INTERNATIONAL MONETARY FUND

IMF Country Report No. 24/89

ALGERIA

SELECTED ISSUES

April 2024

This Selected Issues paper on Algeria was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on March 7, 2024.

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ALGERIA

SELECTED ISSUES

March 7, 2024

Approved By
Middle East and Central Asia Department

Prepared By Mahmoud Harb and Jarin Nashin (both MCD).
The authors are indebted to Emanuele Massetti, Filippos Tagklis, and Karlygash Zhunussova (all FAD) for their insights and technical support.

CONTENTS

FISCAL REFORMS TO SUPPORT ADDRESSING CLIMATE CHANGE CHALLENGES

A. Introduction

1. Algeria and other countries in the Middle East and North Africa (MENA) face multiple challenges associated with climate change. The projected shift in climate patterns over the coming decades poses risks to prosperity, food security, and social development in the region, with most of its population already living under challenging climate conditions (Duenwald and others 2022). Resolute action to build resilience and adapt to these changing conditions is therefore urgently needed. Moreover, against the background of persistent large development needs, curtailing the MENA region's rapidly rising emissions of greenhouse gases (GHG) in line with official pledges would require transformative, and possibly disruptive reforms. For hydrocarbon exporters such as Algeria, the prospect of declining oil and gas revenue amid ongoing efforts to decarbonize the global economy compound these challenges.

2. Fiscal policy instruments are powerful tools that can be deployed by governments in Algeria and elsewhere to respond to the challenges from climate change (IMF 2008, 2019). Well-designed tax and fiscal spending measures can incentivize lower domestic GHG emissions, promote energy conservation, and encourage the development of renewables. Strong fiscal institutions help build resilience to the impact of climate change, whether by planning adequate investment in protective infrastructure or developing cost-effective social protection systems. And as a volatile and more disaster-prone world will likely put fiscal revenue under pressure and generate sizeable spending needs, fiscal reforms would be crucial to safeguard the sustainability of public finances and macroeconomic stability.

3. This paper examines the macroeconomic and fiscal implications of climate change in Algeria. It highlights a range of risks associated with the projected shifts in weather patterns and Algeria's own hydrocarbon-reliant growth model in the context of the global energy transition.

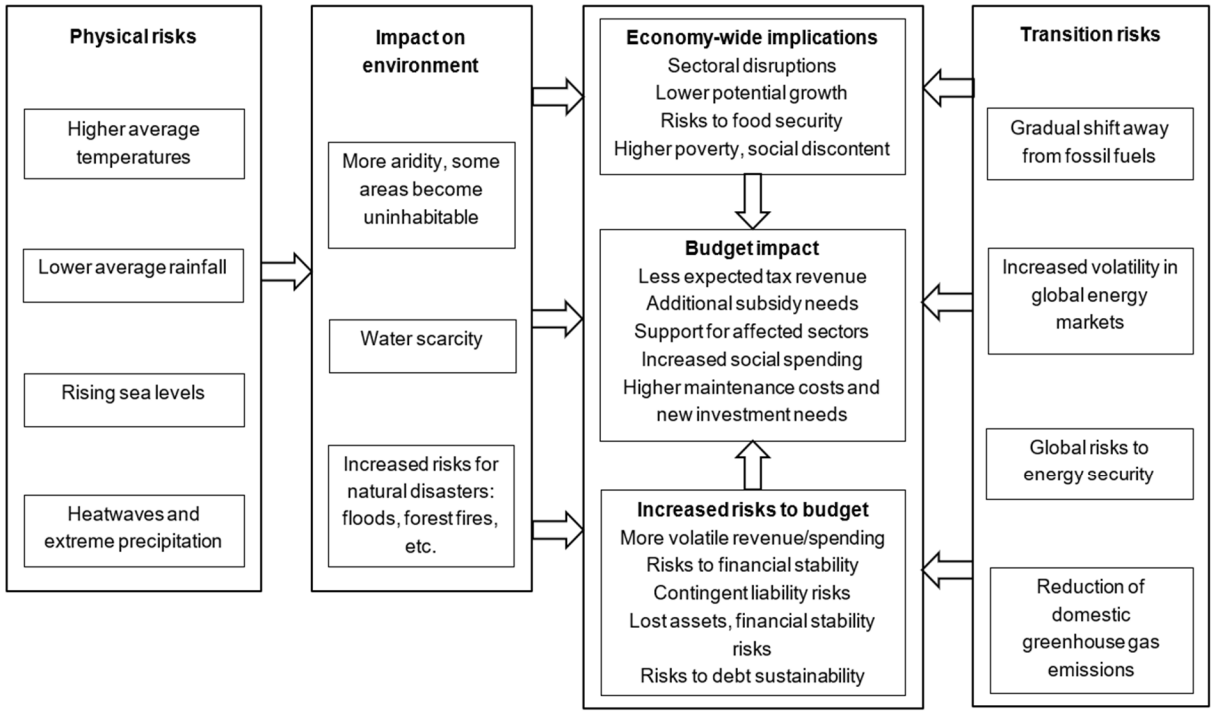
4. The paper also discusses fiscal policy options to achieve Algeria's climate goals. An analysis based on the joint IMF-World Bank Climate Policy Assessment Tool (CPAT) suggests that even partial elimination of existing energy subsidies would help Algeria achieve its GHG emission reduction goals, boost fiscal revenue, encourage the expansion of renewable energy, and generate considerable environmental and public health benefits. Those reforms would create fiscal space for priority budget spending including on targeted social transfers and investment in adaptation to climate change. In parallel, sectoral fiscal interventions such as feebates and targeted subsidies would help accelerate the development of less polluting energy sources. Strengthening public finance management would enable Algeria to maximize the growth and green dividend of public spending. Lastly, the implementation of medium-term fiscal planning, continued progress on tax reform, and stronger fiscal management would support fiscal and macroeconomic resilience in a more volatile world.

5. The rest of the paper proceeds as follows. The second section discusses the risks faced by Algeria and its economy from the expected shifts in climate conditions and the global transition to a low-carbon economy. The third section outlines the main pillars of the Algerian government's climate strategy. The fourth section presents fiscal policy options to achieve Algeria's goals in terms of GHG emission reduction and building resilience against mounting climate risks. The last section summarizes policy recommendations and concludes.

B. Algeria's Climate Change Challenges

6. Like most countries, Algeria faces a range of physical and transition risks from climate change (Box 1). Physical risks stem from shifts in climate patterns (temperatures, level and variability of rainfall, rise in sea levels, etc.) which can damage human settlements, assets, and economic activity. Transition risks stem from changes in the behavior of domestic and foreign economic agents associated with the transition to a low-carbon economy and the related shifts in policies, legislation, technology, and markets.

Box 1. Climate Change: Risks for the Economy and for Public Finances



Source: IMF.

PHYSICAL RISKS: AGGRAVATING CLIMATE ARIDITY

7. Climate change will likely harshen the arid climate conditions that already prevail across most of Algeria's territory. Algeria has two main climate zones: a Mediterranean climate in the Northern band which receives most rainfall in Algeria and a desert climate in the rest of the country, with the latter covering over 80 percent of its territory. Both climate zones are likely to be affected significantly by climate change (Figures 1 and 2):

- ***Average temperatures are projected to continue to rise faster than in the rest of the world.*** Over the last two decades, average temperatures in Algeria exceeded the levels observed over 1950–80 by an average of 1.45°C. While this increase is similar to that of the MENA region (1.31°C), it is larger than in the rest of the world (1.08 °C). This trend is projected to continue in the coming decades: under an intermediate scenario for future GHG emissions and levels—the "Shared Socioeconomic Pathways 4.5" (SSP2-4.5) scenario— average temperatures in Algeria are projected to increase by 1.1°C over 2020–39 and by 2.8°C by the end of the century, all relative to the 1995–2014 reference period, and double the projected global mean of 1.4°C.[1] Conditions in the arid central and southern regions, including some hydrocarbon-rich provinces, risk becoming increasingly harsh.

- ***Average rainfall level is expected to decrease (Figure 2).*** High-frequency data analysis by IMF staff suggests that the Northern coastal band, which receives an average rainfall of 400–800 mm. annually, has experienced a decline of 100 mm/year in annual precipitation since the 1970s.[2] Similarly, Under the SSP2-4.5 scenario, climate model projections indicate that the coastal band will likely face decreased precipitation levels compared to current conditions. This trend will likely continue in the coming decades.

- ***Sea levels will continue rising.*** The projected rise in the Mediterranean Sea level poses risks of coastal inundation, more frequent floods during storms, and deterioration in the quality of underground water due to saltwater intrusion (Ali and others 2022). Algiers has been identified as particularly vulnerable to rising seawater levels (World Bank 2014).

8. The frequency and intensity of extreme weather events is expected to aggravate (Figures 1 and 2). Heatwaves are projected to become longer: under the SSP2-4.5 scenario, the number of days per year with maximal temperatures of more than 35°C is expected to increase by around eight percent during 2020–39 and by 22 percent before the end of the century. The average duration of dry spells would increase by 3–7 percent during 2020–39, and by 7–14 percent by the end of the century, in northern provinces such as Algiers. Current climate models suggest a slight increase in the risk of extreme rainfall at Algeria's country level in the coming decades, with this risk somewhat higher in northern provinces.

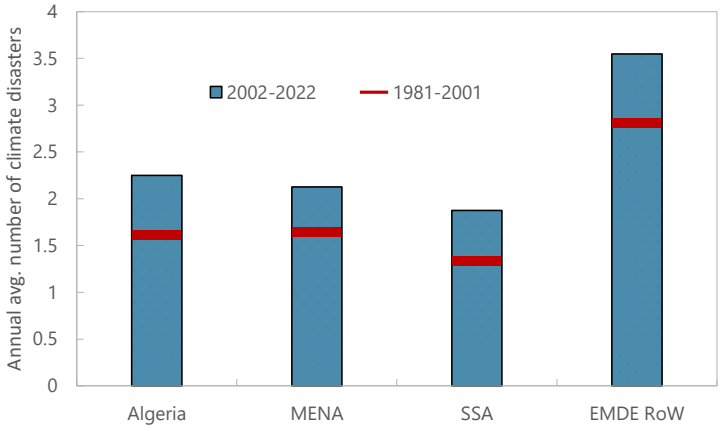
9. The aggravation of water scarcity is likely to be one of the most critical consequences of climate change in Algeria. Algeria already faces an ongoing situation of critical water stress, alongside other countries in the Middle East and Central Asia (FAO 2021): the amount of water available per capita per year in Algeria is only about half the absolute water scarcity level of 500 m3. Drought episodes have been recurring in recent years. Going forward, water resources will be put

[1] Shared Socioeconomic Pathways are a set of five scenarios feeding into the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. They represent alternative paths for global socioeconomic trends based on which future GHG emissions are derived. SSP2-4.5 is a "middle of the road" scenario under which moderate mitigation efforts result in CO2 emissions remaining at current levels until the middle of the century. Under SSP2-4.5, present trends will continue, with a trajectory suggesting that global temperatures could rise by around 1.7°C to 2.6°C by 2100, compared to pre-industrial levels.

[2] FADCP Climate Dataset (Massetti and Tagklis, 2023), using CRU data (Harris et al., 2020), and CMIP6 data (Copernicus Climate Change Service, Climate Data Store, 2021).

under increasing pressure because of lower and more variable rainfall and rising temperatures. Drought episodes risk becoming longer, more intense, and more frequent (Figure 2, D).

Text Figure 1. Frequency of Climate Disasters



Note: Middle-East and North Africa (MENA); Sub-Saharan Africa (SSA); Emerging Market and Dedveloping Economies in Rest of the World (EMDE RoW)
Source: IMF Climate Change Indicators Dashboard

10. The frequency and intensity of floods and wildfires might increase in the part of the Mediterranean basin where Algeria is located (Ali and others 2022). Algeria is exposed to the risk of floods as highlighted by the occurrence of at least 42 severe episodes since the early 1980s (Text Figure 1). Floods cost the budget additional spending of close to 0.2 percent of cumulative GDP between 2004 and 2019, based on official estimates. Flood risks could increase with climate change as desertification and erosion are likely to weaken soil infiltration, leading to more intense flood discharge. Furthermore, 99 percent of forested land in Algeria is at high or medium risk of wildfires (World Bank 2021). Catastrophic wildfires have caused scores of casualties and severe economic losses in recent years, including in 2021 and 2023. The combination of droughts and heatwaves might increase wildfire risks in the future.

Figure 1. Algeria: Historical and Projected Average Temperatures [1/]

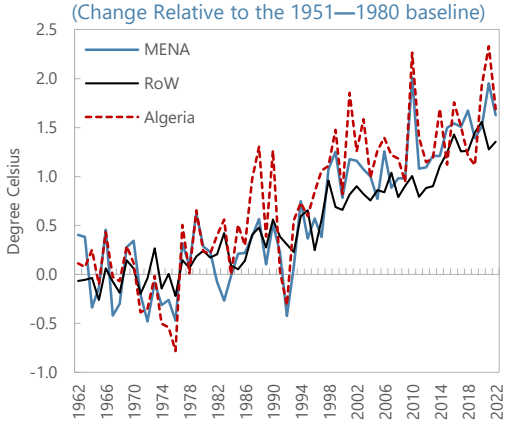
All projections are under the SSP2-4.5 scenario

Average temperatures in Algeria and the MENA have been rising at a faster pace than in the rest of the world.

Average temperatures in Algeria are likely to continue rising in the coming decades.

A. Annual Surface Temperature Change, 1962—2022

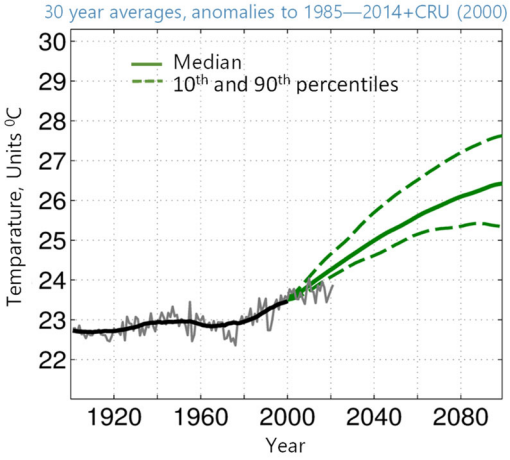
(Change Relative to the 1951—1980 baseline)



Note: This indicator presents the mean surface temperature change during the period 1961-2022, using temperatures between 1951 and 1980 as a baseline.

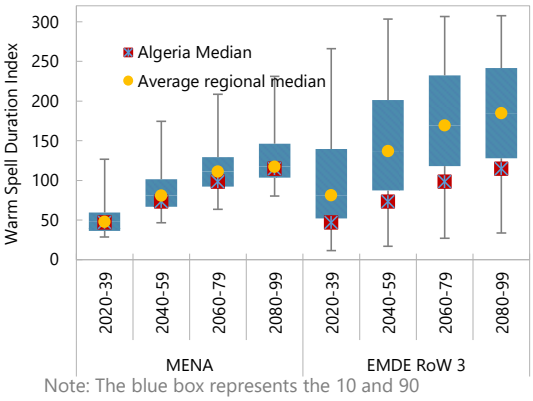
B. Algeria: Projected Mean-Temperature, 1920—2080

30 year averages, anomalies to 1985—2014+CRU (2000)



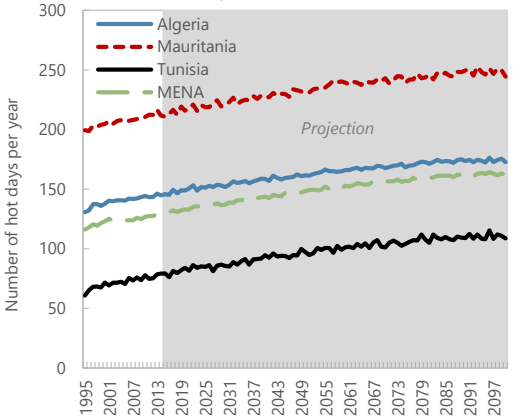
Heat waves are likely to become longer and occur more frequently.

C. Warm—Spell Duration Index [2]



Note: The blue box represents the 10 and 90 percentiles, and the whiskers the minimum and maximum.

D. Maximum Temperature of More than 35 Degree Celsius



[1/] SSP2-4.5 is an intermediate scenario under which moderate mitigation efforts trends will result in CO2 emissions remaining at current levels until the middle of the century.

[2/] The warm-spell duration index reflects the number of days that are part of a sequence of six or more days in which the daily maximum temperature exceeds the 90th percentile of the reference period.

[3/] Emerging Market and Developing Economies Rest of World

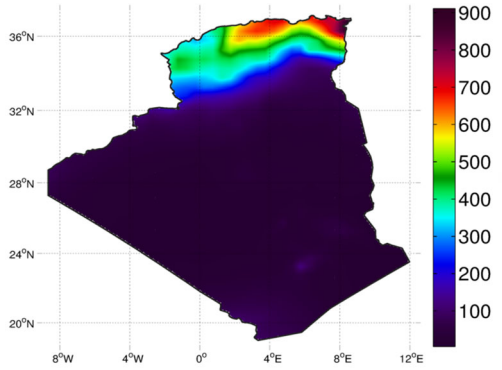
Sources: World Bank Climate Knowledge Portal; IMF Climate Change Indicators Dashboard; *FADCP Climate Dataset (Massetti and Tagklis, 2023), using CRU data (Harris et al., 2020), and CMIP6 data (Copernicus Climate Change Service, Climate Data Store, 2021: CMIP6 climate projections)* and IMF Staff Calculations.

Figure 2. Algeria: Historical and Projected Average Rainfall [1/]

All projections are under the SSP2-4.5 scenario

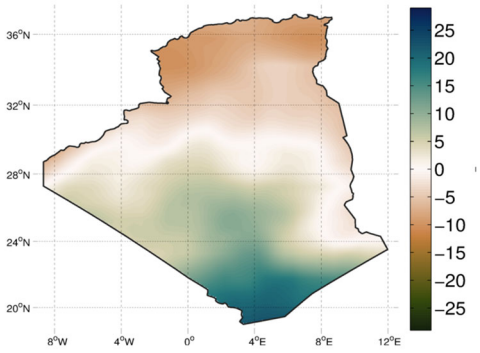
A narrow Northern coastal band receives most of rainfall in Algeria…

A. Algeria: Precipitation, 1990—2021



… and is likely to suffer from a significant fall in precipitations in the coming decades

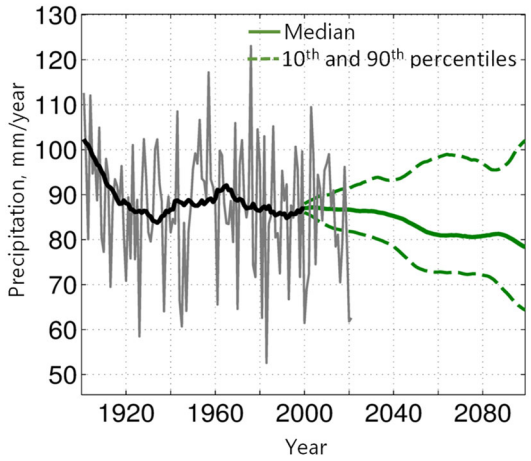
B. Algeria: Precipitation Percentage Change,



At Algeria's country-level, average precipitations have declined over the last century and are expected to drop further.

C. Algeria: Precipitation History and Projections, 1920—2080

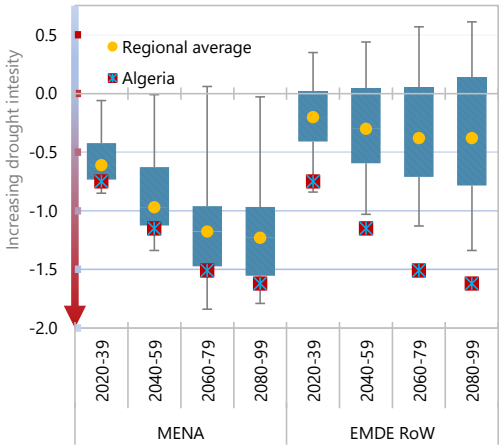
30 year averages, anomalies to 1985—2014+CRU (2000)



Drought conditions are likely to become more intense.

D. Drought Index [2,3]

(Median change)



[1/] SSP2-4.5 is an intermediate scenario under which moderate mitigation efforts trends will result in CO2 emissions remaining at current levels until the middle of the century.
[2/] The drought index reflects changes in the mean of 12-month cumulative water balance, taking into account evapotranspiration.
[3/] EMDE-RoW: Emerging Market and Developing Economies Rest of the World.

Sources: World Bank Climate Knowledge Portal; Haver; FADCP Climate Dataset (Massetti and Tagklis, 2023), using CRU data (Harris et al., 2020), and CMIP6 data (Copernicus Climate Change Service, Climate Data Store, 2021; and IMF Staff Calculations.

11. The projected change in average climate conditions and increased weather shocks could result in heavy economic and social welfare losses. Shifts in weather conditions reduced

economic growth in Algeria by 0.3 percent on average between 1979 and 2019.[3] The impact of climate change on economic growth risks becoming more severe in the coming decade. Impact channels could include:

- ***Sector-specific disruptions.*** Agriculture and energy production are highly exposed to the effects of climate change. The agricultural sector employs around one fourth of Algeria's active population and, together with fishing and forestry, accounts for 9 percent of GDP. Scarcer water resources, rising temperatures, soil degradation, and damages to ecosystems are likely to reduce its productivity, in turn harming jobs and incomes.[4] Lower agricultural productivity would also stoke risks of food insecurity. In the energy sector, hydrocarbon extraction operations could be affected by extreme heat in some central provinces, where large oil and gas deposits are located. Heatwaves would strain the power system due to increased electricity demand and the physical impact on the distribution network and power generation equipment.

- ***Headwinds to potential growth.*** Higher temperatures, lower rainfall, and more frequent extreme events pose risks to physical and human capital and productivity across sectors. The increased frequency of droughts tends to magnify the impact on growth (Zaveri and others 2023) and their effects can endure for years (Damania and others 2017).

- ***Deterioration in social outcomes.*** Climate change is likely to deteriorate health outcomes due to a variety of reasons, including the aggravation of the risks of transmissible disease (IPCC 2022) and the adverse effects of heatwaves and fires. Poverty rates could also rise, in particular due to a hit to agricultural productivity as Algeria's agricultural sector includes smallholder farms and absorbs a high share of informal jobs. Food insecurity, lower access to water, climate disasters, and harsh climate conditions could displace people, in turn intensifying pressures on infrastructure and resources in the northern coastal band. Rural flight towards the coast would also aggravate exposure to climate risks as settlements expand in flood-prone zones.

12. The impact on public finances would also be substantial. It may include:

- ***Lower revenue***. The domestic tax base could shrink as harshened climate conditions constrain productivity and growth, weakening domestic revenue mobilization.

- ***Increased spending.*** The government currently subsidizes a range of food products (milk, sugar, wheat, and derived products, etc.) and agricultural inputs such as fertilizers. The cost of these subsidies will likely rise as the expected hit to agricultural productivity associated with climate change would raise the cost of production of subsidized food products. Worsening social and health outcomes, and rising unemployment and poverty rates would generate spending pressures for social assistance. Flood and droughts would require support to affected

[3] This estimate is produced by Emanuele Massetti and Filippos Tagklis (2023) based on a machine-learning model and following the methodology in Akyapi, Bellon, and Massetti (2022).

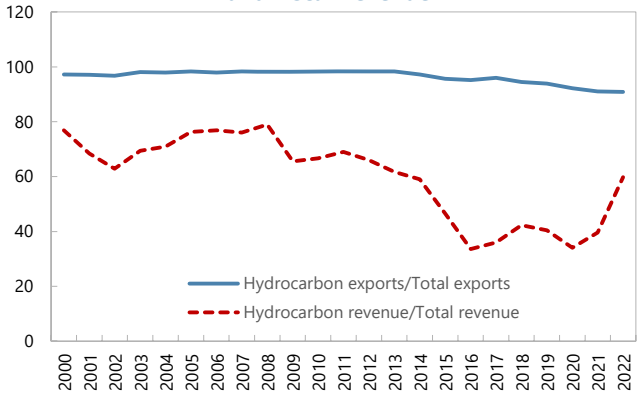
[4] For instance, Algeria's rain-fed olive production could drop by 15–64 percent under a scenario of a 3°C rise in temperatures (Bouregaa 2019).

communities and spending to rebuild damaged assets. The maintenance cost of infrastructure equipment that is not climate resilient would also likely rise (IMF 2021).

- ***Aggravating contingent liability risks from state-owned enterprises (SOEs) and banks (SOBs).*** Algeria has a large commercial public sector with SOE monopolies on activities such as the supply of electricity and water or the purchase and import of cereals and pulses. Several SOEs have weak balance sheets and require regular government financial assistance, partly due to their involvement in quasi-fiscal activities such as selling products and services at below cost-recovery levels and undertaking public investment. Climate change could further weaken the balance sheets of these SOEs and increase the need for government financial support. SOEs in climate-sensitive sectors such as agriculture, construction, power, and water would face increased costs due to climate-related disruptions to their operations and the investments needed to upgrade their equipment. SOBs, which account for more than 80 percent of the banking sector's assets, could see a decline in the creditworthiness of their borrowers, which would affect their profitability and asset quality and pose risks to fiscal and financial stability.

TRANSITION RISKS FROM GLOBAL DECARBONIZATION

Text Figure 2. Share of Hydrocarbon Exports and Fiscal Revenue



Source: IMF Staff Calculations

13. Despite progress towards economic diversification, oil and gas extraction remains the main engine of Algeria's economy. Between 2018–22, the hydrocarbon sector on average accounted for 19 percent of GDP, 19 percent of GDP in exports (92 percent of total exports), and 12.3 percent of GDP in fiscal revenue (43 percent of total budget revenue) (Text Figure 2). The sector's indirect effects on the economy include, for example, spillovers to other sectors such as construction, transport, and banking. Large budget hydrocarbon revenue has enabled the public sector to play a key role in driving economic activity through spending on investment, employment, and social transfers.

14. The global economy is expected to be gradually shifting away from fossil fuels. While the near-term developments in global energy markets may reflect concerns about energy security, consumption of hydrocarbons and other fossil fuels are expected to grow more slowly and

ultimately to decline, over the next decades (BP 2023, IEA 2022, OPEC 2022).[5] Lower use of fossil fuels would drive a durable decline in international oil and gas prices in the long run.

15. However, the short- to medium-term trajectory of hydrocarbon prices is surrounded by uncertainty regarding the relative adjustment of global supply and demand. If the decline in demand for fossil fuels outpaced the phasing out of supply, hydrocarbon prices would likely fall relatively fast as competition among producers intensifies. Conversely, if supply is wound down faster than demand, then prices could surge, at least temporarily. This could happen, for example, if uncertainty about future consumption were to lead to underinvestment in production, or it could be due to regulatory restrictions (Boer and others 2023). Amid such high uncertainty, oil and gas markets are expected to become more volatile (IMF 2022a).

16. Global decarbonization trends would pose risks to Algeria's public sector-led growth, which has been fueled by reinjecting hydrocarbon revenue into the economy. As the world decides to shift away from fossil fuels, Algeria may be confronted with:

- ***A gradual decline in hydrocarbon revenue, albeit with some upside risks as well.*** The projected structural decline in hydrocarbon prices would reduce export and fiscal revenue and put pressure on external and public finances. However, there are also mitigating factors. Algeria's relatively low oil production cost (estimated around US$20 per barrel of oil) would enable it to maintain market share should prices fall fast.[6] Algeria could also benefit from temporary upswings in hydrocarbon prices, as discussed above. Finally, the country could benefit from a rise in demand for gas as the world shifts away from more GHG-intensive fossil fuels such as coal or external partners aim to maintain energy security in the context of current geopolitical tensions.[7]

- ***Increased revenue volatility and uncertainty.*** Higher uncertainty about future demand and volatility in oil and gas prices, and thus of hydrocarbon revenue, would complicate budget planning and the management of the hydrocarbon sector. A decrease in the appetite for risk-sharing from foreign partners through financing and co-investment (Bogmans and others 2023) could push the cost of capital for hydrocarbon investment higher, weaken technology transfers, and lower the profitability of domestic hydrocarbon producers.

- ***Stranded assets.*** Major assets might lose value or be decommissioned early. Such assets include oil and gas reserves that might not be extracted due to regulatory constraints or lack of commercial viability but also related infrastructure (rigs, gas liquefication plants, pipelines, roads,

[5] For instance, under the International Energy Agency's "Announced Pledges Scenario" (APS) which assumes that governments will meet all their announced climate targets, global consumption of oil is projected to decline by 0.6 percent by 2030 and by 39 percent by 2050, relative to its 2021 level, while consumption of natural gas would drop by 7 percent by 2030 and by 45 percent by 2050 (IEA 2022). Under the "Stated Policies Scenario", hydrocarbon consumption would increase through the 2030s, but at a slower pace than recent trends.

[6] The country-level operational cost of production per barrel is proxied by average of well-level breakeven price weighted by actual production, based on data from Rystad Energy.

[7] Algeria has around 2.3 trillion cubic meters of proved natural gas reserves, according to the Energy Institute. It also has a huge untapped potential in shale gas and is estimated to harbor ten percent of the world total recoverable shale gas resources, second only to China and Argentina (EIA 2023).

ports). A large share of these assets is likely to be concentrated in the public sector as the bulk of Algeria hydrocarbon production, refining, and sale is undertaken by SOEs.

17. The introduction of the carbon border adjustment mechanism (CBAM) in the European Union (EU), Algeria's main export market, could affect the competitiveness of Algeria's non-hydrocarbon exports.[8] Algeria's export diversification strategy has so far mostly relied on energy-intensive sectors such as fertilizers, iron and steel, and cement, capitalizing on its comparatively low fossil fuel costs. Exports of the three categories of products reached US$4.3 billion in 2022, or 1.9 percent of GDP and about 72 percent of non-hydrocarbon exports. The three sectors are included in the initial phase of the EU's CBAM, increasing production costs for Algeria's manufacturers with possible implications for their competitiveness.

CURTAILING ALGERIA'S DOMESTIC GHG EMISSIONS

18. Algeria's domestic GHG emissions are small by global standards but have been rising rapidly. Algeria accounts for about 0.6 percent of global GHG emissions. Its annual GHG emissions increased by 65 percent over the last two decades, in line with the growth in MENA's total emissions (68 percent) but much faster than in other emerging and developing economies (IMF 2022b) (Figure 3). Emissions of carbon dioxide (CO2) and other GHGs excluding methane more than doubled over the period. Emissions of methane (accounting for one third of Algeria's total GHG emissions) increased by 17 percent, a slower pace than other GHGs, amid moderate growth in hydrocarbon production volume and some progress on reducing gas flaring.[9] However, the flaring intensity of Algeria's hydrocarbon production remains high and Algeria still ranks as the fourth-largest gas flaring country in the world (World Bank 2023).

[8] A Carbon Border Adjustment Mechanism (CBAM) is a charge on the carbon emissions embedded in certain goods imported into a market where carbon pricing is implemented. It aims at addressing competitiveness and leakage issues arising from the implementation of a domestic carbon pricing. The EU's CBAM will come into full force in 2026.

[9] Methane is a potent greenhouse effect gas often generated by agriculture, energy production and waste management. According to ClimateWatch data, around three fourths of methane emissions in Algeria are from fugitive emissions associated with hydrocarbon extraction, including from leakages and flaring.

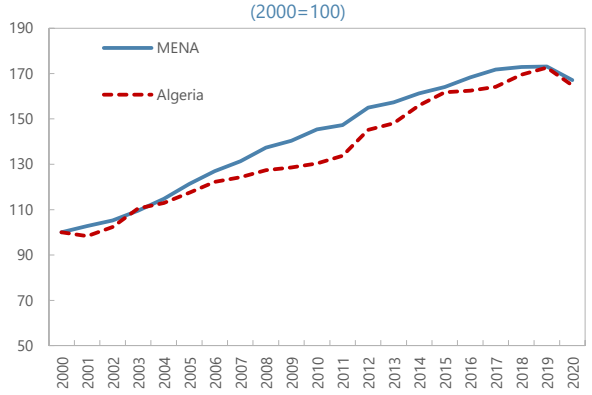
Figure 3. Algeria: Emissions of Greenhouse Gases (GHG)

Annual GHG emissions in Algeria have risen by 65 percent in two decades.

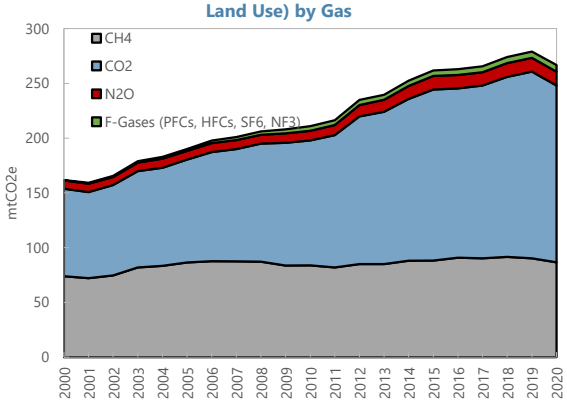
Emissions of CO2 and other GHGs excluding methane more than doubled over the period.

A. Total GHG Emissions excluding Land Use in Algeria and MENA

(2000=100)

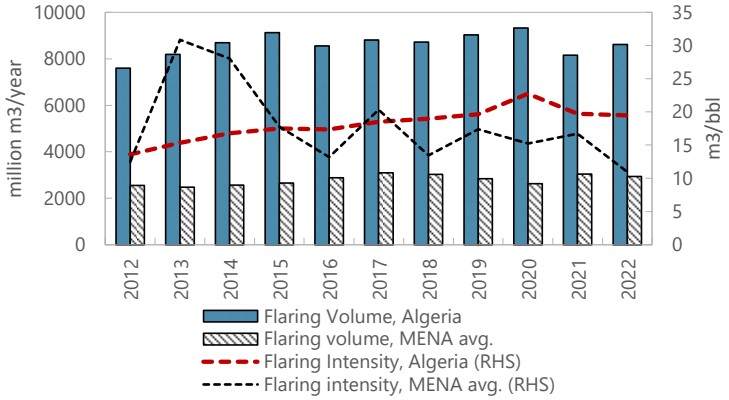


B. Algeria: Historical GHG emission (Total excluding Land Use) by Gas



Despite some progress on reducing gas flaring, flaring intensity in Algeria remains comparatively high.

C. Gas Flaring from Hydrocarbon Extraction

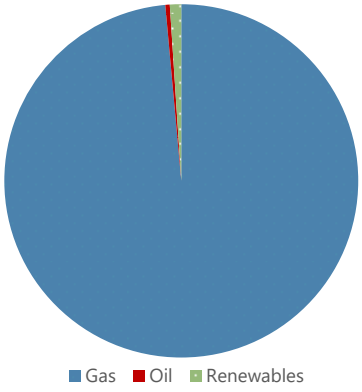


Note: Flaring intensity is the volume of gas being flared per unit volume of hydrocarbons being produced

Sources: Climate Analysis Indicators Tool (CAIT); World Bank; and IMF Staff Calculations.

19. The rise in Algeria's GHG emissions has been driven by economic and demographic growth and rising energy intensity of economic activity (Figure 4). Algeria's population has increased by around 46 percent since 2000 while real GDP per capita rose by 29 percent between 2000 and 2021. Meanwhile, the increase in energy intensity of growth has risen by 22 percent, amid structural shifts in the economy such as rapid urbanization with high access to electricity, and rapid expansion of energy-intensive industrial sectors such as cement, fertilizers, and metal production. Continued reliance on natural gas for nearly all of Algeria's power generation (Text Figure 3) has resulted in little improvement in the emission intensity of energy. The drivers of the fast rise in Algeria's GHG emissions are likely to be persistent, requiring strong policy action to achieve the government's emission reduction goals (see ¶21).

Text Figure 3. Algeria: Electricity Generated by Source (TWh), 2019



Sources: Carbon Price Assessment Tool (CPAT).

A. Algeria's Climate Strategy

20. The Algerian authorities have developed a comprehensive strategy to respond to the challenges brought about by climate change. A Nationally Determined Contribution (NDC) was submitted to the United Nations in 2015.[10] The National Climate Plan (approved in 2021) lists some 155 actions for the mitigation of and adaptation to climate change. The 2021 Government Action Plan (PAG) and the 2021 White Book on the Impact of Climate Change in Algeria also includes various climate actions and plans.

Mitigation

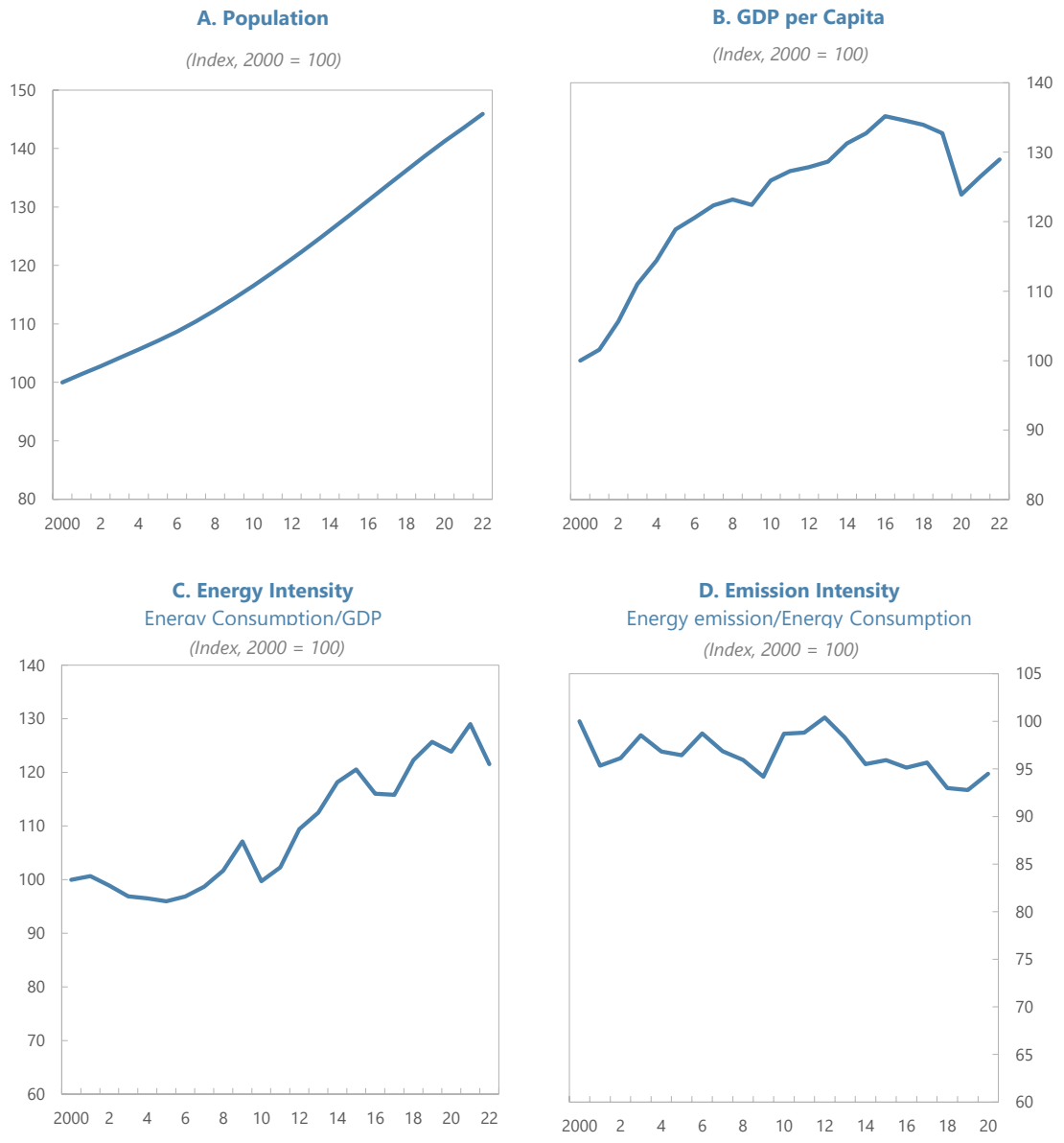
21. The Algerian authorities aim to curtail domestic GHG emissions. The authorities' NDC includes a pledge to reduce carbon emissions by seven percent by 2030 relative to a business-as-usual (BAU) scenario and aims to achieve this target by using Algeria's national resources. The Algerian authorities pledged to reduce emissions by a further 22 percent, conditional on support from foreign partners in terms of financing, technology transfer, and capacity building.

[10] Under the 2015 Paris agreement, countries are required to prepare nationally-determined contributions (NDCs), i.e. national policy documents outlining climate actions to curtail emissions of greenhouse gases and adapt to the impact of climate change. NDCs should be communicated to the UN Framework Convention on Climate Change every five years

Figure 4. Algeria: Kaya Decomposition of GHG Emissions Growth

*The **Kaya identity** decomposes GHG emissions into the product of population, GDP per capita, energy intensity of economic activity and emission intensity of electricity generations, as follows:*

Energy emissions (GHG) ≡ population x GDP/population x Energy consumption/GDP x Energy emissions/energy consumption



Methane emissions are excluded as these are not driven by the factors included in the Kaya identify, and they often do not result from the consumption of fossil fuels. In Algeria, most methane emissions are associated with hydrocarbon extraction, which has remained roughly stable during 2000–20.

Sources: WEO; World Bank; Climate Analysis Indicators Tool (CAIT); and IMF Staff Calculations.

22. The authorities have identified a range of policy measures to achieve the emission reduction goals. The climate strategy includes regulatory measures, policy incentives, and public investment projects to encourage energy conservation (with the aim of reducing national energy consumption by nine percent by 2030 relative to the average of the previous decade), promote the use of less carbon-intensive fuels, and enhance carbon sequestration. These efforts will focus on priority sectors including energy, forestry, housing, industry, transport, and waste management. To reduce the hydrocarbon sector's CO2 footprint, the authorities plan to bring down the share of gas flared into the atmosphere to less than one percent and to upgrade the upstream infrastructure to limit damages to the environment. The authorities also plan to enhance the measurement and monitoring of GHG emissions from hydrocarbon extraction.

23. Ambitious investment goals in renewable energy would curtail emissions and promote economic growth and diversification. Renewable energy currently accounts for about two percent of Algeria's electricity generation capacity. The authorities plan to harness the country's potential in photovoltaic, wind, and geothermal power to raise the share of renewables in energy production to 27 percent by 2030. They also aim to build renewable electricity supply capacity of 15,000 megawatts (MW) by 2035, mostly from solar energy. Most of these investments will be undertaken by SOEs with tenders already launched for a cumulative 2,000 MW. These additional capacities in renewables would also support the authorities' plans to develop a green hydrogen industry under their strategy to diversify away from hydrocarbon fuels.

Adaptation

24. Algeria's climate strategy emphasizes water security as a priority of its adaptation policies. The authorities are planning large investments in (i) *desalination* plants to nearly double production capacity to 1.5 billion m3 per year in 2024 and ultimately raise it to two billion m3 (sufficient to cover 60 percent of drinkable water needs); (ii) *dam infrastructure* to expand aggregate storage capacity to nine billion m3 in 2024 (from 8.3 billion m3 in 2021) and enhance reservoir interconnectedness; (iii) optimizing the use of *underground water resources,* particularly in the Northern Sahara region; and (iv) *recycling* industrial and agricultural wastewater. Upgrading the distribution network would reduce leakages, which currently amount to around 40 percent of supply according to government estimates. In parallel, the authorities will reinforce water conservation through actions such as the installation of waterflow meters at all points-of-use, incentives for water efficient industrial processes, the installation of water saving equipment in large public buildings, and public awareness campaigns.

25. Ensuring food security by strengthening the resilience of the agricultural sector is another key priority. Algeria has trebled the irrigated agricultural area since 2000; it now accounts for 17 percent of the utilized agricultural area (UAA). Investment plans are under preparation to extend both the irrigation network and the UAA. The government encourages water-efficient irrigation techniques such as dripping (which now cover around 45 percent of the irrigated agricultural area, according to official estimates). Several measures aim at increasing agricultural yields, including by deploying climate-resilient crop varieties and improving phytosanitary processes. The planned establishment of an insurance mechanism against agricultural disasters and

the creation of a sectoral social protection system would help shield farm households against climate shocks.

26. The authorities plan to step up data collection and monitoring of climate-related risks. Early alert systems will be developed and disaster management frameworks reinforced, including by enhancing local government capacities.

B. Fiscal Policy Measures to Address the Challenges From Climate Change

27. Fiscal reforms are a crucial policy tool for Algeria to build resilience to the impact of climate change and achieve its climate goals. This section discusses a range of such fiscal reforms including: (i) energy subsidy reform, alongside a spending package to compensate low-income populations and sectoral fiscal interventions such as feebates and targeted subsidies for renewable energy; (ii) reforms to strengthen management of public investment and public finances more broadly; (iii) elaboration of a medium-term budget framework and stronger management of fiscal risks.

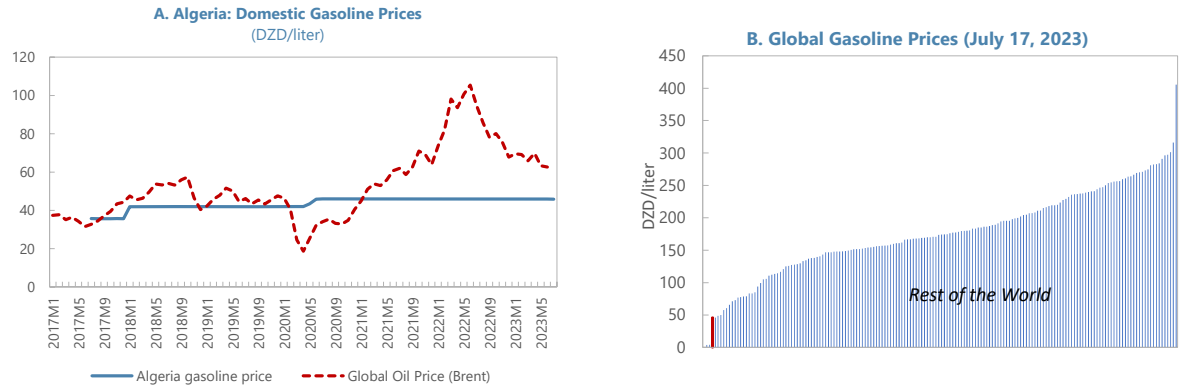
Energy Subsidy Reform

28. In Algeria, domestic energy prices are among the lowest in the world, reflecting onerous universal subsidies (Figure 5). The prices of gasoline, diesel, and electricity were more than 60 percent below cost-recovery levels in 2023, while those of natural gas and liquified petroleum gas were more than 90 percent below cost recovery levels, based on IMF staff's estimates using the Climate Policy Assessment Tool (CPAT) developed by IMF and World Bank staff.[11] The Algerian authorities estimate that the cost of these implicit subsidies (foregone budget revenue) was about 10.7 percent of GDP in 2021.[12]

[11] CPAT is a spreadsheet-based model jointly developed by IMF and World Bank staff. It provides projections of fuel consumption and GHG emissions for major sectors in 188 countries. The model assesses the impact of a range of mitigation policy instruments based on their proportionate impacts on fuel prices and price responsiveness of fuel use in each sector. The model is widely used in IMF surveillance, cross-country analysis, and technical assistance.

[12] In Algeria, state-owned enterprises (SOEs) dominate the domestic oil and gas supply chain of extracting, producing, and selling hydrocarbons, and, if needed, import-derived products to domestic end-users. Transactions are made at administered prices well below cost recovery levels. Natural gas for power generation is also sold below cost-recovery levels to the public electricity company which, in turn, supplies electricity to consumers at subsidized prices. Annual on-budget spending on the subsidies of electricity, gas, and water desalination is about 0.5 percent of GDP. However, the bulk of the fiscal cost of subsidies are implicit (off-budget) through foregone taxes, royalties, and dividends from hydrocarbon extraction and sales. The government has also occasionally made transfers to SOEs in the energy sector to offset the cost of subsidies, for example on imported fuel products.

Figure 5. Algeria: Gasoline Prices



Sources: Haver; Global Petrol Prices; and IMF Staff Calculations.

29. Universal hydrocarbon subsidies encourage excessive consumption of fossil fuels and are inefficient. They disincentivize energy conservation and low-carbon technologies, contributing to high energy intensity of economic activity and increased GHG emissions. Setting power prices below cost-recovery levels limits the commercial viability of renewable energy projects, putting the burden of investment in green energies on the public sector alone. What is more, even though energy subsidies support the purchasing power of all households, they tend to be regressive by benefiting high-income households more than low-income ones (IMF 2013).

30. The authorities are considering reforms to the subsidy system. Algeria's 2022 budget law included plans to gradually phase out universal subsidies and replace them with a targeted cash compensation mechanism to support households. A new law on the power sector is also under preparation.

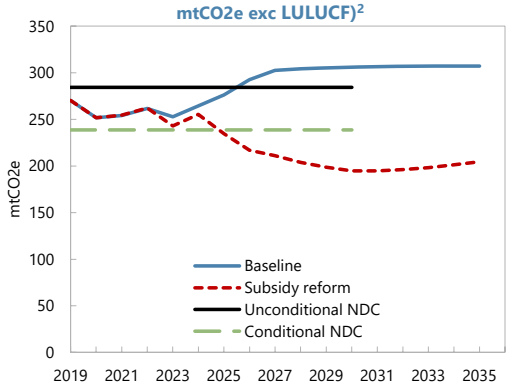
31. Staff analysis suggests that subsidy reform could reduce GHG emissions by a third compared with a business-as-usual scenario. Staff's analysis is based on the CPAT model (Annex I). The application of this stylized model calibrated to the Algerian context suggests that a gradual adjustment (over six years starting in 2024) of prices for gasoline, diesel, electricity, natural gas, and liquified petroleum gas towards the estimated supply cost could reduce GHG emissions by over a third by 2030, relative to the business-as-usual (BAU) scenario (Figure 6). Even a partial narrowing by one third of the price gaps on such products could reduce emissions by 22 percent by 2030 (Figure 7). Such reductions in GHG emissions could also have virtuous knock-on effects from less air pollution, better health and mortality outcomes, and efficiency gains from reduction in traffic congestion. While these estimated outcomes are encouraging, it is important to note that the CPAT model is highly stylized and therefore its results depend on a range of assumptions and parameters, including the elasticity of demand to higher prices and the availability of alternative energy sources (such as renewables). Even so, the impact of subsidy reform may be expected to be sizeable, as suggested by the model.

Figure 6. Algeria: CPAT Simulations of the Impact of the Full Elimination of Fossil Fuel Subsidies[1/]

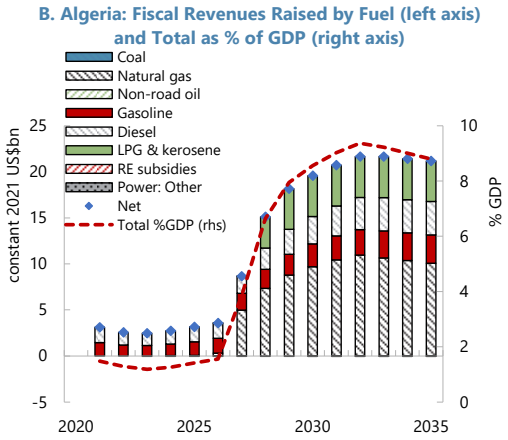
Full elimination of energy subsidies would reduce GHG emissions by one third relative to a BAU scenario by 2030.

The reform would generate additional fiscal revenue of eight percent of GDP on average per year.

A. Algeria: GHG Emissions vs. Paris Pledge ('NDC'; mtCO2e exc LULUCF)[2]



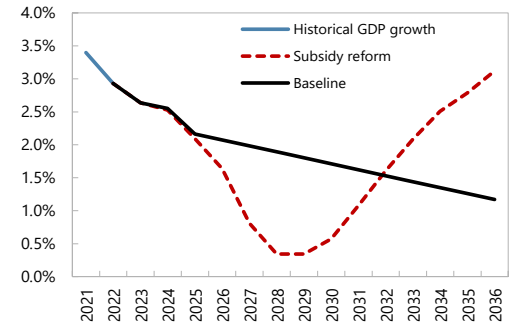
B. Algeria: Fiscal Revenues Raised by Fuel (left axis) and Total as % of GDP (right axis)



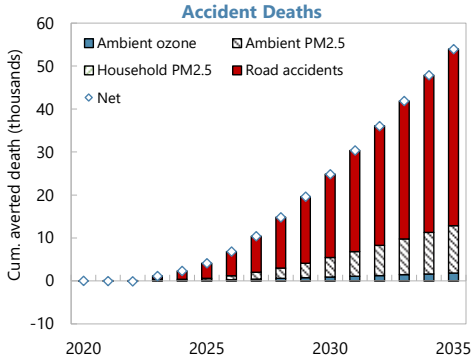
Rising energy prices would affect growth in the medium term, requiring remedial measures to support economic activity.

The reform would produce significant benefits in terms of averted deaths from better air quality and road safety.

C. Algeria: GDP: Annual Growth Forecasts (baseline and policy scenario)



D. Algeria: Co-benefits: Averted Air Pollution & Road Accident Deaths



Source: Climate Policy Assessment Tool (CPAT).

[1/] The subsidy reform scenario assumes full convergence of the administered prices of hydrocarbons and electricity to the estimated supply cost level. The reform is assumed to start in 2024 and be implemented over six years.

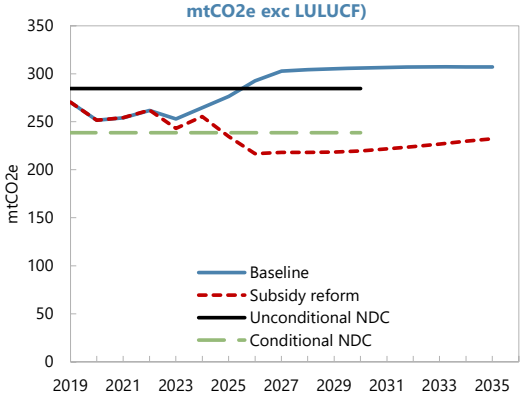
[2/] Metric tons of carbon dioxide equivalent (mtCO2); Land Use, Land-Use Change and Forestry (LULUCF).

Figure 7. Algeria: CPAT Simulations of the Impact of a Partial Elimination of Fossil Fuel Subsidies [1/]

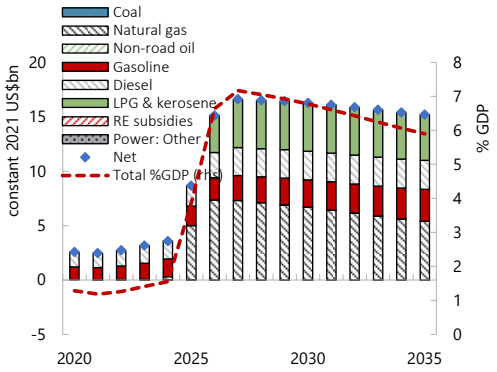
Partial elimination of fossil fuel subsidies would reduce GHG emissions relative to a BAU scenario by 22 percent by 2030.

The reform would generate additional fiscal revenue of six percent of GDP on average per year.

A. Algeria: GHG Emissions vs. Paris Pledge ('NDC'; mtCO2e exc LULUCF)



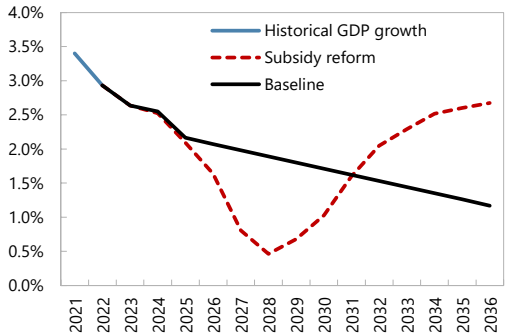
B. Algeria: Fiscal Revenues Raised by Fuel (left axis) and Total as % of GDP (right axis)



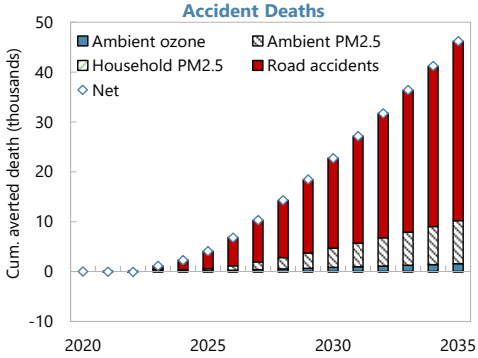
Rising energy prices would affect growth in the medium term, requiring remedial measures to support economic activity.

The reform would produce significant benefits in terms of averted deaths from better air quality and road safety.

C. Algeria: GDP: Annual Growth Forecasts (baseline and policy scenario)



D. Algeria: Co-benefits: Averted Air Pollution & Road Accident Deaths



Source: Climate Policy Assessment Tool (CPAT).

[1/] The partial subsidy reform scenario assumes a gradual elimination of one third of the existing gap between the administered prices of hydrocarbons and electricity and the estimated supply cost level. The reform is assumed to start in 2024 and be implemented over six years.

32. Energy subsidy reforms would create fiscal space for priority budget spending including compensation measures that mitigate their social and economic impact and building resilience to climate change. Staff estimates that average annual fiscal revenue of seven percent of GDP could be generated over the next decade if the fossil fuel price gap were reduced by one third.[13] Full elimination of fossil fuel subsidies would bring in additional annual budget revenue of eight percent of GDP.[14] Part of these savings should be used to:

- ***Support low-income households.*** Even as subsidies benefit high-income households disproportionately, they still support the purchasing power of low-income households. A portion of the savings accruing from the subsidy reform could be used to offset the social impact of the energy price increase, for example through a targeted cash transfers mechanism to low-income households, as envisaged in Algeria's 2022 budget. Developing the public transport network or reducing the cost of access to public services such as health or education would also help moderate the impact of the reform on low-income households.

- ***Protect firm competitiveness in priority sectors.*** The rise in energy prices would increase costs in energy-intensive sectors such as cement and metals which are important drivers of Algeria's diversification strategy, as well as in agriculture and fisheries. Fiscal measures could be adopted to protect competitiveness in these sectors without undermining mitigation incentives, for instance through cuts to distortionary taxes. For example, the labor tax wedge is comparatively high in Algeria according to IMF staff estimates. Reducing the tax wedge in line with past IMF advice would help boost competitiveness while also discouraging informality.

- ***Invest in the foundations of strong, resilient, and sustainable growth and job creation.*** Public investment in network infrastructure (for example to upgrade power grids) can crowd-in private investment and support the development and diffusion of green technologies. Investing in human capital, for example by further improving the quality of and access to education and health services, would bolster productivity and resilience to climate change.

- ***Build a fiscal saving buffer.*** A portion of the additional revenue could be saved to make the medium-term fiscal path more resilient to shocks, including by reducing fiscal deficits or by supporting the build-up of a fiscal asset buffer to cushion volatility in hydrocarbon revenue and other sources of macroeconomic shocks (see also below).

Incentives to Accelerate the Energy Transition

33. Phasing out subsidies would make investment in renewables more attractive for private investors, help mobilize FDI, and facilitate technology transfer. To spur private

[13] The business-as-usual (BAU) scenario assumes that administered retail fuel prices in Algeria will remain constant in real dinar terms (that is, they will be adjusted in line with inflation) over the projection horizon. This may be a relatively conservative assumption given the irregular frequency of adjustments to administered fuel prices in Algeria which has led to an erosion of their real value in recent years.

[14] The increase in fiscal revenue is less than proportional to the share of subsidies that is eliminated as fossil fuel demand is assumed to adjust in response to the rise in prices, partly offsetting the reform's impact on fiscal income.

investment in renewables, subsidy reform should be complemented with business climate reforms to create a competitive and well-regulated energy market.

34. Sectoral fiscal interventions could accelerate the transition to lower carbon energy sources. Green taxes such as those on heavily polluting activities or plastic bags have been introduced in Algeria in the early 1990s. They can be extended and completed by measures such as:

- *Feebates.* Feebates are effective in promoting the use of energy-efficient and low-carbon technologies in sectors such as transport or manufacturing. They are sliding scales of fees and rebates (subsidies) on products and activities whose average emissions (or energy consumption) are respectively above or below defined critical thresholds. Feebates can be designed to be almost revenue-neutral, do not raise the average tax burden which increases their acceptability, and have low administrative costs (Parry 2021). For example, feebates could be included in the car registration system or applied to the sales of home appliances as well as to emissions by carbon-intensive industries and large farms.

- *Incentives for renewable energies*. Transitory incentives for renewable energy generation such as subsidies (tax credits, accelerated depreciation, low interest loans) or feed-in tariffs (guaranteed prices) can promote the shift from fossil fuels to cleaner energies (Krupnick and Parry 2012). When considering such subsidy measures, the authorities should properly assess their costs and benefits (IMF 2008) and calibrate them to available fiscal space. They should also put in place strong governance mechanisms, make them time-bound, and ensure that they are compliant with international trade agreements (IMF 2023).

Boosting the Green and Growth Dividends of Public Spending

35. Climate change poses a challenge for the management of public investment, raising the need for robust planning and governance frameworks. First, given their long lifecycle, infrastructure projects that will be undertaken in the near term will be exposed to increased risks from climate change over the coming decades. Thus, a climate-related forward-looking approach is needed for the appraisal and selection of public investment projects, both to lessen these risks and make sure that low-carbon and climate-resilient projects are undertaken (Aydin and others 2022). Second, public investment in climate-resilient infrastructure raises a debt-growth tradeoff, weighing large upfront costs against benefits that are difficult to estimate *ex ante* and materialize only in the long run (Aligishiev and others 2022). These challenges call for adequate planning and selection of adaptation projects, based on thorough cost-benefit analysis which considers their social and distributive impact (Bellon and Massetti 2022).

36. Strengthening Algeria's public investment management framework would support efficient investment in adaptation. There is room to improve Algeria's investment management framework as evidenced by comparatively low physical access and quality of infrastructure despite a relatively large public capital stock and consistently high public capital spending (IMF 2022a). Addressing these weaknesses could increase the return on public investment in adaptation and other areas. The IMF's Public Investment Management Assessment (C-PIMA) may help the authorities to identify priority reforms to strengthen public investment institutions and processes. It

includes a climate dimension which focuses on areas for improvement to strengthen the management of investment in climate-resilient infrastructure.

37. More broadly, better integration of climate policies into public financial management would support Algeria's climate efforts at little additional costs (IMF 2022). In particular, the authorities could:

- *Integrate climate priorities into budget preparation.* Climate priorities are currently not explicitly incorporated in the key documents underpinning the budget preparation process (such as, for example, the presentation report of the budget law). Including the climate dimension into budget guidelines would highlight its importance to policy makers and encourage public administrations to incorporate it in their own resource allocation processes. Budget guidelines could also require an assessment of the climate implications of new budget measures and their alignment with the government's climate strategy.

- *Leverage public procurement.* The integration of climate priorities into the public procurement process can help reduce the environmental impact of the public sector and encourage its suppliers to contribute to mitigation and adaptation efforts. A recently approved law on public procurement in Algeria mandates taking into consideration the conservation of the environment and sustainable development in public procurement. It also sets out criteria related to environment protection and for the use of renewable energies in tender specifications.

Box 2. Fiscal Reforms to Enhance Water Use Efficiency

Algeria's indicators measuring the efficiency of water use efficiency are lower than in regional and income-level peers (Box 2 Figure 1). In the agricultural sector which accounts for the bulk of water withdrawals, water use efficiency compares unfavorably to regional peers but has improved in recent years as the government implemented various measures to streamline consumption, for example by offering subsidized access to water-saving irrigation equipment.

Furthermore, Algeria's share of water production that is not billed to customers is one of the highest in the MENA region (de Waal and others 2023). This could indicate the presence of large physical losses due to leakages or be associated with commercial losses, for example from meter inaccuracies or fraudulent behaviors.

It is crucial to improve the efficiency of water use in order to balance demand and supply and build resilience to climate change. Fiscal reforms that could be effective in this regard include:

- *Adequate water tariffication.* Algeria's tiered water tariffication structure subsidizes all tranches, setting prices at only a fraction of supply costs. Tariffs do not reflect the social value of water as a scarce resource. Raising water tariffs towards cost-recovery levels while maintaining a progressively tiered tariff structure would help rationalize demand, reduce waste, and create incentives to use water more efficiently (Kochhar and others 2015). Prices could be still differentiated by consumption level, with lower price blocks guaranteeing affordable and equitable access to households, and particularly low-income ones, while the upper price tranches would aim at penalizing excessive demand. In line with past IMF advice, prices could also be differentiated by geographic areas or type of users, for example with higher tariffs for users in the tourism or industrial sectors. The fiscal savings from higher tariffs could be rechanneled towards investment to boost supply, upgrade the water grid, and improve the quality of

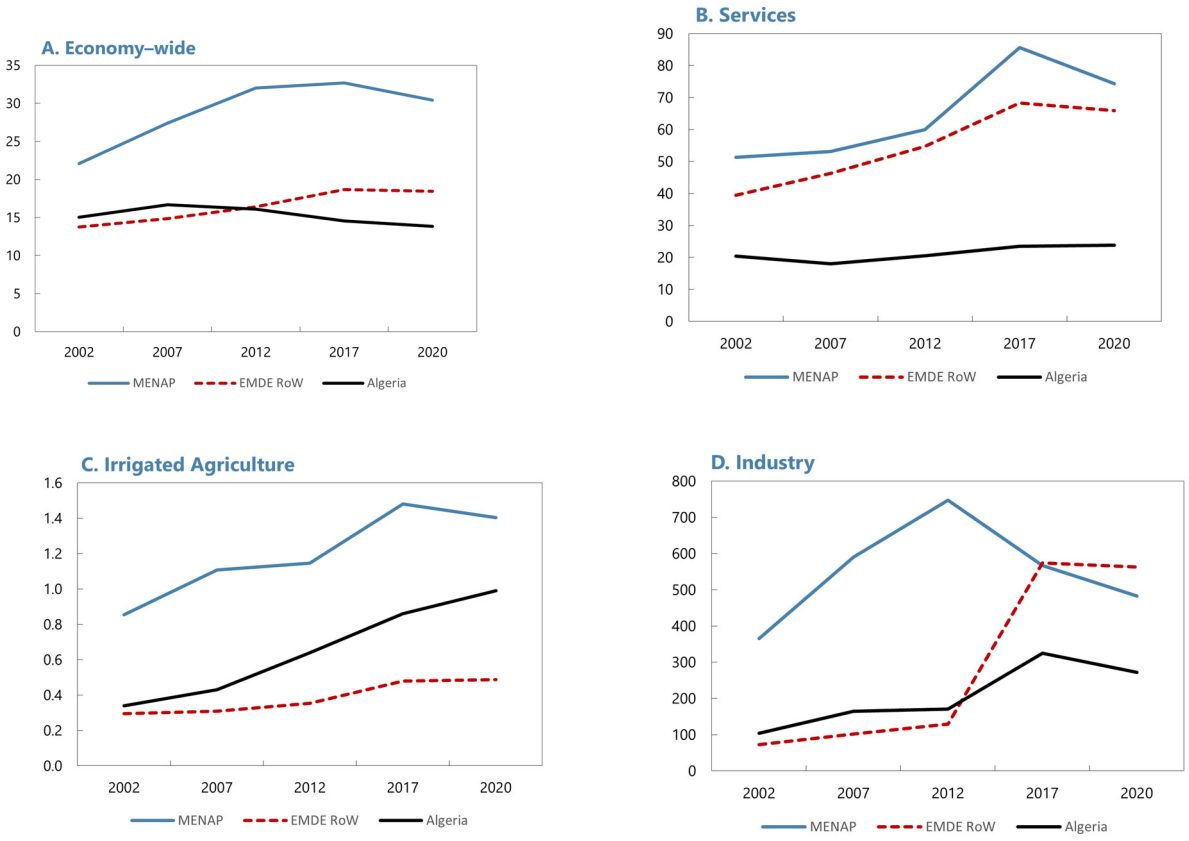
Box 2. Fiscal Reforms to Enhance Water Use Efficiency (concluded)

service. Technical assistance from the IMF could help prepare this reform and identify measures to mitigate its distributional impact.

- *Energy subsidy reform*. Underpricing of electricity, diesel, and gasoline reduces the cost of pumping and encourages overexploitation of underground aquifers and excessive irrigation. Phasing out energy subsidies (as discussed in section D) would incentivize efficiency.
- *Institutional reforms***.** Water supply in Algeria is mostly undertaken by state-owned utilities which rely on fiscal transfers to balance their budget. Alongside adequate tariffication, corporate governance reforms could improve the cost efficiency of these utilities and their financial performance, enhancing their ability to ensure supply sustainability and respond to aggravating water scarcity while minimizing the burden for the budget.

The effectiveness of such fiscal reforms also requires various complementary policy actions, including, for example, regulatory reforms and stronger monitoring and controls of consumption. Reform in water-intensive sectors such as agriculture can encourage the allocation of water resources to their most productive uses.

Figure 1. Water Use Efficiency (U.S dollars per m3)



Note: The water efficiency indicator represents the value added in USD per m3 of water used.

Source: FAO AQUASTAT.

REINFORCING FISCAL AND SOCIAL RESILIENCE

38. A medium-term fiscal framework could help Algeria to navigate the increased volatility of hydrocarbon revenue and preserve fiscal sustainability. Previous analysis by IMF staff has concluded that a well-calibrated fiscal buffer would help cushion Algeria's public finances against hydrocarbon price shocks and maintain space for countercyclical fiscal policies (IMF 2022a). This buffer could be constituted under dual-pillar framework combining (i) a *debt anchor* requiring to keep government debt below a certain level, and (ii) a floor on *fiscal savings* constituted trough an oil price-smoothing rule.

39. In parallel, continued progress on tax reforms would reduce Algeria's budget dependence on hydrocarbon revenue and create space for priority spending, including in adaptation and social protection. The authorities aim to enhance tax revenue mobilization through tax policy and administrative reforms. Continuing and intensifying these efforts in line with IMF advice would help prepare Algeria's budget for the projected structural decline in the global use of hydrocarbons. Economic diversification would also help mobilize non-resource taxes.

40. Strengthening fiscal risk management would support the resilience of public finances to shocks and other disruptions from climate change. The Committee for the assessment of fiscal risks (*"Haut Comité d'Alerte et d'Évaluation des Risques Budgétaires"*) at the Ministry of Finance plans to map key fiscal risks in Algeria. Establishing a holistic framework to analyze, disclose, and manage fiscal risks would help Algeria's response to the challenges from climate change (as well as from other sources of macroeconomic shocks). The analysis of the exposure and vulnerability of Algeria's public finances to climate shocks could build on a backward-looking assessment of past occurrences and a forward-looking analysis of the implications of climate change. The Committee could prepare a risk statement that is included in the draft budget, and its analysis and policy advice could inform contingency planning (Aydin and others 2022). Incorporating climate considerations in the upcoming law on Private-Public Partnerships (PPPs) would help establish appropriate risk sharing between the State and investors.

41. Fiscal reforms could help build social resilience to climate shocks. For example, the cash transfer mechanism which is envisaged by the authorities in replacement of universal subsidies could be leveraged to provide targeted support to communities affected by climate disasters such as droughts. The continuation of tax reforms to incentivize job formalization, particularly in climate-sensitive sectors such as agriculture, would support households' ability to weather income shocks through better access to social safety nets and financial services.

SUMMARY OF POLICY RECOMMENDATIONS AND CONCLUDING REMARKS

42. Fiscal policies are key elements of Algeria's toolkit to tackle the challenges associated with climate change. This paper discussed a set of fiscal reforms that could help Algeria achieve its climate goals and build resilience to the impact of climate change. Energy subsidy reform accompanied by a well-designed spending package and sectoral fiscal interventions such as feebates would allow Algeria to reduce its GHG-emissions as envisaged in its NDC and catalyze the development of renewable energy. These reforms would create fiscal space for investment in building resilience to climate change and targeted social assistance. In parallel, reforms to strengthen public finance management would help to improve the growth and climate impact of public spending without raising additional budget costs. Lastly, a medium-term budget framework and stronger management of fiscal risks would support the sustainability of public finances and macroeconomic stability in the medium term.

43. Climate change is a cross-cutting issue and other climate policy actions should supplement fiscal reforms. Mainstreaming climate change considerations across all sectoral policies would contribute to an effective and comprehensive national strategy to build climate resilience. Developing green finance mechanisms would encourage sustainable projects and innovations. Business climate reforms are crucial to create an environment conducive to investment in green technologies and sustainable practices. Public awareness campaigns could contribute to broad ownership of climate policies. Continuing and intensifying engagement in international cooperation on climate issues would help mobilize external financing for climate investment, facilitate technology transfer and shape a coordinated global response to the formidable challenges raised by climate change.

Annex I. The Climate Policy Assessment Tool (CPAT)

1. The Climate Policy Assessment Tool (CPAT) allows for the rapid quantification of impacts of climate mitigation policies, including on energy demand, prices, emissions, revenues, welfare, GDP, households and industries, local air pollution and health, and many other metrics. The tool provides, on a country-by-country basis for about 200 countries, projections of fuel use and CO_2 emissions by major energy sector.[1] This tool starts with use of fossil fuels and other fuels by the power, industrial, transport, and residential sectors[2] and then projects fuel use forward in a baseline case using:

- GDP projections;[3]
- Assumptions about the income elasticity of demand and own-price elasticity of demand for electricity and other fuel products;
- Assumptions about the rate of technological change that affects energy efficiency and the productivity of different energy sources; and
- Future international energy prices.

In these projections, current fuel taxes/subsidies and carbon pricing are held constant in real terms.

2. The impact of carbon pricing on fuel use and emissions calculated in the model depend on: (i) their proportionate impact on future fuel prices in different sectors; (ii) a simplified model of fuel switching within the power generation sector; and (iii) various own-price elasticities for electricity use and fuel use in other sectors. For the most part, fuel demand curves are based on a constant elasticity specification.

3. The basic model is parameterized using data compiled from the International Energy Agency (IEA) on recent fuel use by country and sector.[4] GDP projections are from the latest IMF forecasts.[5] Data on energy taxes, subsidies, and prices by energy product and country is compiled from publicly available and IMF sources, with inputs from proprietary and third-party sources. International energy prices are projected forward using an average of IEA and IMF (projections for coal, oil, and natural gas prices. Assumptions for fuel price responsiveness are chosen to be broadly consistent with empirical evidence and results from energy models (fuel price elasticities are typically between about -0.5 and -0.8).

[1] CPAT was developed by IMF and World Bank staff and evolved from an earlier IMF tool. For descriptions of the model and its parameterization, see the 2023 working paper: "*The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change*" available here: https://www.imf.org/en/Publications/WP/Issues/2023/06/22/The-IMF-World-Bank-Climate-Policy-Assessment-Tool-CPAT-A-Model-to-Help-Countries-Mitigate-535096

[2] International aviation and maritime fuels are excluded from the model and from computations of fossil fuel subsidies.

[3] GDP projections exclude the negative growth effects of global climate change.

[4] See IEA *World Energy Balances Dataset*. Any fuel consumption that could not be explicitly allocated to a specific sector was allocated apportioned based on the relative consumption by sector in a given country.

[5] A modest adjustment in emissions projections is made to account for partially permanent structural shifts in the economy caused by the pandemic.

4. Carbon emissions factors by fuel product are from IEA. The domestic environmental costs of fuel use are based on IMF methodologies.[6]

5. One caveat is that the model abstracts from the possibility of mitigation actions (beyond those implicit in recently observed fuel use and price data) in the baseline. Another caveat is that, while the assumed fuel price responses are plausible for modest fuel price changes, they may not be for dramatic price changes that might drive major technological advances or rapid adoption of technologies like carbon capture and storage or even direct air capture, though the future viability and costs of these technologies are highly uncertain.[7] In addition, fuel price responsiveness is approximately similar across countries—in practice, price responsiveness may differ across countries with the structure of the energy system and regulations on energy prices or emission rates. The model also does not explicitly account for the possibility of upward sloping fuel supply curves, general equilibrium effects (e.g., changes in relative factor prices that might have feedback effects on the energy sector), and changes in international fuel prices that might result from simultaneous climate or energy price reform in large countries. Parameter values in the spreadsheet are, however, chosen such that the results from the model are broadly consistent with those from more detailed energy models that, to varying degrees, account for such factors.

6. Finally, while the emissions abatement costs are broadly in line with those from many sophisticated 'general equilibrium' models, there are two limitations. First, they do not account for interactions between carbon pricing and distortions in the economy created by the broader fiscal system—a large literature shows that these interactions can on net decrease policy costs if the carbon pricing revenues are used to reduce an especially distortive tax.[8] Second, the costs above do not account for changes in international fuel prices from global mitigation which can result in transfers from energy producing countries to energy consuming countries.

[6] See Parry, Black and Vernon (2021) "Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies." Working paper 20/236, International Monetary Fund, Washington, DC.

[7] Marginal abatement costs are linearized beyond prices of $75 per ton—for example, if $75 reduces emissions in a country by 30 percent below BAU levels then a 50 percent reduction implies a marginal cost of $75 times 50/30. Alternative assumptions moderately affect the abatement cost and carbon price calculations for AEs.

[8] Parry (2021). "Carbon Taxation and The Paris Agreement." Oxford Research Encyclopedia of Economics and Finance, Oxford University Press

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