Energy Transition in Saudi Arabia: Key Initiatives and Challenges

BY FATEH BELAID AND AISHA AL SARIHI

Abstract

The global energy sector is undergoing a rapidly accelerating transition. This accelerated path is motivated by a range of drivers. Tackling climate change is a critical consideration among these drivers, but policy makers and governments are faced with other priorities, including ensuring affordable energy supply, energy security, and energy access to everyone. Fossil fuel will continue to play a role in meeting future increasing energy demand. Two key energy policies to tackle change are: energy efficiency and renewable energy. Within this context, this analysis intends to: (1) explore the ongoing energy transition in Saudi Arabia; (2) examine the role of renewable energy in achieving the sustainability goals in Saudi Arabia. The results have important policy implications, highlighting how aggressive energy transition initiatives may achieve sustainability and climate goals in the context of very active and engaged economy in the energy transition. It can help policy-makers design effective mitigation policies and consider renewable energy as a vehicle for tackling climate change and building a better future.

Keywords: *Energy Transition; Renewable energy; Sustainability; Climate change; Saudi Arabia*

1. Introduction

Global warming is rapidly escalating, pushing the world to the edge of the precipice. This paper covers a timely and critical topic for accelerating energy transition and mitigating climate change effects. It develops a straightforward analysis to explore the ongoing energy transition. It focuses primarily on the role that alternative energy sources may play in shaping economic and sustainability goals. The setting of the study is the energy transition challenges and perspectives in Saudi Arabia, as an illustration of a particular developing economy that has been very conscious of the current situation and has invested significant efforts to accelerate the energy transition pace (Hilmi et al., 2020).

Energy transition has become one of the most prominent concerns of policy-makers around the world. In this context, alternative energy sources will undoubtedly play a key role not only in the long-awaited process of energy mix decarbonization, but also in the implementation of a new economic model, aiming to advance social well-being and sustainability (Belaïd et al., 2021a; Tiba and Belaid, 2020, 2021).

Considering the existence of ambitious policy goals to decrease global economy-related carbon emissions, the acceleration of the decarbonization process and its financing pose many challenging issues for researchers and policy-makers. In fact, the sustainable transition process depends on unpredictable future conditions, such as market innovations and energy prices.

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However, in an attempt to understand the magnitude of the efforts and to try to place this enormous challenge within a broader economic and public policy framework, it is crucial to have a comprehensive overview of the existing efforts and feedback from the different initiatives. From a policy perspective, this will help policy-makers move beyond the specific types of single policies and practices and embrace a holistic approach to decision making in order to expand well-being economies. This will be reflected in national policy frameworks that mandate collaboration between different stakeholders, including government bodies and agencies, place well-being and sustainability in the center of budgeting decisions and introduce indicators of performance.

The rest of this article is presented as follows. Section 2 provides a global view of the main challenges associated with energy transition and sustainable paths. Section 3 reviews and discusses Saudi Arabia's efforts toward decarbonisation process. Section 4 concludes the analysis and provides some useful policy recommendations and avenues for future research.

2. Global view of the critical challenges associated with energy transition and tackling climate change

The crisis the world is going through these last years is patent. It includes economic, social, environmental, ecological, and even health aspects. In this setting, climate change poses a real threat to both human and ecosystem sustainability. The increasing frequency and intensity of storms and heatwaves, droughts, rising sea levels, melting glaciers, and oceans warming are threatening species and their habitats. Addressing this crisis requires an urgent need to reduce greenhouse gas emissions (GHG) and address the consequences of the threat which is already being faced (Belaïd et al., 2020).

However, despite existing divergences among economists, some convergences could be found on the best policy for the climate (Tol, 2020). It has been widely accepted since Nordhaus (1977), d'Arge (1979), and Schelling (1992) that climate change is, by and large, a negative externality and that GHG emissions should be priced, preferably taxed. Notably, most economists agree that sound climate policy starts modestly and then accelerates (Wigley et al. 1996, Goulder and Mathai 2000), although long-term climate goals continue to be the subject of intense debate (Stern et al. 2006; Nordhaus 2013).

Decarbonization initiatives in different sectors of the economy are on a clear upward trajectory around the world. However, they must accelerate in both scale and pace to meet climate and sustainability goals of the Paris Agreement.

The global energy sector is undergoing a rapidly accelerating transition. This accelerated path is motivated by a range of drivers. Tackling climate change is a critical consideration among these drivers, but policy-makers and governments are faced with other priories, including ensuring affordable energy supply and reinforcing energy security and ensuring energy access to everyone. Within this context, fossil fuel will continue to play a role in meeting future increasing energy demand. Two key energy policies to achieve the Paris Agreement goals are: energy efficiency and renewable energy (see Figure 1).

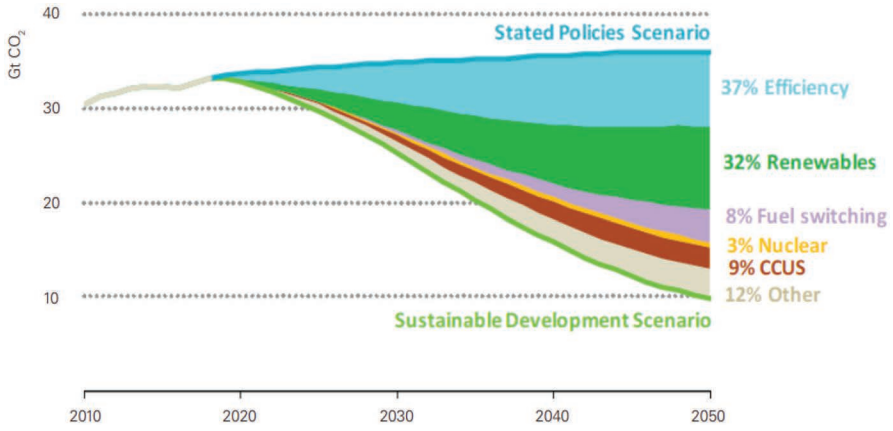

Figure 1: Drivers of GHG emissions reduction (in gigatons) within the framework of IEA's 66% 2 °C Scenario- relative to the New Policies Scenario (Source IEA, 20200). Note: CCUS = Carbon Capture, Utilization and Storage.

There are many challenges to accelerate energy transition pace. One of the success factors is to accelerate the development and rapid adoption of high-impact clean energy technologies (Mongo et al., 2021a, 2021b; Omri and Belaïd, 2021). While many technologies, such as batteries, solar, and wind, have achieved significant cost reductions and large-scale adoption thresholds, critical technology shortfalls exist in other sectors, including industry and transportation. Therefore, cooperative actions among public and private entities can accelerate the timeline for reaching these critical thresholds, sometimes by a decade or more, pursuing targeted R&D and implementation in domains such as long-term energy storage, hydrogen production, insulation materials, and industrial processes.

Second, reaching the well-being economic model goal requires the improvement of energy efficiency, which has multiples advantages. Energy efficiency improvement helps countries achieve their energy goals while sustainably meeting energy demand. Energy efficiency eases pressures on national budgets, increases competitiveness of industries and services, creates jobs, alleviates fuel poverty, and improves system reliability by reducing energy demand and peak load. In this framework, the energy efficiency potential in building sector is enormous both in existing and new constructions (Belaïd, 2016, 2017; Bakaloglou and Belaïd, 2022). Hence, deep renovation of existing buildings and electrifying end uses can be cost-effective and generate significant energy savings (Belaïd et al., 2021; Belaid and Rault, C 2021).

3. Key energy transition initiatives in Saudi Arabia

Along with joining global forces to addressing climate change and accelerating the needed energy transition, Saudi Arabia is driven by other socio-economic factors to developing alternative energy sources. Saudi Arabia's renewable potential is remarkable, especially solar and wind, and more so given the geographic location of Saudi Arabia within the sunbelt, there is a match between peak sun hours and electricity peak demand. Furthermore, the development of alternative energy sources will help meeting the Kingdom's increasing domestic energy demands resulting from general economic development, together with population growth and increasing standards of living. Additionally, developing alternative energy sources is in line with the Kingdom's economic diversification Vision 2030 which aims to diversify the economy by substantially reducing reliance on oil. Withing this context, Saudi Arabia has been actively engaged in joining global forces to addressing climate change and managing energy transition both at international and domestic levels.

At the international level, Saudi Arabia ratified the U.N. Framework Convention on Climate Change (UNFCCC), an international environmental treaty, by accession on December 28, 1994, and acceded to the Kyoto Protocol on January 31, 2005. In response to the protocol, the kingdom submitted its first, second, and third National Communications in 2005, 2011, and 2016, respectively. In December 2015, when parties to the UNFCCC reached a landmark agreement, i.e., Paris Agreement,[1] to combat climate change and accelerate and intensify the actions and investments needed for a sustainable low carbon future, Saudi Arabia submitted its Intended Nationally Determined Contribution (INDC) ahead of the Conference of Parties in December 2015 (UNFCCC, 2021), and ratified the Paris Agreement on November 3, 2016. Also, in April 2021, Saudi Arabia joined the 'Net Zero Producers Forum,' alongside the US, Canada, Norway and Qatar – together responsible for 40% of global oil and gas production, to come up with "pragmatic net-zero emission strategies," including methane abatement, advancing the circular carbon economy approach, development and deployment of clean-energy and carbon capture and storage technologies, diversification from reliance on hydrocarbon revenues, and other measures in line with each country's national circumstances (DOE, 2021).

At the domestic level, along with submitting its NDC, Saudi Arabia has adopted many targets and strategies to addressing climate change and accelerate energy transition. These include the country's initiatives in energy efficiency, renewable energy, nuclear, and hydro-

gen. Most notably, to ensure an inclusive and holistic approach to managing energy transition and GHG emissions, Saudi Arabia has adopted a circular carbon economy (CCE) approach that encompasses a broad range of transition pathways and options available, considering different national circumstances, while striving to meet shared global aspirations. The Saudi's energy transitions journey is displayed in Figure 2.

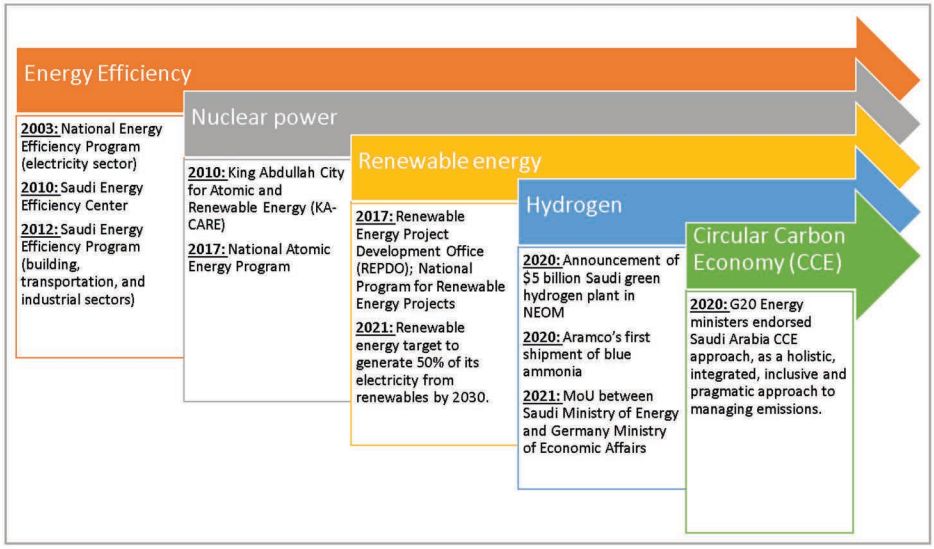

Figure 2: Saudi's energy transition journey. Source: Authors.

3.1 Energy efficiency

One of the first energy efficiency initiatives in the KSA is the launch of the National Energy Efficiency Program in 2003 as a three-year program to improve the management and efficiency of electricity generation and consumption in the kingdom. Building on the experiences gained during that period, a Council of Ministers' Decree established the Saudi Energy Efficiency Center in 2010. The center is managed by a Board of Directors composed of more than 26 entities from ministries, government departments, and the private sector. Its main tasks have included development of a national energy efficiency program, promoting awareness about energy efficiency, participating in the implementation of pilot projects, and proposing energy efficiency policies and regulations and monitoring their implementation. In 2012, the Saudi Energy Efficiency Center launched the Saudi Energy Efficiency Program to improve the kingdom's energy efficiency by designing and implementing energy efficiency initiatives. To establish the program, an executive committee was created by the Saudi Energy Efficiency Center board, chaired by Prince Abdulaziz bin Salman, vice minister of petroleum and mineral resources (now the Ministry of Energy), and composed of members from 14 government and semi-government entities. The executive committee targeted more than 90 percent of the kingdom's energy consumption by creating specialized teams that focused on the building, transportation, and industrial sectors. The National Energy Efficiency Plan is currently focusing on the design of the first energy conservation law and national and regional regulations, preparation of a new national database on energy supply and demand, capacity development of energy efficiency managers, and public awareness. Furthermore, in 2010, the Saudi Green Building Forum was launched to promote the construction of energy and resource efficient and environmentally responsible buildings. By the end of 2014, the kingdom had more than 300 green building projects, investing approximately $53 billion.

3.2 Renewable Energy

In 2017, a Renewable Energy Project Development Office (REPDO) was established at the Ministry of Energy. REPDO launched the National Program for Renewable Energy Projects to oversee the development of KSA renewable energy projects and achieving its renewable energy targets. After the launch of the National Program for Renewable Energy Projects in 2017, the target renewable energy source size was only 9.5 GW. Then, on January 9, 2019, REPDO announced its new plan to expand renewable energy projects by increasing the target to 58.7 GW, to be implemented by 2030. This new plan included developing more than 35 sites distributed throughout the Kingdom. The energy expected to be generated from three main sources is 40 GW of solar PV, 16 GW of wind power, and 2.7 GW of Concentrated solar power (CSP) (AlOtaibi, 2021). In January 2021, Saudi Arabia announced its intent to generate 50% of its electricity from renewables by 2030, with the other half coming from natural gas-fired power generation (Paraskova, 2021). The total renewable energy installed capacity in Saudi Arabia has increased from 3 MW in 2011 to 413 MW in 2020 (Figure 3).

3.3 Nuclear power

At present, Saudi Arabia has no nuclear power plants, but has plans to include atomic energy in its future energy mix and build domestic nuclear industry in anticipation to meeting rapid increase in energy demand across the industrial and residential sectors. Preliminary studies show that Saudi Arabia boasts an estimated 60,000 tonnes of uranium ore (Mansouri, 2020).

The Saudi government has put forward the legal and institutional framework that will regulate the Kingdom's nuclear energy sector. In 2010, the King Abdullah City for Atomic and Renewable Energy (KA-CARE) was established by Royal Order No. A/90, and in 2017, it launched the National Atomic Energy Program. Along with the National Atomic Energy Program, the government issued the National Policy for the Kingdom's Atomic

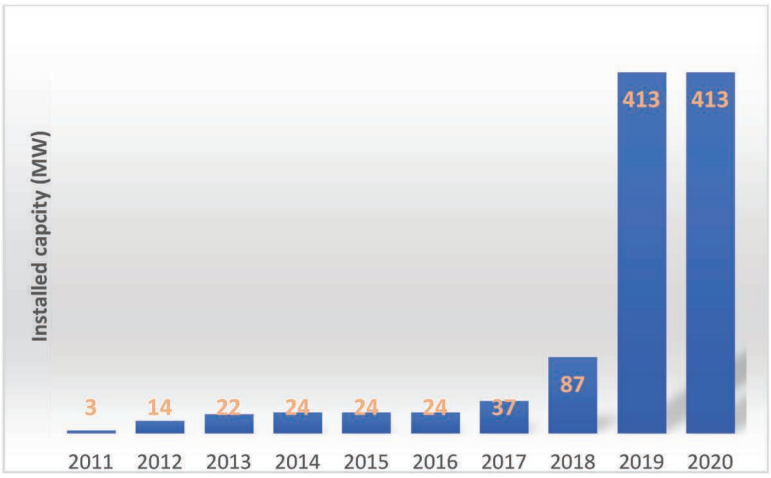

Figure3: Renewable energy installed capacity in Saudi Arabia, 2011-2020. Source: IRENA: 2021

Energy Program, the Nuclear Law, and the Law of Civil Liability for Nuclear Damage. It established the Nuclear and Radiological Regulatory Commission, an independent regulatory agency, to monitor the implementation of its nuclear energy program, ensure the program complies with relevant laws, the protection of humans and the environment, and ensure it maintains the highest operational safety standards (Mansouri, 2020).

3.4 Hydrogen

In line with its economic diversification plan, Vision 2030, and plans to adopt a circular carbon economy approach (CCE), Saudi Arabia has embarked in several hydrogen development initiatives. In July 2020, a $5 billion Saudi green hydrogen plant was announced, to be powered by 4 gigawatts (GW) from renewables and located in Neom city in the Tabuk Province of northwestern Saudi Arabia (north of the Red Sea). Jointly owned by Saudi Arabia's ACWA Power and Air Products, it is planned that the plant will produce 650 tonnes of hydrogen by 2025 for exportation in the international market (Valley, 2020). Also, in September 2020, Saudi Aramco announced the world's first shipment of blue ammonia – produced from natural gas with CCS in the Hydrogen Plant in Jubail – to Japan where it is used in power stations to produce emissions-free electricity (Ratcliffe, 2020). Also, early this year, Energy Minister HRH Abdulaziz bun Salman Al Saud and Economic Affairs Minister of Germany, Peter Altmaier, signed a MoU on hydrogen with an objective to enhance bi-lateral cooperation between the two countries in hydrogen (Kane, 2021).

3.5 Circular Carbon Economy

As part of its G20 Presidency 2020, Saudi Arabia, led by the Ministry of Energy, has put forward the concept of the Circular Carbon Economy (CCE) and plans to put it at the center of its climate mitigation plan (Williams, 2019). A key insight from CCE is to achieve a pathway towards net zero emissions. This is based around 'four Rs:' **Reduce**: energy efficiency, renewable energy and other low carbon energy such as nuclear; **Reuse**: carbon capture and utilization (CCU) and emissions to value (E2V); **Recycle**: natural sinks such as forests and oceans, bio-energy and hydrogen; and **Remove**: carbon capture and storage (CCS) and direct air capture (KAPSARC, 2020). CCE builds on the kingdom's earlier efforts on reducing its carbon emissions, including the kingdom's first carbon dioxide enhanced oil recovery demonstration project, which commenced its operation in 2015. The Uthmaniyah carbon dioxide enhanced oil recovery demonstration compresses and dehydrates carbon dioxide from the Hawiyah natural gas liquid recovery plant in Saudi Arabia's Eastern Province (Global CCS Institute, 2018). The captured carbon dioxide is transported via pipeline to the injection site at the Ghawar oil field (a small flooded area in the Uthmaniyah production unit) for enhanced oil recovery. At the center of this ambitious CCE approach are the Ministry of Energy and the Energy Ecosystem consisting of King Abdullah Petroleum Studies and Research Center (KAPSARC), King Abdullah City for Atomic and Renewable Energy (KACARE), Saudi Energy Efficiency Center (SEEC), Designated National Authority (DNA), Electricity and Cogeneration Regulatory Authority (ECRA), Nuclear and Radiological Regulatory Commission (NRRC), and the Executive Committee for Governance of Price Adjustment of Energy and Water Products.

4. Conclusions & Policy recommendations

The global energy system is undergoing a fast transformation driven mainly by climate change mitigation, strengthen energy security, ensuring affordable energy supply for everyone, and alleviating energy poverty (Belaïd, 2018, 2019). Policy-makers are putting enormous efforts to decarbonize the energy mix. Withing this context, this paper provides a concise/overview/brief of the ongoing energy transition process in Saudi Arabia. It starts with discussing the energy transition landscape and the key challenges associated with energy transition and tackling climate change. Second, it reviews the ongoing energy transition initiatives in Saudi Arabia. This is to understand and identify the most successful initiatives dedicated to decarbonizing energy mix. From a policy perspective, this may help decision-makers to improve the effectiveness of their energy policy choices.

The analysis shows that Saudi Arabia has in place all the ingredients, including institutional, human and financial capacities, needed to weather the ongoing energy transition. Specifically, its adoption of CCE presents an opportunity to facilitate the Kingdom's energy transition with a holistic approach that enhances harmonization of national energy policy and avoid duplication of efforts or energy policy fragmentation. CCE assures both centrality of leadership to steering energy transition as well cross-sectoral collaboration between different stakeholders including from academic, government, and industry. Nevertheless, there is still a

room for improvement to reaching Saudi Vision 2030 and the Kingdom's energy transition goals. Accordingly, we recommend:

Use existing arrangements and institutional architectures. Energy transition is cross-sectoral in nature and require collective action and coordination between actors representing different sectors and institutions. Saudi Arabia can take advantage of existing institutional arrangements dedicated to energy transition (see Section 3), but further enhanced coordination among different institutions (e.g., between public, private, financial, and academic) and sectors while planning for energy transition in order to reduce risks of conflicting strategies, additional regulatory burdens, or inefficient budget allocation. It is also essential to assigns clear duties and responsibilities to ensure effective coordination between entities.

Support research and evidence-based policy making. Additional efforts to enhance data collection and facilitate exchange of information and data between different stakeholders involved in decision making – including between research institutions and the political level, private sector, and other business sectors – is important to inform decision making and ensure cost-effective implementation of energy transition measures.

Support innovation in the energy sector. Saudi Arabia has the financial and human capacity to strengthen its national innovation system and stimulate cooperation between all stakeholders who can be potentially involved in energy innovation, including the academic, private and government sectors. Enhancing localization of alternative energy technologies is not only important to reduce dependence on other countries in importing technology and know-how, especially that most of the imported technologies do not work efficiently in the hosting countries, but also to enhancing the competitiveness of the Kingdom in a changing energy market. Specifically, the Kingdom's support of research on energy storage technologies would complement its ongoing energy transition initiatives.

Footnotes

[1] The Paris Agreement builds upon the convention and – for the first time – brings all countries, including developing countries, into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. Entered into force on November 4, 2016, the Paris Agreement requires all parties to put forward their best efforts through Nationally Determined Contributions and to strengthen these efforts in the years ahead. This includes requirements that all parties report regularly on their emissions and their implementation efforts (UNFCCC, 2015).

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