals and direct contracting. Additionally, to strengthen the alignment between the PPP law and Egypt's climate commitments, secondary regulations should be introduced to integrate environmental sustainability and climate resilience into PPP processes.

International trade, including new trade rules and preferences shifting toward lower-carbon-content goods, will generate transition risks and opportunities for Egypt's economy, and actions to facilitate this transition can help avoid future losses. Aggregate impacts on Egypt from the European Union's NDCs and their implementation through the EU's Carbon Border Adjustment Mechanism (CBAM) are expected to be small (0.6% decline in real income, 2.6% decline in outcome, and 0.3% decline in imports and exports by 2030).[259,260] However, losses can be expected in a small number of sectors, and with the implementation of the EU's NDCs, there will be a sharp reduction in fossil fuel demand, resulting in a decline in output in 2030 for Egypt. This decline in fossil fuel demand means that the main contributors to the reduction of output will be the industries of gas power (output reduction of 15% or US$52 billion)[261] and electricity transmission (output reduction of 5% or US$22 billion). Projected exports losses will be the highest in the electricity transmission, oil, and chemical (including fertilizers) sectors, with declines of 8.3%, 4.3%, and 3.9% respectively. These impacts underscore the importance of taking the steps highlighted in Chapter 3 to decarbonize the oil, gas, and electricity sectors.

---

[256] Climate Change and Water-Food Energy Nexus. Background Paper for Egypt CCDR, World Bank (2022).
[257] Egypt: Enabling Private Investment and Commercial Financing Infrastructure, World Bank.(2018).
[258] World Bank 2018 https://documents1.worldbank.org/curated/en/588971544207642729/pdf/132784-v2-WP-PUBLIC-Final-Report-Egypt-InfraSAP-English.pdf.
[259] Various scenarios are explored to better understand the long-term quantitative impacts of collective NDCs and the EU CBAM on Egypt's economy. The respective scenarios were implemented in an Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) Computable General Equilibrium (CGE) model. Full results available in World Bank (2022) Boosting Green Growth of Egypt's Private Sector. Egypt's CCDR Background Note
[260] The CBAM is linked to the EU Emissions Trading System (ETS). The sectors covered by the existing EU ETS include power and heat generation, energy-intensive industrial sectors and aviation within Europe. The CBAM modelling conducted only includes the products currently covered by CBAM namely cement, aluminium, fertilizer, electricity production, iron and steel. If CBAM is extended to additional product categories and/or additional countries adopt CBAM, the effects on Egypt will likely be larger. Note for example that automobile, aeronautic and electric industries are neither covered by the EU ETS nor are they considered energy/emission intensive activities (using broad definitions). The EU has not imposed a carbon price on light manufacturing sectors, nor discussed an imposition of CBAM on them.
[261] All values use 2014 US dollars.

The private sector in Egypt and abroad is recognizing the market opportunity that the transition to a green economy offers, but non-tariff barriers to environmental goods and services may merit review. The nascent and growing "clean tech" innovation scene in Egypt is evidence of the opportunities seen by the private sector. This is also evidenced by emerging exports of environmental goods (EG) and services. Start-ups in areas such as recycling, biowaste, and soil sensor technology are also emerging. Some Egyptian firms have been able to enter the international market for environmental goods, but export levels remain low; Egypt's exports of EGs peaked at US$126 million in 2015 and declined to US$76 million in 2020. Egypt has a lower EG export CAGR than that of the global EG market, and of benchmark countries such as Tunisia, Turkey, Vietnam and Malaysia. The private sector's knowledge of feasible clean technologies and ease of access to those clean technologies are important levers in the transition to low carbon. Egypt has initiated several programs that contribute to enabling the transition by creating demonstration effects.[262] In terms of sourcing the actual technologies, many of these technologies are available in the international market. While Egypt's import tariffs on environmental goods and services are comparatively low, non-tariff barriers are extensive and may merit review.

A carbon tax, implemented within the framework of the Medium-Term Revenue Strategy and with complementary measures in place to ease regressive impacts, could help reinforce the positive impacts of sector-specific actions on the wider economy and provide resources to complement private sector investments in adaptation and mitigation. The impact of a carbon tax on growth and distribution depends on how the additional revenues are used. If revenues are used to reduce other tax rates in a way that stimulates investment, such a tax could be growth-enhancing. If the additional revenues are applied to transfers, adverse distributional impacts can be mitigated or even improved upon.

A basic analysis of carbon tax impacts for Egypt suggests that a carbon tax can help increase revenue by up to 3% by 2033, but detailed assessments on economic, social and environmental implications would be needed before implementation. This is a standardized methodology for the initial simulation of carbon tax impacts, including distributional impacts. It is best used as a quick diagnostic and for an overview of the scale of impacts, which can then be used to identify areas where comprehensive follow-up analysis of poverty, social, and sectoral impacts is needed. For Egypt, the CPAT model uses data from the 2019 household survey. It is important to note that CPAT is a tool to inform climate-fiscal reforms (carbon taxes, subsidy reform, revenue spending etc.). It is not a tool for decarbonization / net zero analysis. The CPAT analysis for this report suggests that a carbon tax set at $25 per ton of CO2, along with a fossil fuel subsidy phaseout, could increase revenue as a share of GDP by up to 3% by 2033 if applied to all carbon fuels used in different sectors and industries.[263] The associated spending would generate additional growth over the baseline of around 0.5% per year (to a total of 6.3% in the medium term). If the tax is gradually raised from US$25 to US$75 with a pro-poor mix of revenue recycling, the growth effect rises to 1%. Another study on Egypt suggests that if hypothetical carbon tax revenue is used to finance a reduction in tax rates on domestic sales, it could have a progressive distributional effect, with low-income households benefiting disproportionately from this type of policy.[264] It is important to note that complementary policies, including social protection and those highlighted above regarding SOEs, must be in place in order for a carbon tax to be effective and

---

[262] Examples include with the help of international partners such as the Egyptian Pollution Abatement Program, the Green Value Chain Program, and the Industrial Energy Efficiency Project to avail information, finance and technical support to firms that would like to invest in upgrading. Such programs play a vital role in enabling.

[263] The study assumes the use of revenue to increase government spending (20%) to invest in renewable energy (40%) and for cash transfers/income tax cuts (50%).

[264] In this study of the impact of carbon taxation we consider the introduction of a carbon tax at a uniform final rate of US$20 per ton of CO2 emissions on refined petrol and natural gas. As a share of GDP, the carbon tax revenue rises gradually from 0.4 %in the first year to about 2.1% in the long-run equilibrium. An expansionary impact is possible (+2% of GDP in the model) if the carbon tax revenue is used to reduce other distortionary taxes, Abeer Elshennawy & Dirk Willenbockel, 2021. "The Effect of a Carbon Tax on The Egyptian Economy: A General Equilibrium Analysis," Working Papers 1525, Economic Research Forum, revised 20 Dec 2021.

additional analysis on the economic, social and environmental impacts would be required to inform the implementation of such instrument.

A strategy to implement carbon credit markets under article 6 would be critical to ensure alignment with Egypt's NDCs and national development priorities, as well as to provide certainty to the private sector seeking to invest in carbon credit generating projects. Of particular relevance would be to define the sectors allowed to monetize carbon credits in international markets avoiding strategic sectors for Egypt's current and future NDC pledges. Components of the strategy should include: i) a policy framework defining the roles and responsibilities of government entities in carbon credit markets, as well as the corresponding legal and regulatory frameworks; ii) the development of a national registry system with a monitoring, reporting and verification (MRV) system; iii) a framework for project certification aligned with international standards and credible to international demand for carbon credits; iv) a framework ensuring environmental and financial integrity of the carbon credit market (the latter would include the market regulations and architecture from a financial perspective). The strategy would need to be developed gradually as the market grows, including institutional capacity building in the relevant government entities, such as the Ministry of Environment, the Ministry of Finance and the Financial Sector Regulatory Authority. Finally, the carbon credit markets strategy would need to be coordinated with Egypt's planned strategy to access international blended finance for national strategic projects linked to NDCs.

4.2. Mobilize finance to build resilience to climate and support the transition to low carbon

To implement the needed adaption and mitigation actions, it will be necessary to mobilize private finance to complement public investments to build resilience to climate. Some milestones have been achieved in green finance in recent years, but more financing will be necessary to implement the priority actions highlighted in this report. Stronger actions to ensure that public investments and expenditures are aligned with climate action can provide the right signals to the private sector and help leverage additional resources.

The banking sector's high exposure to transition-sensitive industries deepens transitional risks. These sectors include, among others, construction; oil, gas and petrochemical; iron and steel; and real estate. Oil, gas and petrochemical alone represent 16% of banks' total credit exposure to the largest 100 borrower customers in the public and private business sectors. These three industries are likely to be particularly vulnerable to transition risks, since the energy transition toward cleaner options is a core element of mainstreaming climate change into the development agenda. The banking sector also has some exposure to the tourism and agriculture sectors, which are also vulnerable to physical climate risks such as prolonged droughts, heat waves and flooding.

Leveraging the private sector for climate action will require deepening green finance and enhancing climate financial risk management through better monitoring and public access to climate information. A recent stress test conducted by the Central Bank of Egypt (CBE) suggests that increases in temperature driven by climate change could lead to a decrease of up to 50% in the weighted credit risk rating for high-risk sectors (e.g., agriculture, tourism, and tobacco) and up to 25% for medium-risk sectors (e.g., construction, oil and natural gas, and petrochemicals). The stress test also identified possible operational risks stemming from physical damage to assets from increased natural disasters and disruptions to banks' supply chains. To better manage climate-related financial risks, they much be regularly assessed and monitored. To promote the integrity of green finance instruments, the Financial Regulatory Authority (FRA) is developing a sustainability disclosure framework (ESG KPIs) that would first apply to the largest firms.[265] To boost transparency and allow growth in the demand for and supply of green finance, an important first step would be the endorsement of the Environmental Sustainability Standards prepared by the Ministry of Environment, as those standards would support the development of a green taxonomy for the financial sector. The second steps both have to do with building transparency. In the short term, financial institutions should be required to collect and report climate-related risk information as part of their regular reporting practices. In the medium term, national disclosure and reporting standards that are aligned with international best practices should be in place for financial institutions' public disclosure.[266] Lastly, to strengthen the contribution of infrastructure to Egypt's NDCs and facilitate the mobilization of private sector financiers seeking ESG assets, the authorities could consider aligning PPP project screening and structuring with ESG criteria as is done in the financial sector.

Further efforts are needed to develop and expand the availability of financial instruments that can help government, households and firms manage residual risk. Despite Egypt's high vulnerability to climate change, overall insurance penetration in the country was just 0.7% of GDP in 2019,[267] and plans for the development of a catastrophe insurance market have been delayed due to COVID-19. A Disaster Risk Finance strategy and ex-ante pre-planned financial response instruments would help reduce the economic, fiscal, and social impact of climate events. In the short term, Egypt could begin by drafting financial preparedness plans, developing disaster risk insurance products (such as natural catastrophe insurance), and developing risk transfer products such as partial credit guarantee schemes to act as a back stop to extreme climate events.

Finally, the development of a systematic strategy on structured finance and private placement instruments linked to green finance can help bridge the financing needed for climate action. Financial sector authorities, such as the CBE and the FRA, have taken important steps to develop the institutional and governance framework for sustainable finance and raise awareness about risks, including through the recent publication of the CBE's Guiding Principles for Sustainable Finance in July 2021, the publication of technical papers on sustainable finance policies and strategies, and the creation of a new FRA think-tank and training center on sustainable finance. To build on previous success, Egypt could consider tapping the international green capital market again, while working on strengthening issuer capacity, reducing barriers to entry, and increasing awareness in order to promote demand for green and sustainable debt and loans in the domestic market. As a next step, Egypt could leverage existing initiatives and momentum on securitization of future cashflows and on private equity and venture capital (PEVC) to finance MSMEs. For example, Egypt could explore replicating efforts seen in Colombia of creating a climate change blended finance platform for infrastructure.

4.3. Ensure a focus on the most vulnerable

The poor and vulnerable face locational, asset, and human capital disadvantages that deepen the challenges they already face. In cities, the poor are more likely to live in hazardous sites and slums, have higher exposure to air and water pollution and congestion, and lack green amenities. Further, poor households do not own many assets, nor do they have the right skills to enable them to cope with shocks, self-insure and adapt. While a high share of the poor is located in rural areas (67% in 2017), poverty has been urbanizing. Between 2015 and 2017, while the share of urban population remained relatively stable, the share of the poor living in urban areas increased by 6 percentage points. In 2019, about 30% of Egyptians were living in poverty and another 30% had consumption levels very close to

[265] FRA issued a decree in July 2021 on mandatory ESG disclosure for EGX-listed firms and NBFS companies. https://enterprise.press/greeneconomys/esg-reporting-is-coming-to-egypt-in-2022

[266] Disclosure requirements could include, for example, guidance on publishing the approach to climate risk in firms' annual financial reports requirements for additional climate or ESG/climate risk reporting, and data quality expectations, in line with the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD).

[267] This is just under the emerging market average of 1.3% and far below the global of average of 6.2% (Insurance Federation of Egypt annual report 2020, www.ifegypt.org/).

the poverty line, making them vulnerable to fall into poverty if they experience income or expenditure shocks. Furthermore, women are also more vulnerable to climate change due to their low access to income opportunities, higher engagement in the agriculture sector, limited productive assets and access to services, and limited social capital and voice in decision-making. The differential impact on women is also recognized in the NCCS 2050, which includes a sub-goal on helping them adapt to climate change. The poor are also at increased risks from the transition to a low carbon economy, since they are more engaged in informal, agricultural, and "brown" activities.[268] It is estimated that about 40% of Egypt's employment share is concentrated in brown sectors, and 58% in yellow sectors. For example, sectors like construction and transport sectors are identified as brown sectors, and crop and rice are identified as yellow sectors, with a large potential for emissions reduction. At the same time, these sectors employ a large share of poor (47% in crops and rice and 12% in construction) and informal workers (28% in crops and rice, and 17.4% in construction).

With the climate impacts on food prices and availability expected to be large, gradually reforming the food subsidy program can contribute to strengthening food security, enhancing resilience of the most vulnerable to the impacts of climate change, and reducing the fiscal burden. Climate change will likely impact food prices in a context where Egyptian households spend almost 40% of their disposable income on food. Wheat, a key food staple that represents 35-39% of per capita caloric consumption in Egypt, is highly susceptible to variations in international markets, since 62% is imported. A US$25 increase in global wheat prices is expected to increase the Egyptian government's wheat imports bill by approximately USD$128 million per year. This is equivalent to a 10% increase over the original budget for wheat imports for the Egyptian Food Subsidy Program, which represents 1.4% of GDP annually and accounted for more than 32% of total social assistance spending in FY2020. While food subsidies generate significant anti-poverty impacts given their large coverage amongst the poor, evidence shows that the program has higher costs and lower effectiveness than other social assistance schemes. Importantly, the program still has substantial leakages to higher income groups, despite recent efforts by the government to gradually reduce leakages. Accordingly, in comparison to the Takaful & Karama Programme (TKP) cash transfers, for instance, Egypt's food subsidy programs score lower in terms of effectiveness.[269] To achieve better adequacy and larger efficiency gains, it would be necessary to make coverage, adequacy and the efficiency of targeting more stringent. The options for reforms include: (i) raising the adequacy of food subsidies for the poor; (ii) adjusting the food voucher system; (iii) gradually moving from food vouchers to cash; and (iv) assessing the impacts of a general price increase of bread. Simulations indicate that improvements in the program's targeting would have positive impacts for the poor, slightly negative impacts for non-poor households, and a very important positive fiscal impact.[270] If the cost savings from these reforms are channelled into higher investments, longer-term growth benefits would eventually outweigh short-term welfare losses.[271]

The adaptation interventions needed for cities may raise costs, which would disproportionately impact the most vulnerable, suggesting the need for supporting mechanisms for the urban poor to mitigate these effects. The investments needed in public transport, housing, and waste management in urban areas are expected to result in higher consumer prices in the short term. Households spend around 4%

---

[268] Brown sectors are identified as those emitting significantly more GHG emission than the world's median for such sector. Yellow sectors are identified as those sectors emitting a more GHG emission than the world's median for the sector. See background note on World Bank (2021), *Jobs for a Green, Resilient, and Inclusive Recovery.*

[269] For instance, the share of the population receiving the ration card and bread subsidies in 2019/2020 reached 76% and 60% of households in the top two deciles, respectively. On the other hand, 86% of Takaful & Karama beneficiaries are amongst the poorest 40% of households. Egypt Social Public Expenditure Review. World Bank. (2022).

[270] Breisinger, Clemens; Kassim, Yumna; Kurdi, Sikandra; Randriamamonjy, Josée; and Thurlow, James. 2021. Food subsidies and cash transfers in Egypt: Evaluating general equilibrium benefits and trade-offs. MENA RP Working Paper 34. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134427

[271] The analysis suggests that the faster growth from eliminating food subsidies is not enough to offset the slower growth caused by expanding cash transfers. Raising taxes to finance cash transfers for poor households leads to a small, but persistent, decline in consumption amongst nonpoor households. However, the large deceleration in economic growth, caused by government borrowing to finance this program would lead to larger welfare losses for nonpoor households over time (and smaller welfare gains for poor households). Breisinger, Clemens; Kassim, Yumna; Kurdi, Sikandra; Randriamamonjy, José; and Thurlow, James. 2021. Food subsidies and cash transfers in Egypt: Evaluating general equilibrium benefits and trade-offs. MENA RP Working Paper 34. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134427

of their consumption on transport (2017/2018). A simulation of the short-term impacts of an increase in public transport costs[272] predicts a small reduction in consumption—less than 1%.[273] Investments in waste management may also translate into higher prices, but these are not expected to have significant direct distributional implications. Investments impacting housing costs, however, could have larger welfare implications for the poorest households, which are more likely to be renters and for which rental costs comprise about a quarter of total expenditures.[274] The impacts would depend on the ability of households to switch to cheaper options, but on average, a 20% increase in housing rents could increase urban poverty by about 1 percentage point and the welfare loss in terms of consumption would range between 1.8% (poorest decile) to 0.45% (richest decile). Actions that provide well targeted support to affected households will be needed to minimize the impacts on the most vulnerable. Examples include targeted interventions to ensure affordability of urban services and guarantee that housing options are available for low-income populations.

Raising residential water services tariffs and removing electricity subsidies will also have distributional impacts, but careful design and sequencing of the appropriate support mechanisms will protect the poor. A simulation of the impact on household welfare of removing the remaining energy subsidies suggests the impacts on poverty are small, leading to an increase in the poverty rate of about half a percentage point,[275] with relatively higher impacts in rural areas.[276] Further, water expenditures represent only about 1% of households' total expenditures (HEICS 2017/18), with only minor differences across deciles: while the lowest decile spends 1.5% on water, the top decile spends 1%. Raising water cost by 20% would lead to a very small increase in poverty (one tenth of a percentage point), suggesting there is scope for raising residential electricity and water tariffs while ensuring inclusion.[277] As tariffs are revised, it would be important to target affected households to ensure no one is left behind, and that any increases in poverty, however small, are avoided. Complementary analysis to identify those affected to provide targeted and effective support would be important.

Equipping Egyptians with in-demand skills will be a critical element in implementing the move toward a low carbon development path and in fostering better overall labor market outcomes. Decarbonization of industries, of water, agriculture, and food production, and of the transport and energy sectors requires the introduction of new technologies and approaches. Achieving Egypt's targets for renewable energy and energy efficiency could translate into 2 million additional new job opportunities between 2020 and 2050,[278] which is equivalent to about 2.2% of the unemployed in 2020.[279] But critical workforce skills are weak in Egypt, stressing the need for skilling and upskilling of the labor force. Despite a high unemployment rate and a relatively small formal economic sector, employers encounter difficulties in finding employees with suitable skills. About 19% of employers in Egypt identified lack of skills as a key barrier to their competitiveness and growth.[280] The skills of the current Egyptian workforce underperform on the Global Competitiveness Index (GCI), where Egypt ranks 99 out of 141 countries.[281] The skills of the future Egyptian workforce rank even lower, at only 133 out of 141

[272] Estimation of a 5 to 20% price increase.
[273] The impact will be twice as larger for the poorest deciles, with poverty losses of about 0.5 percentage points in the most severe scenario.
[274] In 2017/18, 43% of urban households in the poorest decile rented their place of residence, compared to 23 percent in the richest decile.
[275] Household spending is between 5% (poorest deciles) to 3% (richest deciles) of the total consumption in energy, according to Household Income, Expenditure, and Consumption Survey 2017/2018. Poverty, Jobs and Climate Change. World Bank (2022). Egypt's CCDR Background Note.
[276] This impact would be higher in poorer rural households, with a poverty change of about .56% in rural households compared to .35 in urban households. Poverty, Jobs and Climate Change. Egypt CCDR Background Note.
[277] Using the Household Income, Expenditure, and Consumption Survey (HIECS) 2017-2018 The analysis models effects on increase of water prices between 5% to 20%, through all the income deciles. Poverty, Jobs and Climate Change. Egypt CCDR Background Note. World Bank (2022)
[278] About 67,000 new jobs per year including jobs gained,
[279] These results come from the WB's CEEAT Employment Assessment Tool for estimating direct, indirect and induced jobs of clan energy transition The Employment Benefits of An Energy Transition in Egypt, November 2021 (from the Clean Energy Jobs and Skills Regional ASA lead by Energy, including Egypt).
[280] Egypt: Enterprise Survey, World Bank (2016).
[281] The following indicators are aggregated into a composite score to measure current workforce skills: (i) extent of staff training; (ii) quality of vocational training; (iii) skill set of graduates; (iv) digital skills among active population; and (v) ease of finding skilled employees. Some of the indicators are based on official statistics, others from the Executive Opinion Survey of the World Economic Forum. See World Economic Forum, 2019, World Economic Competitiveness Report 2019: Egypt Profile, p. 200, http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

countries.[282] In addition, Egypt's score on digital skills is 4.7 out of 7, below the MENA average, indicating a substantial room for improvement.

For Egypt to reach full potential in the transition, climate skills are critical. The transition toward greener technologies will both create and destroy jobs, and it will also demand a different set of skills from those available in the economy. Reskilling/upskilling within existing jobs will be needed, especially in low-skilled jobs, which tend to require more environmental awareness or simple adaptations to existing work processes (e.g., for waste collectors). Most low-skilled occupations that will be lost during the transition are expected to be reallocated with some reskilling. At the medium-skilled jobs level, there will be some new occupations and substantial changes to the content of existing occupations (e.g., AC technicians). Job destruction will likely have the greatest effect on male workers in mid-skill occupations.[283] To ensure that women have access to the new jobs created, specific measures need to be introduced to train them. Most of the completely new types of occupations created will be among high-skilled jobs, which will require a completely different set of technical knowledge and skills and thus require new upskilling programs or specialized university degree programs (e.g., solar and hydrogen engineers, energy-efficient building architects). Understanding which skills will need to be developed, as well as which sectors will lose more jobs and which will benefit from a move to higher-skilled jobs, may facilitate the transformation that is required.

Education and increased awareness can also encourage positive behavior to strengthen adaptation and mitigation efforts. Efforts to build green skills and increase awareness can open the door for behavioral changes, which can complement the technological transition and reduce the costs of emission reduction. Because consumption patterns are often the result of social interactions and norms, investments in education and awareness can help shape behavior, contributing to reducing residential emissions.[284] Empirical analysis suggests, for example, that behavioral norms have the power to amplify the impacts of a carbon tax.[285] Given the large scale of Egypt's education system, efforts such as the ones promoted by the Ministry of Education and Technical Education (MOETE) and the World Bank[286] to train teachers on awareness of climate actions can contribute to reshaping behavior and promote enrollment in green skills-driven tertiary education programs. This is in addition to the MOETE's efforts to incorporate climate change concepts in the new curriculum under ongoing sector reform being rolled to grade 5 in 2022/2023 (reform was launched in 2018).

[282] The GCI is the product of an aggregation of 103 simple indicators, derived from a combination of data from international organizations as well as from the World Economic Forum's Executive Opinion Survey. Indicators are organized into 12 pillars: Institutions; Infrastructure; ICT adoption; Macroeconomic stability; Health; Skills; Product market; Labor market; Financial system; Market size; Business dynamism; and Innovation capability. The 2019 edition covers 141 economies. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

[283] Skills for Green Jobs Update 2018, ILO (2018).

[284] Niamir, L., Kiesewetter, G., Wagner, F. et al. (2020), Assessing the macroeconomic impacts of individual behavioral changes on carbon emissions," Climatic Change 158, 141–160 (2020). https://doi.org/10.1007/s10584-019-02566-8

[285] Bryan Bollinger and Kenneth Gillingham (2012) "Peer Effects in the Diffusion of Solar Photovoltaic Panels (with Bryan Bollinger)," Marketing Science (2012), 31(6): pg. 900-912.

[286] MOETE has already taken steps in this direction by building climate awareness in the Teachers' Continuous Professional Development (CPD) Framework. With the World Bank support, the CPD framework includes performance standards associated with climate awareness and will guide the development and delivery of teacher training modules to incorporate climate awareness training.

5. Summary of Priority Actions

Figure 19 and Figure 20 provide a summary of priority actions identified in this report for the short term (need to start in the next 1 to 3 years) and the medium term (more than 3 years) as a roadmap for Egypt to strengthen resilience and adaptation, and make headway in the transition to a low carbon development path. Detailed steps that can be taken to make headway in this direction are outlined in the Annex, and an indication of investment needs for some priority actions are highlighted in the Annex. To implement these actions, additional financing will be required, and improving the institutional framework and ensuring a central role for the private sector to support the transition and help leverage additional resources is a must. The transition must be just and leave no one behind, and for that a focus on the most vulnerable and building human capital should be at the heart of any action. Additional detailed actions to be taken along these lines are provided in the Annex.

Figure 19. Priority Actions in the Short Term

Priority Actions

Strengthen Resilience and Adaptation

Enhance efficiency in the way resources are used and allocated based on their true value

- Implement wastewater resource circularity
- Rationalize urban water use
- Enable public-private partnerships for green investments in infrastructure and utilities
- Establish a water allocation policy coupled with a drought risk mitigation system
- Rationalize urban residential water tariffs
- Develop a national policy and city-level strategies to guide urban growth away from high-risk areas

Provide better information and information and increase awareness about climate change impacts for collective action

- Develop a comprehensive, multi-stakeholder disaster risk management plan (drought/flash flood)
- Strengthen information for preparedness through an integrated hydro-meteorological system
- Strengthen climate risk sensitivity in local planning systems and development plans (with flooding, heat, SLR as priorities)
- Develop robust city-level early warning systems for floods (pluvial, coastal, and fluvial), heat waves, and other climate change impacts/natural disasters

Enhance resilience and reduce the risk of stranded assets through complementary actions

- Modernize irrigation systems
- Improve connectivity/logistics infrastructure resilience
- Enhance the operational efficiency and performance monitoring of existing wastewater treatment plants
- Establish resilient storm water management systems with integrated NBS
- Develop and implement a climate-resilient trade logistics strategy

Transition to a Low Carbon Development Path

Accelerate the transition to renewable energy

- Reform the electricity sector and ensure cost recovery
- Increase the RE-base integration
- Enable private investment through regulatory reforms

Reduce emissions in the oil and gas value sector and lower the carbon intensity of the energy supply mix

Reduce carbon intensity of energy mix and exports through:

- decarbonization of oil & gas production (in anticipation of carbon taxes and CBAM measures in export markets)
- abatement of CO2 and methane emissions along the oil & gas value chain

Reduce inefficiencies in the use of energy for electricity and industry

- Remove distortionary subsidies and reduce T&D losses
- Monitor energy and water use, water treatment and re-use by industrial sub-sector
- Leverage the industrial zones to demonstrate the business case for circularity
- Put in place the quality assurance infrastructure for green certifications
- Enact policies to support circularity e.g. plastic-focused EPR policy for prioritized plastic waste streams and upstream plastic circularity
- Remove bottlenecks to the use of alternative fuels by cement companies

Reduce emission in the transport sector

- Develop a Sustainable Transport Vision
- Facilitate multimodal urban transport
- Adopt soft measures that encourage the shift from cars/trucks to low carbon modes of transport
- Lay the foundations for increased private participation in the transition toward low carbon vehicles

Take synergetic actions across adaptation and mitigation

- "Green" desalination
- Equip wastewater treatment plants with biogas capture systems
- Implement "green" building and EE across municipal services
- Undertake a comprehensive reform of the SWM sector
- Develop bio-energy resource recovery (bio-CNG, bio-methane, etc.) for bio-waste policy to incentivize bio-energy applications for bio-waste streams

Supporting Actions

Create an enabling environment:

Enact executive regulations for amended PPP law; incentivize green certifications; review non-tariff barriers on environmental goods; leverage industrial and investments green zones; assess challenges to the private sector and reach out to leaders to strengthen partnerships

Create a central repository of data on energy, water, WWT, and reuse of industrial subsectors; integrate climate into fiscal planning, budget preparation and execution; strengthen capacity at national and local level for climate-smart actions

Mobilize finance: Complete a climate and disaster risk financing assessment; develop risk finance instruments; reform transfers to include performance on green and climate-smart investments while improving local capacities

Ensure a focus on the most vulnerable: Assess the social impact of climate change and development and create an action plan response; create an institutional framework for linking initiatives for green skilling; build partnerships with private sector for training and upskilling, including g with focus on women; improve flexibility of social protection system to respond to shocks

Figure 20. Priority Actions in the Medium and Long Term

Priority Actions in the Medium and Long Term

Strengthen Resilience and Adaptation

Enhance efficiency in the way resources are used and allocated based on their true value

- Scale up reuse of treated wastewater to supplement agricultural water for selected crops
- Implement investments to promote wastewater resource circularity
- Support upstream circular interventions
- Support implementation of bio-waste to bio-energy projects at the local level on a PPP basis
- Reform land management for better agricultural outcomes and efficient urban expansion

Provide better information and information and increase awareness about climate change impacts for collective action

- Amend the national environmental law and national environmental assessment system to strengthen the process of assessing and managing social impacts and risks
- Mainstream climate risk sensitivity (flooding, heat, SLR on priority) in local planning systems and development plans
- Improve city-level early warning systems for floods (pluvial, coastal, and fluvial), heat waves and other climate change/natural disasters

Enhance resilience and reduce the risk of stranded assets through complementary actions

- Develop and implement a climate-resilient trade logistics strategy
- Develop and launch transport asset management systems of arterials/highway assets for corridors of strategic importance, optimizing lifecycle operation and maintenance costs and resilience
- Mainstream nature-based solutions, covering green & blue infrastructure, as part of urban form across key cities
- Implement "green" building and EE across municipal services
- Enhance the operational efficiency of existing wastewater treatment plants

Transition to Low Carbon Development

Accelerate the transition to renewable energy

- Carry out needed analysis to assess the benefits and costs of introducing a carbon tax and developing a carbon credit market

Reduce emissions in the oil and gas value sector and lower the carbon intensity of the energy supply mix

Reduce carbon intensity of energy mix and exports by:

- developing a prioritized action plan and Marginal Abatement Cost Curve for selected oil & gas value chain assets
- developing a policy, regulatory (carbon intensity standards, adoption of detection, measurement and reporting standards, adoption of abatement targets), and PSP-enabling contractual framework for sector decarbonization

Reduce inefficiencies in the use of energy for electricity and industry

- Foster acceptance of blended cement and alternative raw materials
- Introduce Carbon Capture and Storage (CCS) in large industrial plants such as iron and steel and petrochemicals

Reduce emissions in the transport sector

- Execute policy/ regulatory reforms and investment program to enable pricing interventions to encourage shift from cars to sustainable transport
- Introduce Sustainable Logistics and Freight reforms
- Introduce Sustainable Logistics and Freight Investment Program

Take synergetic actions across adaptation and mitigation

- Transition to higher levels of the "waste hierarchy" and plastics circularity
- Implement EPR models, cost recovery & monitoring systems for plastic waste
- Develop a roadmap to improve climate resilience and financial sustainability

Supporting Actions

Create an enabling environment:

Develop & test existing and new blended finance instruments to leverage finance; develop a systematic strategy on structured finance and private placement instruments linked to MSMEs; create a green taxonomy for the financial sector

Mainstream CC and green objectives into core government functions and public sector operations; keep strengthening subnational capacities for climate smart actions (planning, budgeting, and investment)

Mobilize finance: Ensure adoption of international sustainability standards by financial institutions; consider integrating climate related financial risks into supervisory

Ensure a focus on the most vulnerable: Identify skills needed through a labor market information system; invest in skills considering international standards for education of technicians

6. References

Abdallah, L., El-Shennawy, T. Evaluation of CO2 emission from Egypt's future power plants. Euro-Mediterr J Environ Integr 5, 49 (2020). https://doi.org/10.1007/s41207-020-00184-w.

Abeer Elshennawy & Dirk Willenbockel, 2021. "*The Effect of a Carbon Tax on The Egyptian Economy: A General Equilibrium Analysis*," Working Papers 1525, Economic Research Forum, revised 20 Dec 2021.

Abdel Monem, M. A., & Lewis, P. (2020). "Governance and Institutional Structure of Climate Change in Egypt"in *Climate Change Impacts on Agriculture and Food Security in Egypt* (pp. 45-57). Springer, Cham https://link.springer.com/chapter/10.1007/978-3-030-41629-4_3

African Development Bank (2021) African Economic Outlook. https://www.afdb.org/en/countries/north-africa/egypt/egypt-economic-outlook

Alnashar,Sara Bahaa Hamed; Elashmawy,Fatma Ibrahim Mohamed; Metwally,Yosra Ahmed Samy Bedair; Erian,Jala Emad Youssef; Dunand,Eric Raoul Philippe; Hussein,Maha Abdelhamid Mohamid Tawfik; Alotaibi,Fatimah Mutlaq H. Egypt Economic Monitor, December 2021 : The Far-Reaching Impact of Government Digitalization (English). Egypt Economic Monitor Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/754121644245654929/Egypt-Economic-Monitor-December-2021-The-Far-Reaching-Impact-of-Government-Digitalization

Breisinger, Clemens; Kassim, Yumna; Kurdi, Sikandra; Randriamamonjy, Josée; and Thurlow, James. 2021. "*Food subsidies and cash transfers in Egypt: Evaluating general equilibrium benefits and trade-offs*". MENA RP Working Paper 34. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134427

Bryan Bollinger and Kenneth Gillingham (2012) "*Peer Effects in the Diffusion of Solar Photovoltaic Panels (with Bryan Bollinger)*,"Marketing Science (2012), 31(6): pg. 900-912. https://resources.environment.yale.edu/gillingham/BollingerGillingham_PeerEffectsSolar.pdf

Burke, E.J., S.E. Chadburn, C. Huntingford, and C.D. Jones, 2018: "CO2 loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2.0 °C." https://iopscience.iop.org/article/10.1088/1748-9326/aaa138/meta#:~:text=CO2%20loss%20by%20permafrost,1.5%20or%202%20%C2%B0C

CGIAR Research Program on Climate Change, Agriculture and Food Security, "CCAFS Big Facts - Drought-tolerant maize boosting food security in 13 African countries," https://ccafs.cgiar.org/bigfacts/#theme=evidence-of-success&subtheme=crops&casestudy=cropsCs2

Chin Yee Chan, Nhuong Tran, Kai Ching Cheong, Timothy B. Sulser, Philippa J. Cohen , Keith Wiebe , Ahmed Mohamed Nasr-Allah, 2021. Future of Fish in Africa: Employment and Investment opportunities, PLoS ONE 16(12): e0261615. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0261615

Christopher M. Free, Tracey Mangin, Jorge García Molinos, Elena Ojea, Christopher Costello, Steven D. Gaines, 2019, "Realistic fisheries management reforms could mitigate the impacts of climate change in most countries". PLoS ONE 15(3): e0224347. https://doi.org/10.1371/journal.pone.0224347

Clemens Breisinger, Askar Mukashov, Mariam Raouf, Manfred Wiebelt (2019), "*Energy subsidy reform for growth and equity in Egypt: The approach matters,*" Energy Policy, Volume 129. https://www.sciencedirect.com/science/article/pii/S0301421519301491

Climate Watch. 2022. Washington, DC: World Resources Institute. Available online at: https://www.climatewatchdata.org.

Crippa et al., 2021. "Global Anthropogenic Emissions in Urban Areas: Patterns, Trends, and Challenge" https://iopscience.iop.org/article/10.1088/1748-9326/ac00e2

Dalberg. 2019. "Stop the Plastic Flood: How Mediterranean Countries Can Save their Sea." Report for the Worldwide Fund for Nature (WWF), Gland, Switzerland. http://awsassets.panda.org/downloads/a4_plastics_reg_low.pdf

Dasgupta, P. 2021. "The Economics of Biodiversity: The Dasgupta Review." (London: HM Treasury). https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review

Egypt's Central Agency for Public Mobilization & Statistics. Egypt in Figures March 2022. https://www.capmas.gov.eg/Pages/Publications.aspx?page_id=5104

Egyptian Electricity Holding Company, FY21 Report. http://www.moee.gov.eg/english_new/EEHC_Rep/REP2021-2022en.pdf

Egyptian Electric Utility and Consumer Protection. Regulatory Agency. March 2022 Report http://egyptera.org/ar/ElectricityObservatory.aspx

Egypt Environmental Affairs Agency, 2016. Egypt Third National Communication submitted to UN Framework Convention on Climate Change. https://www.eeaa.gov.eg/portals/0/eeaaReports/N-CC/Egypt's%20third%20national%20communication%20report%20.pdf

Egypt Environmental Affairs Agency, 2017. Egypt State of the Environment 2017 (in Arabic), https://www.eeaa.gov.eg/portals/0/eeaaReports/SoE-2017/Egypt%20SOE%202017%20-%20Full%20Report%20Arabic.pdf

Egyptian Environmental Affairs Agency *(2021) Sowing seeds for Future generations: https://www.eeaa.gov.eg/Portals/0/eeaaReports/events/photo-album-Egypt%20leadership%20on%20climate%20mitigation%20and%20adaptation.pdf*

Egypt's First Biennial Updated Report (BUR), 2018 https://www.eeaa.gov.eg/portals/0/eeaaReports/N-CC/BUR%20Egypt%20EN.pdf

Egypt First Updated Nationally Determined Contributions, June 2022. https://unfccc.int/sites/default/files/NDC/2022-07/Egypt%20Updated%20NDC.pdf.pdf

Egypt Ministry of Planning and Economic Development Egypt's 2021 Voluntary National Review https://mped.gov.eg/AdminPanel/sharedfiles/vnr_en.pdf

Egypt's National Climate Change Strategy 2050. https://www.eeaa.gov.eg/portals/0/eeaaReports/N-CC/EgyptNSCC-2050-Summary-En.pdf

EWRA (2018). Egyptian Water Regulatory Agency Report for 2017-18 http://www.ewra.gov.eg/DocumentsLibrary/Library/1/English%20Anual%20Repot%202017-2018.pdf

European Bank for Reconstruction and Development (EBRD). 2019. Transition Report 2019-2020 https://www.ebrd.com/transition-report-2019-20

Food and Agriculture Organization of the United Nations. FAOSTAT Statistical Database.2021

Fedi, L, M Amer, and A Rashad. 2019. "Growth and Precariousness in Egypt." Working Paper No. 2. ILO/SIDA Partnership on Employment. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/publication/wcms_735169.pdf

Fine, M., Gildor, H., and Genin, A. (2013). A coral reef refuge in the red sea. *Glob. Chang. Biol.* 19, 3640–3647. doi: 10.1111/gcb.12356

Fine, M., Cinar, M., Voolstra, C. R., Safa, A., Rinkevich, B., Laffoley, D., et al. (2019). Coral reefs of the Red Sea — Challenges and Potential Solutions. *Reg. Stud Mar. Sci.* 25:100498. doi: 10.1016/j.rsma.2018.100498

GAFRD, Fish Statistics Year Book (27th Edn.), 27th ed. (General Authority for Fish Resources Development (GAFRD), Ministry of Agriculture and Land Reclamation, Egypt, 2017).

Gregg et, al .2021. "Benefit Accounting of Nature-Based Solutions for Watersheds: Guide." https://pacinst.org/publication/benefit-accounting-nbs/#:~:text=Nature%2Dbased%20solution%20(NBS),mitigation%2C%20adaptation%2C%20and%20resilience.

Global CCS Institute, Facilities Database (https://co2re.co/FacilityData)

Global Commission on Adaptation. 2019. "Adapt Now: A Global Call for Leadership on Climate Resilience," https://gca.org/reports/adapt-now-a-global-call-for-leadership-on-climate-resilience/

Global Water Intelligence, WaterData Indicators database, 2016. https://www.gwiwaterdata.com/

Global Water Intelligence.2020. "Egypt outlines $15 billion desalination programme". Vol 21, Issue 10. https://www.globalwaterintel.com/global-water-intelligence-magazine/21/10/general/egypt-outlines-15-billion-desalination-programme

Harrison Charo Karisa, Ahmed Nasr-Allah, Diaa Al-Kenawy, Nabil Ahmed Ibrahim, Jeleel Opeyemi, Walid, Elsawy Aly, Alaa El Far, Seamus Murphy and Michael Phillips, 2019. "Capturing value from Egyptian Blue Economy: Aquaculture and Fish Supply Chains," World Fish.

Hallegatte, Stephane; Bangalore, Mook; Bonzanigo, Laura; Fay, Marianne; Kane, Tamaro; Narloch, Ulf; Rozenberg, Julie; Treguer, David; Vogt-Schilb, Adrien. 2016. Shock Waves: Managing the Impacts of Climate Change on Poverty. Climate Change and Development;. Washington, DC: World Bank.

Hany F. Abd-Elhamid et. al. "Safe Reuse of Treated Wastewater for agriculture in Egypt"(2018).

Harris I, Osborn TJ, Jones P and Lister D (2020) Version 4 of the CRU TS Monthly High-Resolution Gridded Multivariate Climate Dataset. Sci *Data* 7, 109 (2020). https://doi.org/10.1038/s41597-020-0453-3

Hassan, Salwa K. and Khoder, Mamdouh I. Chemical characteristics of atmospheric PM2.5 loads during air pollution episodes in Giza, Egypt. Atmospheric Environment, 2017; 150 346e355

Heger, Martin Philipp; Vashold, Lukas; Palacios, Anabella; Alahmadi, Mala; Bromhead, Marjory-Anne; Acerbi, Marcelo. 2022. Blue Skies, Blue Seas: Air Pollution, Marine Plastics, and Coastal Erosion in the Middle East and North Africa. MENA Development Report;. Washington, DC: World Bank http://hdl.handle.net/10986/36912

Heger, Martin; Zens, Gregor and Meisner, Craig. 2019. Particulate matter ambient air pollution and respiratory disease in Egypt. The World Bank. http://hdl.handle.net/10986/35810

Hegazy, M., 2022. *Egypt transport policies 2014-2021*. Arab Reform Initiative. Available at: https://www.arab-reform.net/publication/egypt-transport-policies-14-21/

High Level Panel for a Sustainable Ocean Economy. Summary for Decision-makers: The Expected Impacts of Climate Change on the Ocean Economy. Available at: http://www.oceanpanel.org/sites/default/files/2019-12/expected-impacts-climate-change-on-the-ocean-economy-executive-summary.pdf

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J.Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018 , "Impacts of 1.5ºC Global Warming on Natural and Human Systems. In: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty." https://research-repository.uwa.edu.au/en/publications/impacts-of-15%C2%BAc-global-warming-on-natural-and-human-systems

Imane Helmy & Rania Roushdy, 2019. "Household Vulnerability And Resilience To Shocks In Egypt," 1362, Economic Research Forum, revised 20 Oct 2019. https://erf.org.eg/publications/household-vulnerability-and-resilience-to-shocks-in-egypt/

IMF Country Focus: Egypt: Overcoming the COVID Shock and Maintaining Growth (July 2021) https://www.imf.org/en/News/Articles/2021/07/14/na070621-egypt-overcoming-the-covid-shock-and-maintaining-growth

International Energy Agency: Egypt statistical data (https://www.iea.org/countries/egypt)

IFC. 2019. Green Buildings, A Finance and Policy Blueprint for Emerging Markets, International Finance Corporation 2019. https://documents1.worldbank.org/curated/en/586841576523330833/pdf/Green-Buildings-A-Finance-and-Policy-Blueprint-for-Emerging-Markets.pdf

IFC. 2020. Country Private Sector Diagnostic: Creating Markets in Egypt. International Finance Corporation 2020. https://www.ifc.org/wps/wcm/connect/af513599-08b4-45a4-b346-1a44de58cda6/CPSD-Egypt.pdf?MOD=AJPERES&CVID=npT1-BJ

IFC. 2020. "A Green Reboot for Emerging Markets," IFC, Guidehouse Insights. https://www.ifc.org/wps/wcm/connect/26f79a1b-c191-494b-b2d9-c891e138bb37/IFC_GreenReport_FINAL_web_1-14-21.pdf?MOD=AJPERES&CVID=ns1JVaR

International Labor Organization. 2019. Working on a warmer planet: The impact of heat stress on labor productivity and decent work. International Labour Office – Geneva, ILO. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf

International Labor Organization. 2018. Skills for green jobs Update 2018. https://www.ilo.org/skills/projects/WCMS_707582/lang--en/index.htm

Izaguirre, C., Losada, I.J., Camus, P. et al. Climate change risk to global port operations. Nat. Clim. Chang. 11, 14–20 (2021). https://doi.org/10.1038/s41558-020-00937-z

JICA, Almec Corporation, Katahira & Engineers International, & Oriental Consultants Co., Ltd., 2012. MiNTS – Misr national Transport Study – The Comprehensive Study on the Master Plan for Nationwide Transport System in the Arab Republic of Egypt – Final Report

Laher I. (eds) Handbook of Healthcare in the Arab World. "Infectious Disease in Relation to Climate Change in the Arab World". Springer, Cham, 2019; DOI https://doi.org/10.1007/978-3-319-74365-3_135-1, Publisher: Springer Nature https://link.springer.com/referenceworkentry/10.1007/978-3-319-74365-3_135-1

Larsen, Bjorn. 2019. Arab Republic of Egypt - Cost of Environmental Degradation : Air and Water Pollution. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/32513 License: CC BY 3.0 IGO.

Lee, SW., Lee, K. & Lim, B. Effects of climate change-related heat stress on labor productivity in South Korea. Int J Biometeorol 62, 2119–2129 (2018). https://doi.org/10.1007/s00484-018-1611-6

Mahmoud, S. H., & Gan, T. Y. 2018. *Urbanization and climate change implications in flood risk management: Developing an efficient decision support system for flood susceptibility mapping. Science of the Total Environment, 636, 152-167. https://www.sciencedirect.com/science/article/pii/S0048969718314591*

McCarron, B., Giunti, A. and Tan, S. 2018, Climate Costs for Asia Pacific Ports. HSBC. https://www.sustainablefinance.hsbc.com/carbon-transition/climate-costs-for-asia-pacific-ports

Monroe, A.A., Ziegler, M., Roik, A., Röthig, T., Hardenstine, R.S., Emms, M.A., Jensen, T., Voolstra, C.R., Berumen, M.L., 2018, "In situ observations of coral bleaching in the central Saudi Arabian Red Sea during the 2015/2016 global coral bleaching event," PLoS ONE 13, e019581. http://dx.doi.org/10.1371/journal.pone.0195814

Naoko Kumano, Makoto Tamura, Tomomi Inoue , and Hiromune Yokoki, 2021. "Estimating the cost of coastal adaptation using mangrove forests against sea level rise", Coastal Engineering Journal, 63 (3) 263-74. https://www.tandfonline.com/doi/full/10.1080/21664250.2021.1892968?tab=permissions&scroll=top

Niamir, L., Kiesewetter, G., Wagner, F. et al. (2020), Assessing the macroeconomic impacts of individual behavioral changes on carbon emissions," Climatic Change 158, 141–160 (2020). https://doi.org/10.1007/s10584-019-02566-8

Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart, 2014: Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

Nicholls RJ, Hinkel J, Lincke D and van der Pol T, 2019. Global Investment Costs for Coastal Defense through the 21st Century, World Bank Policy Research Working Paper 8745, World Bank, Washington DC. http://hdl.handle.net/10986/31308

Simoes, AJG and CA Hidalgo. (2011) The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. (2011) (last accessed March 20, 2022) https://oec.world/en/profile/country/egy

Perez, Nicostrat's D.; Kassim, Yumna; Ringler, Claudia; Thomas, Timothy S.; and ElDidi, Hagar. 2021. Climate change and Egypt's agriculture. MENA Policy Note 17. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134318

Perez, Nicostrato D.; Kassim, Yumna; Ringler, Claudia; Thomas, Timothy S.; and ElDidi, Hagar. 2021b. Climate change adaptation strategies for Egypt's agricultural sector: A 'suite of technologies' approach. MENA Policy Note 18. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134321

Regulatory Indicators for Sustainable Energy (RISE), Egypt Country Profile. https://rise.esmap.org/

Seddon Nathalie; Chausson Alexandre; Berry Pam; Girardin Cécile A. J.; Smith Alison and Turner Beth. 2020, “Understanding the value and limits of nature-based solutions to climate change and other global challenges,” Phil. Trans. R. Soc. B3752019012020190120 http://doi.org/10.1098/rstb.2019.0120

Seneviratne, S.I., X. Zhang, M. Adnan, W. Badi, C. Dereczynski, A. Di Luca, S. Ghosh, I. Iskandar, J. Kossin, S. Lewis, F. Otto, I. Pinto, M. Satoh, S.M. Vicente-Serrano, M. Wehner, and B. Zhou, 2021: Weather and Climate Extreme Events in a Changing Climate. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1513–1766, doi:10.1017/9781009157896.01

Seung-Wook Lee et. al. 2018. Effects of climate change-related heat stress on labor productivity in South Korea https://www.researchgate.net/publication/327825699_Effects_of_climate_change-related_heat_stress_on_labor_productivity_in_South_Korea

Smith JB, McCarl BA, Kirshen P, Jones R and others (2014) Egypt’s economic vulnerability to climate change. Clim Res 62:59-70. https://doi.org/10.3354/cr01257

Shinan N Kassam and Boubaker Dhehibi. 2016. “Mechanization to Drive a Process for Fertilizer Subsidy Reform in Egypt.” Economic Research Forum Policy Brief No. 22, December 2016. https://erf.org.eg/publications/mechanization-to-drive-a-process-for-fertilizer-subsidy-reform-in-egypt/

Siam M. S. and E. A. B. Eltahir. 2017.Climate change enhanced interannual variability of the Nile river flow. Nature Climate Change vol. 7 https://eltahir.mit.edu/wp-content/uploads/2017/04/Climate-change-enhances-interannual-variability-of-the-flow-in-the-Nile-river.pdf

Stephane Hallegatte, Colin Green, Robert J Nicholls, Jan Corfee Morlot, 2013, “Future Flood Losses in Major Coastal Cities, Nature Climate Change”, 18 August 2013. https://www.nature.com/articles/nclimate1979

Steven D. Gaines, Christopher Costello, Brandon Owashi, Tracey Mangin, Jennifer Bone, Jorge García Molinos, Merrick Burden, Heather Dennis, Benjamin S. Halpern, Carrie V. Kappel, Kristin M. Kleisner, Daniel Ovando, 2018. “Improved fisheries management could offset many negative effects of climate change,” Science Advances, 4: eaao1378. https://www.science.org/doi/10.1126/sciadv.aao1378

Thurlow, James; Holtemeyer, Brian; Kassim, Yumna; Kurdi, Sikandra; Randriamamonjy, Josée; Raouf, Mariam; Elsabbagh, Dalia; Wiebelt, Manfred; and Breisinger, Clemens. 2020. Investing in the agri-food system for post-COVID-19 recovery: An economywide evaluation of public investments in Egypt. MENA Policy Note 7. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.133773

United Nations COMTRADE database (2020) https://comtrade.un.org/

United Nations, Department of Economic and Social Affairs, Population Division .2018. World Urbanization Prospects: The 2018 Revision, Online Edition.

United Nations Development Programme. 2021. Human Development Report: Egypt file:///C:/Users/wb227883/Downloads/English_Full-Report_Sep-12EHDR.pdf

United Nations Industrial Development Organization: "UNIDO and Switzerland to support Egypt with the development of eco-industrial parks (17 January 2022) https://www.unido.org/news/unido-and-switzerland-support-egypt-development-eco-industrial-parks

Vazquez Alvarez,Victor; Buchauer,Konrad. (2015) *East Asia and Pacific - Wastewater to energy processes : a technical note for utility managers in EAP countries : Main report (English).* Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/489941468188683153/Main-report

Verschuur, J., Koks, E.E., and Hall, J.W. (2020). "Port disruptions due to natural disasters: Insights into port and logistics resilience," Transportation Research Part D: Transport and Environment, 85, 102393. https://doi.org/10.1016/j.trd.2020.102393

World Bank.2016. Egypt: Enterprise Survey. https://www.enterprisesurveys.org/en/citing-the-data

World Bank. 2018.Egypt: Enabling Private Investment and Commercial Financing Infrastructure. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/588971544207642729/report

World Bank. 2019-2020a. Egypt Enterprise Survey. https://www.enterprisesurveys.org/en/citing-the-data

World Bank. 2019-2020b. Egypt Enterprise Survey: Green Module. https://www.enterprisesurveys.org/en/citing-the-data

World Bank. 2021a. Unlocking Egypt's Potential for Poverty Reduction and Inclusive Growth : Egypt Systematic Country Diagnostic Update. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/36437 License: CC BY 3.0 IGO.

World Bank. 2021b. *Climate Risk Country Profile: Egypt. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-04/15723-WB_Egypt%20Country%20Profile-WEB-2_0.pdf*

World Bank. 2021c. *Climate Change and Future Flood Impacts in Alexandria, Egypt's CCDR Background Note*

World Bank. 2021d. *Resilient Cities and Coastal Economies*, Egypt's CCDR Background Note

World Bank. 2021e. *The Changing Wealth of Nations 2021: Managing Assets for the Future*

World Bank. 2021f. *Enabling Private Investment and Commercial Financing in Infrastructure.* http://documents.worldbank.org/curated/en/588971544207642729/Report

World Bank. 2021j. *Jobs for a Green, Resilient, and Inclusive Recovery.* Egypt's CCDR Background Note

World Bank. 2021h. The Employment Benefits of An Energy Transition in Egypt, November 2021. (from the Clean Energy Jobs and Skills Regional ASA lead by Energy, including Egypt).

World Bank. 2022a. Energy Transition Energy, Transport and Industry (ETI) pathway. Egypt's CCDR Background Note

World Bank. 2022b. High-level CCUS Hubs Screening Assessment for Algeria and Egypt", April - June 2022

World Bank. 2022c. Poverty, Jobs and Climate Change. Egypt's CCDR Background Note

World Bank. 2022d. *National Transport Emission Analysis.* Egypt's CCDR Background Note

World Bank. 2022e. Financial Sector Assessment. Egypt's CCDR Background Note

World Bank: Egypt Overview, Update March 16, 2022f https://www.worldbank.org/en/country/egypt/overview

World Bank. 2022g. Climate Change and Water-Food Energy Nexus. Egypt's CCDR Background Note

World Bank. 2022h. Boosting Green Growth of Egypt's Private Sector. Egypt's CCDR Background Note

World Bank: Egypt Overview, Update March 16, 2022i https://www.worldbank.org/en/country/egypt/overview

World Bank. Forthcoming. Decarbonizing Natural Gas using CCUS Technology,".

World Bank. Forthcoming. Financial Sector Development and Stability Policy Loan (P178324), Program Document.

The World Bank. "World Development Indicators." URL: http://data.worldbank.org/data-catalog/world-development-indicators

World Health Organization. 2015. *Climate and Health Profile – Egypt*. URL: https://apps.who.int/iris/bitstream/handle/10665/208860/WHO_FWC_PHE_EPE_15.06_eng.pdf?sequence=1

World Fish. 2019.Capturing Value from the Egyptian Blue Economy: Aquaculture and Fish Supply Chains.

Wyndham CH (1969), "Adaptation to heat and cold,". Environ. Res Oct;2(5):442-69. doi: 10.1016/0013-9351(69)90015-2. PMID: 5381589.

Yigezu, Yigezu A., et al. "Food Losses and Wastage along the Wheat Value Chain in Egypt and Their Implications on Food and Energy Security, Natural Resources, and the Environment," Sustainability 13.18 (2021): 10011. http://www.arc.sci.eg/NARIMS_upload/NARIMSdocs//545141/sustainability-13-10011.pdf