NDC ASPECTS

Country Report

Transition pathways for Iran

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Key messages

- Iran is a signatory to the Paris Agreement, while being one of the few countries that hasn't officially ratified the treaty. Iran is the largest GHG emitting country in this position, accounting for 2% of the total global emissions.
- The unconditional NDC target of Iran is reducing GHG emissions by 4% in 2030, compared to the business as usual (BAU) scenario, while it also has set the conditional target of 12% reduction of GHG emissions, in comparison to BAU. Iran has still not submitted a long-term target (LTT).
- The electrification of the Iranian economy and the deployment of renewable energy are necessary to significantly cut CO_2 emissions, improve energy efficiency and meet the goals of the Paris Agreement.

Introduction and Overview

This report provides information and analysis about the Nationally Determined Contributions (NDCs) of the Islamic Republic of Iran. In the document, we provide a general overview of Iran's current energy and emissions status, and explore climate mitigation scenarios for the future. Iran is one of the largest countries in the Middle East, and has significant geopolitical influence in the region and the world. As a founding member country of OPEC, Iran has significant financial interests in the fossil fuel industry, with its economy being dependent on oil and gas exports. This situation is challenging, and local policy makers need to balance between economic growth with a just transition towards sustainability.

Key socio-economic figures and outlook

Iran is classified as an emerging economy, having a GDP of USD '2010 420 billion in the year 2020. The country's economy is mostly comprised of the hydrocarbon supply, agricultural and services sectors, while a significant percentage of companies are state-owned. Furthermore, Iran is also one of the largest producers of fossil fuels, with huge oil and gas production and reserves. Consequently, hydrocarbons comprised approximately 55% of Iran's exports in 2022, for a total amount of USD 42.6 billions (OPEC, 2023). Due to the complex geopolitical situation of the Middle East, significant sanctions have been imposed on Iran, hindering its economic development. Nevertheless, the Iranian economy is expected to grow at an average annual rate of 3.1% by 2050, reaching approximately USD 1 trillion in 2050 (Figure 1). In addition, the country's population is expected to grow from 84 million in 2020, to around 100 million in 2050, hence Iran is currently ranked in the 17th place worldwide on population. The national GDP per capita is expected to grow at an average annual rate of 2.5% by 2050.

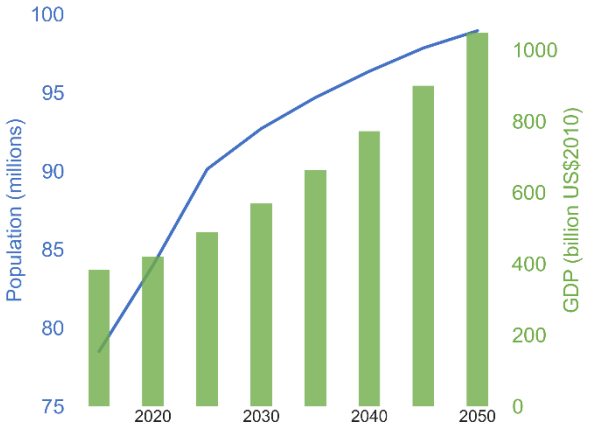

Figure 1: Iran's expected population and GDP development.

The Emission Situation of Iran in 2015

Iran is one of the major greenhouse gas (GHG) emitting countries, being consistently ranked among the top, with comparable emissions to Japan, Mexico and Saudi Arabia. As seen in Figure 2, the total GHG emissions of Iran were 912 MtCO2eq in 2015, when the Paris Agreement was initially adopted. The vast majority of those emissions were generated by the energy sector, amounting to 762 MtCO2eq, i.e. 83.6% of the total. The industry sector followed with 75 MtCO2eq and a percentage of 8.2%, while the agriculture sector was responsible for approximately 4.3% of total emissions, or 40 MtCO2eq. Finally, the waste sector emitted 35 MtCO2eq, which is equivalent to 3.9% of the total emissions. It should also be noted that emissions per capita amounted to 11.62 tCO2eq in 2015. Exploring the energy sector in more detail, we note that the Iranian electricity system was dominated by fossil fuels in 2015, accounting for 94% of the total electricity production (BP, 2020). More specifically, gas, oil and coal were used to generate more than 260 TWh of electricity, whereas renewable energy sources (RES) generated approximately 14 TWh. Considering the various RES types, hydropower was the most prominent (13.3 TWh), while solar, wind, geothermal and biomass only generated 0.3 TWh. It is also worth pointing out that nuclear power plants generated a considerable amount of energy at 3.6 TWh.

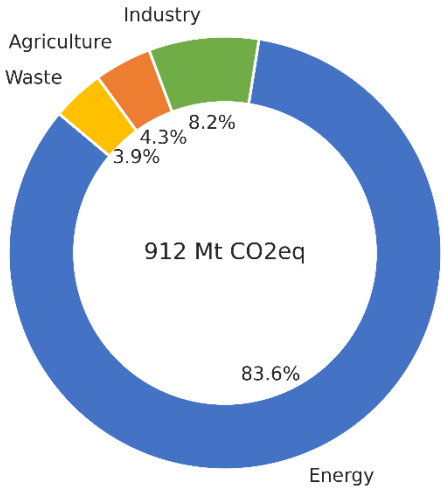

Figure 2: Iran's CO_2eq emissions by sector in 2015. Source: Potsdam Institute for Climate Impact Research (PIK).

The Current State of GHG Emissions

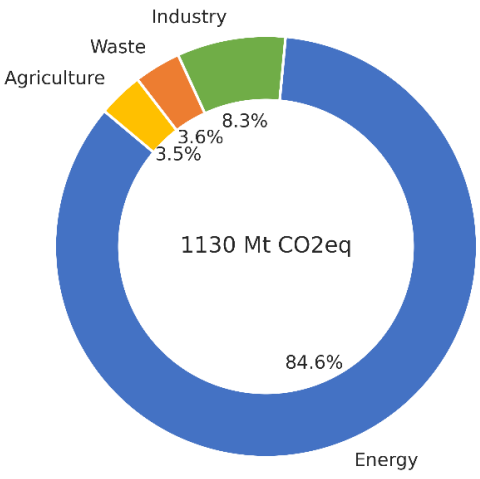

Figure 3: Iran's CO_2eq emissions by sector in 2022. Source: PIK

In the year 2022, Iranian greenhouse gas emissions amounted to 1130 MtCO2eq, a considerable increase of 24% compared to 2015. As seen in Figure 3, the sectoral emission distribution remained relatively unchanged, with emissions from the energy sector accounting for about 85% of total GHG emissions of Iran, for a total amount of 956 MtCO2eq. Furthermore, the share of industrial emissions remained stable at 8.3%, while agricultural emissions dropped slightly to 3.6%. Furthermore, emissions per capita increased to 13 tCO2eq, or approximately 12% higher compared to 2015. Hence, the country has made very limited progress in decoupling economic growth from greenhouse gas emissions since the adoption of the Paris Agreement. This raises some concerns about the Iranian government's commitment to reduce GHG emissions, and contribute meaningfully to climate change mitigation.

Nationally Determined Contributions of Iran

Iran is a signatory to the Paris Agreement, while also being one of the few countries that haven't officially ratified it. Notably, Iran is the largest GHG emitting country that hasn't ratified the treaty, and accounts for approximately 2% of global emissions. Nationally determined contributions (NDCs) are commitments made by individual countries with the purpose of reducing GHG emissions, and achieving the global targets specified in the Paris Agreement (UNFCCC, 2015). Countries that haven't ratified the treaty yet, did submit intended nationally determined contributions (INDCs), which are converted to NDCs upon the ratification. In November 2015, Iran submitted its INDC document, including details about the country's climate change mitigation efforts and plans. Specifically, the unconditional target of Iran is reducing its GHG emissions by 4% in 2030, compared to the business as usual (BAU) scenario, while also adopting a conditional target of 12% reduction of GHG emissions, compared to BAU (Iran, 2015). The conditions specified as a requirement for the ambitious conditional NDC target include the following: termination of economic sanctions, financial support and technology transfer, exchange of carbon credits, bilateral or multilateral implementation mechanisms and more.

Description	Unconditional Target for 2030	Conditional Target for 2030	Long-term Target
GHG Mitigation	4% reduction compared to BAU	12% reduction compared to BAU	N/A
Absolute Emissions	1940 MtCO2eq	1778 MtCO2eq	N/A
Compare with 2010	145% above 2010	125% above 2010	N/A

Table 1: Basic NDC information of Iran

The INDC document elaborates on the unconditional mitigation action planned by Iran, which includes the adoption of renewable energy sources and nuclear power, the reduction of gas flaring, the increase of energy efficiency in energy consuming sectors, economic diversification, as well as the participation in international market-based mechanisms. Apart from the main targets, the INDC document of Iran elaborates on other topics related to the climate change mitigation strategy of the country. For example, specific needs are detailed, including technologies to curb gas flares, and reduce natural gas leakage in distribution networks. The document emphasizes the need to utilize renewable energy sources and Carbon Capture and Storage (CCS) technology. Regarding financial needs, the annual investments needed to achieve the unconditional and conditional mitigation targets are estimated to be about 17.5 and 52.5 billion USD respectively. In addition, the INDC also explores the climate vulnerability aspect, including the risk of extreme weather events and reduced agricultural production. Considering climate change adaptation, the document emphasizes the need to protect natural resources, ensure food security and invest in water resource infrastructure, requiring an additional investment of USD 140 billion. Apart from the INDC, Iranian officials have also submitted the Third National Communication to the UNFCCC, further clarifying their targets regarding climate policy. Still, the NDC targets have been assessed by independent experts, who rated them as critically insufficient, indicating that Iran's climate policies and commitments are not consistent with the Paris Agreement's 1.5°C and 2°C global temperature increase limit (CAT, 2023).

Key Decarbonization Pathways

In this section, we explore the key decarbonization pathways of Iran, based on the targets set in the INDC document, as well as expert analysis and modelling. This will help us evaluate the climate pledges of Iran, with the purpose of assessing its alignment with the Paris Agreement goals. This analysis was based on the output of MENA-EDS (Fragkos et al, 2013), an energy system model that has been utilized in various climate policy studies and academic research, focusing on Middle East and North Africa countries (Fragkos, 2023). As seen in Table 1, the Iranian government has not set a long-term target, hence the 2050 projections were based on expert assessment about the potential aspirations of Iran in this time frame. Therefore, the NDC/LTT scenario resulted from a combination of the actual Iranian NDC targets for 2030, as well as an estimation for potential long-term targets for 2050, while the Base scenario assumes that the Iranian emissions follow a business as usual trajectory (in line with the BAU scenario included in the Iranian NDC).

Impact of Iranian NDCs on Primary Energy Consumption

As seen in Figure 4, the BAU and NDC/LTT scenarios have key differences regarding the consumption of primary energy. For example, the total amount of consumed energy is expected to increase in both cases driven by increasing economic activity and rising standards of living in Iran, albeit at a lower rate in the NDC/LTT scenario. This results from the improved energy efficiency pledge, as stated in the Iranian INDC document, as well as the uptake of more efficient technologies and energy forms (e.g. electricity instead of using fossil fuels). In the BAU scenario, the Iranian energy system remains almost completely dependent on fossil fuels up to 2050 due to the absence of ambitious climate policies, with natural gas and oil being the main energy sources, accounting for almost 95% of the total amount, indicating a major deficit in Iranian current policies. In this scenario, the uptake of renewable energy and nuclear is projected to be limited, i.e. 4% and 1% respectively. The NDC/LTT scenario paints a completely different picture, with fossil fuels having a significantly smaller share in 2050, i.e. approximately 51% of the total amount as they are increasingly replaced by low-carbon sources in the various sectors (e.g. biofuels, low-carbon electricity). Furthermore, solar and wind energy are notably boosted, amounting to approximately 40% of the total, while nuclear energy is projected to increase to 9%.

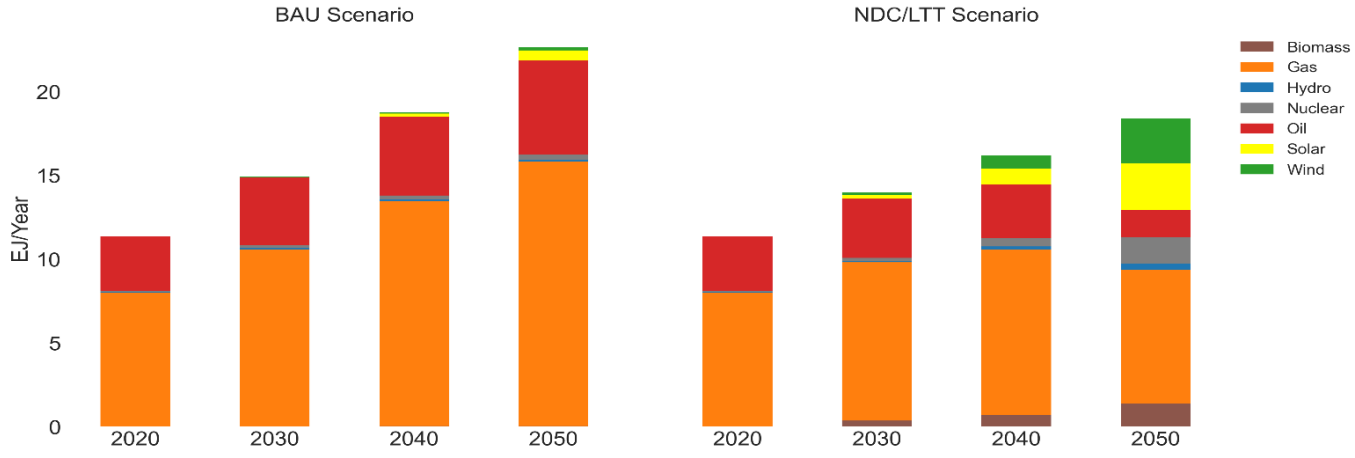

Figure 4: Primary energy consumption of Iran in the BAU and NDC/LTT Scenarios. Source: MENA-EDS Model

Sectoral System Transformations

In this section, we examine the sectoral transformations induced in the NDC/LTT scenario (developed by the MENA-EDS model) in the industry, buildings, energy supply and transportation sectors. As seen in Figure 5, final energy consumption of all sectors is projected to be lower in the NDC/LTT scenario compared to BAU, a result driven by stronger efficiency improvements and the replacement of inefficient technologies with more advanced, and less carbon-intensive options (e.g. electric vehicles instead of conventional vehicles).

Industry

In the BAU scenario, the Iranian industry sector remains heavily reliant on fossil fuels, with electricity accounting for only 21% of the industrial fuel mix in 2050 indicating a strong deficit to transform this sector towards a low-carbon paradigm. In comparison, electricity share is projected to almost double to 39% in the NDC/LTT scenario replacing the use of fossil fuels, while sectoral energy consumption drops by 1 EJ/year compared to BAU due to various efficiency enhancements, including heat recovery and the application of Best Available Technologies in the manufacturing sector.

Buildings

As with industry, the buildings sector is highly dependent on fossil fuels (especially natural gas and oil), with electricity accounting for 25% in the BAU scenario indicating the difficulties to reduce emissions from the sector under current policies. Final energy demand in households is projected to grow vigorously over the period 2020-2050 at a much higher rate than population, as a result of rising incomes and increasing standards of living leading to a large uptake of electric and electronic appliances and higher use of energy. The NDC/LTT scenario projections show a significantly different result, with electricity rising to almost 65% of the total consumption in the sector driven by the increasing electrification of space and water heating end-uses, requiring a major shift in households' investments and behaviour patterns. Furthermore, sectoral consumption will drop by 14% compared to BAU, highlighting the improved energy efficiency, in particular through renovations and increased thermal insulation of residential and services buildings.

Transportation

The transportation sector almost exclusively relies on fossil liquids in the BAU scenario, indicating the dominance of internal combustion engines (ICE) using predominantly refined oil products. In the BAU scenario, the amount of energy consumption is projected to constantly increase driven by rising economic activity and trade, leading to increases in freight transport activity. Furthermore, the improved standards of living and higher car ownership rates will result in higher passenger transport demand indicating that more ambitious policies and measures are required to transform the transport sector. In contrast, the NDC/LTT scenario projects a significant increase of electricity in the transport fuel mix, amounting to almost 50% of total transport-related consumption in 2050, through the massive adoption of electric vehicles (EV), both in passenger and freight transport. Given the much higher efficiency of EVs compared to conventional ICE vehicles, transport-related energy consumption is projected to decline by 32% compared to the BAU scenario in 2050. Other low-carbon fuels are also deployed in the transport sector (e.g. advanced biofuels) to reduce emissions from hard-to-electrify sectors, like aviation and shipping.

Electricity Production

As seen in Figure 6, total electricity production is remarkably higher in the NDC/LTT scenario, being 142% higher than BAU in the year 2050. There are many factors contributing to this, such as the projected adoption of electric vehicles in the transportation sector and the increased electrification of industrial, commercial and residential end-uses. The utilization of renewable energy sources to generate electricity is limited in the BAU scenario, amounting to 26% of the fuel mix in 2050, while 70% of electricity is produced in gas-fired power plants.

In contrast, the NDC/LTT scenario projects a significantly higher uptake of renewable energy, with the share of RES increasing to 73% of the power supply mix (mostly through the massive uptake of solar and wind), gas share dropping to 17% in 2050, and nuclear covering the rest 9%.

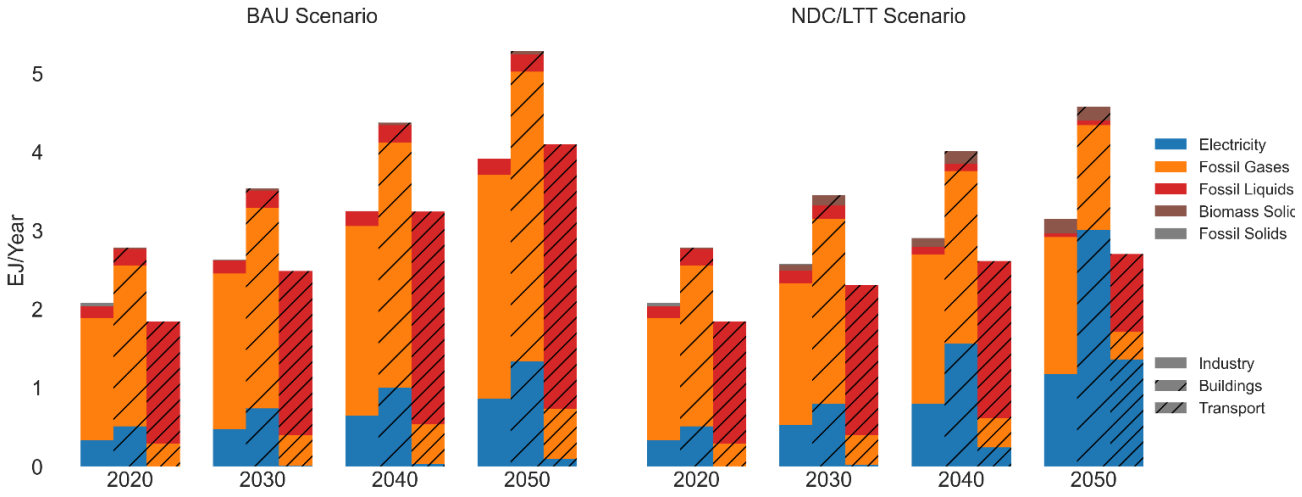

Figure 5: Final energy consumption of Iran by main sector and fuel in the BAU and NDC/LTT Scenarios. Source: MENA-EDS Model

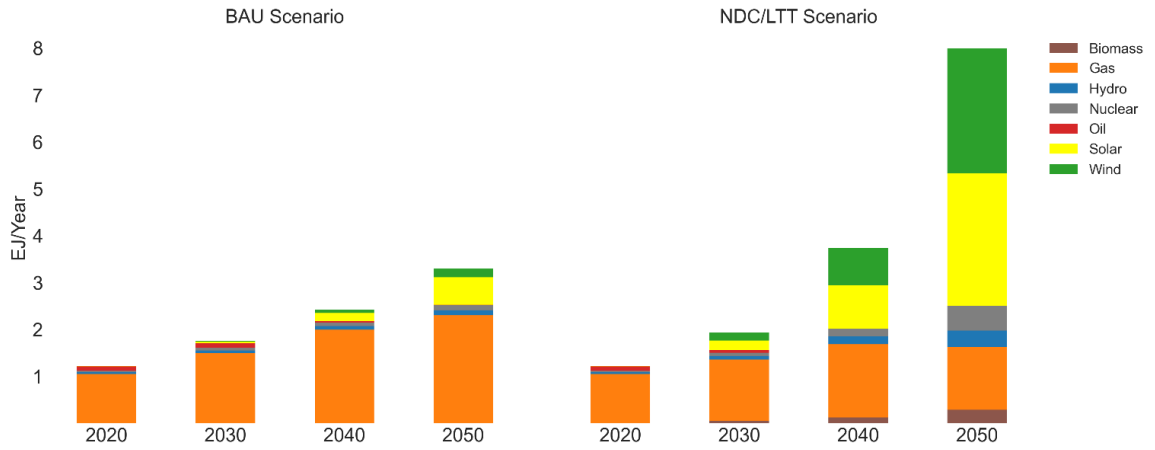

Figure 6: Electricity production of Iran by fuel in the BAU and NDC/LTT scenarios. Source: MENA-EDS Model

Greenhouse Gas Emissions

In this section, we focus on the CO_2 emission trajectories of Iran in the BAU and NDC/LTT scenarios. As seen in Figure 7, annual CO_2 emissions keep rising in the BAU scenario due to activity growth and the absence of strong climate policies; they are projected to increase from 582 $MtCO_2$ in 2015 to 804 $MtCO_2$ in 2030, and further to 1180 MtCO2 in 2050. In contrast, the NDC/LTT scenario projects the stabilization of CO_2 emissions by 2030 at a level of around 710 $MtCO_2$ (i.e. 12 % lower than in BAU), followed by a significant emissions reduction by 2050 to an amount of 541 $MtCO_2$. In the BAU scenario, the demand sectors (i.e. industry, buildings and transportation) are projected to emit approximately 740 $MtCO_2$/year in 2050, whereas the energy supply sector will account for 440 $MtCO_2$/year. In contrast, the NDC/LTT scenario projects that CO_2 emissions will decline from BAU levels both in the demand (304 $MtCO_2$/year) and supply sectors (237 $MtCO_2$/year) in 2050. Regardless, independent experts have assessed that emissions should decrease significantly faster to become aligned with the Paris Agreement. More specifically, total GHG emissions of Iran should be approximately 600 $MtCO_2$eq in 2030, to contribute to achieving the 1.5°C temperature increase Paris Agreement goal (CAT, 2023).

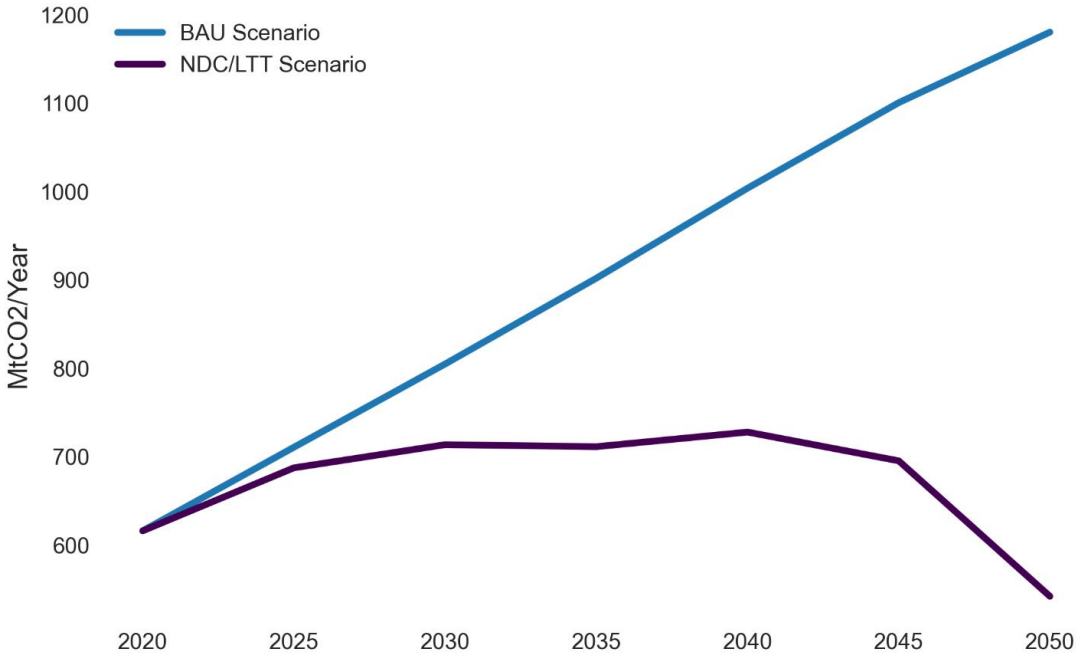

Figure 7: Annual CO2 Emissions of the Iranian energy sector in the BAU and NDC/LTT Scenarios. Source: MENA-EDS Model

Key messages for next NDCs

Our analysis indicates that rapid electrification of all demand sectors combined with the expansion of renewable energy for electricity generation is necessary to drastically reduce the GHG emissions of the Iranian energy sector and should be the main focus of the next Iranian NDC. Such an ambitious goal will not be easily accomplished for several reasons. First, the Iranian economy has been hindered for decades by numerous problems, such as the

significant lack of diversification. Second, the vast Iranian oil and gas reserves are a strong incentive to avoid any radical climate-related transformations, such as phasing out fossil fuels, because the Iranian economy is fueled by cheap oil and gas, while its large hydrocarbon exports support economic development. In addition, the transition to sustainability requires enormous financial inflows that typically come with high upfront costs especially in countries with high risk premiums like Iran. The necessary transformation of the economy may lead to social upheaval, which is a major challenge for policy makers. Finally, Iran has been largely dependent on fossil fuels, therefore lacking a sufficient number of experts in renewable energy sources and other sustainable low-emission technologies.

Regardless, the country is remarkably vulnerable to the effects of climate change, as detailed extensively in the Iranian INDC document. For example, the reduction of agricultural production threatens food security for Iranians, which can become a significant concern in the future. Other region-specific risks caused by climate change include biodiversity loss, dust storms, water shortages and epidemics. In addition, the increased frequency of extreme weather events, including heatwaves and droughts, should motivate Iranian officials to ratify the Paris Agreement. Additionally, the commitment to climate change mitigation will have additional benefits for Iran, like minimizing the lock-in risk to fossil fuel infrastructure. Therefore, the country will be prepared for the eventual transition, without making investments that become stranded in the upcoming years. Finally, the Iranian government should set more ambitious NDCs (before COP30) prioritizing the implementation of low-hanging fruits, including accelerated uptake of solar and wind power and rationale energy use (e.g. with the gradual removal of inefficient fossil fuel subsidies) to achieve emissions reductions in a cost-efficient manner. The government should also set ambitious long-term climate targets to ensure alignment with the Paris Agreement goals in line with international standards and assessments, with the aim of contributing to a sustainable future for humanity.

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