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ORIGINAL PAPER

Fossil gas lock-in risks: analysis of Algeria's electricity sector and implications for a renewable energy transition

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Abstract
Algeria's electricity sector is dependent on fossil gas. Domestic gas demand is growing, and gas-fired power plants are projected to make up 84% of total installed capacity by 2028. This brings the country into a Sustainability Nexus dilemma: on the one hand, Algeria is committed to reduce its greenhouse gas emissions and other environmental impacts of the gas sector, whereas on the other hand, the energy and export revenue derived from gas would need to be substituted in order to ensure social and economic development in the country. Socioeconomic tradeoffs and alternatives must therefore be understood and managed in a way that ensures continued political and public support for the country's energy transition and fossil fuel exit. This paper aims to (a) identify fossil gas lock-in factors and (b) explore the opportunities to overcome these obstacles in order to facilitate a transition into renewable energy. Using a deductive approach, we draw on theoretical assumptions regarding carbon lock-in theory and the 2020 framework of Trencher et al. to study (1) technological and infrastructural conditions, (2) actors and agency, (3) formal and informal institutions, knowledge and competences, and (4) exogenous context. Between November 2021 and March 2022, a total of 23 semi-structured interviews were conducted in Algeria with stakeholders from the government, power and industry organizations, civil society organizations, and scientific institutions. The interview transcripts were then thematically analyzed to get a picture of recurrent themes and patterns. Our analysis identified several factors contributing to the fossil gas lock-in in Algeria's electricity system: economic dependence on oil and fossil gas; the significant influence of oil and gas actors, and the governmental support for fossil gas; gas and electricity subsidies, which lock out all other energy alternatives; and an overall lack of attention to climate change in energy policy formulation and in political and societal debate, despite the major capacity expansion plans prompted by heatwaves. The paper ends with a brief discussion of how Algeria's gas lock-in may worsen due to the war in Ukraine.

Keywords Natural gas · Lock-in mechanisms · Algeria · Energy transition

1 Introduction

While Algeria has long produced, consumed, and exported fossil gas as an excellent solution to many of its energy needs, it faces mounting pressure to minimize its gas sector emissions due to its commitment to greener energy. One of the first countries in the Global South to submit an Intended Nationally Determined Contribution (INDC), in 2015 the country committed to reduce GHG emissions by 7% through endogenous measures by 2030 and by 22% with international support (UNFCCC 2015).

Since 2010, however, Algeria's gas balance has deteriorated. Fossil gas exports are impeded not only by static or declining output, but also by rapidly expanding domestic consumption. Indeed, electricity generation is the country's largest domestic consumer, accounting for more than 40% of total gas consumption. And this usage will only increase: Algerian government projects that gas-fired turbines will generate 126 terawatt-hours (TWh) by 2028, accounting for 84% of total built capacity. This increasing domestic reliance on fossil gas could seriously restrict the contribution of renewable energy sources to the energy mix (Ouki 2019). To understand Algeria's gas lock-in, it is important to grasp

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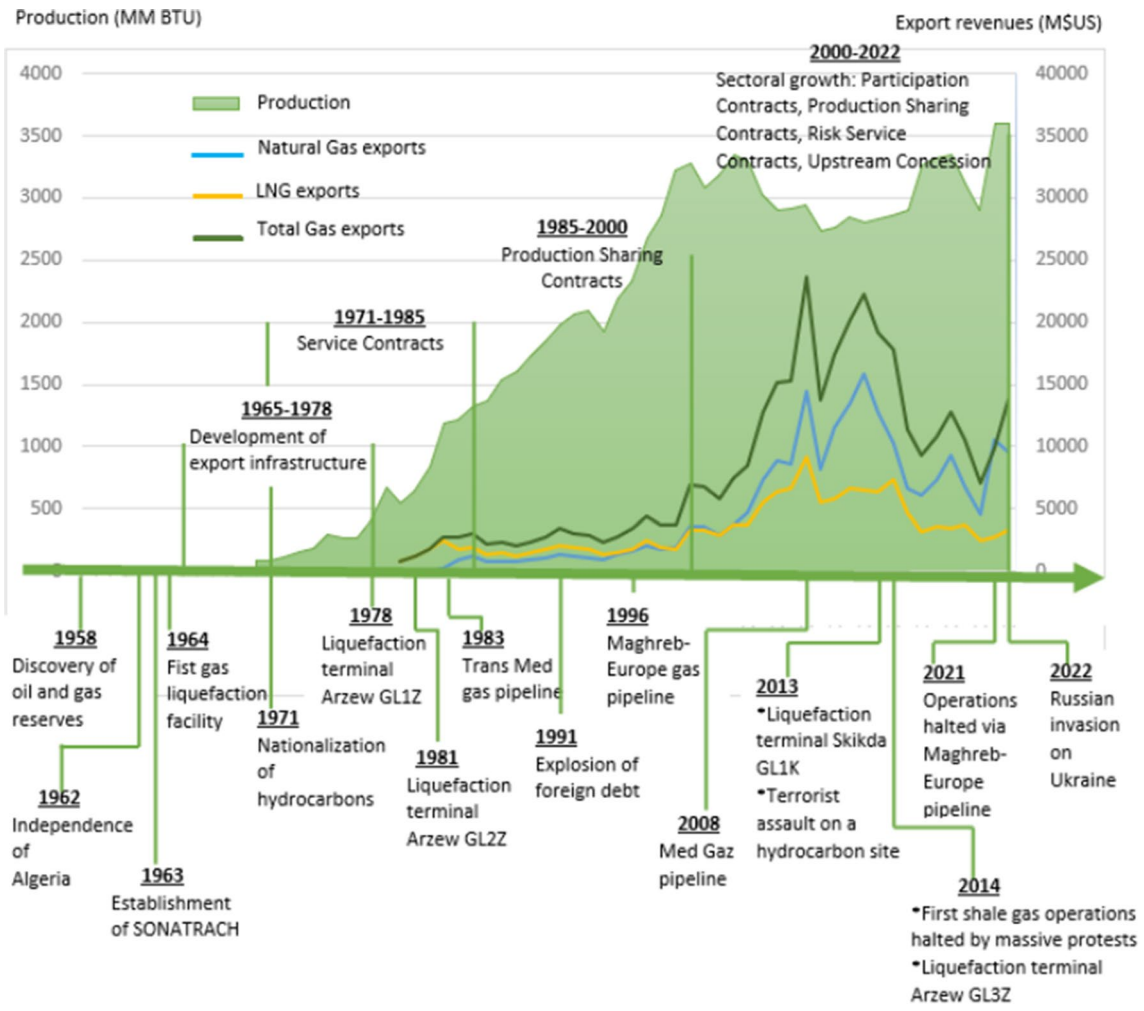

Fig. 1 Major events shaping gas production in Algeria from 1958 to 2022; own illustration

its political and historical underpinnings (see the detailed description presented in Appendix: "The development of the oil and gas sector from independence in 1962 until 2023" and additional summary of the history of renewables in Algeria in Appendix "Renewable energies in Algeria"). Figure 1 shows the country's gas extraction volumes, gas export revenues, governing periods, and related important events from 1962 to 2022.

The war in Ukraine caused gas prices to rise in 2022, with European Union (EU) demand for the fossil fuel expected to increase by 30% in the winter of 2023. To compensate for the Russian supply shortage, the EU plans to reduce usage by 15% in addition to building pipelines and increasing LNG imports (Consilium 2022). Algeria is a major fossil gas exporter to the EU, ranking third behind Russia and Norway (8.2% of total EU gas imports in 2021). In March 2022, it pledged to increase its gas exports, but this would require large capital investment to increase in gas production. Such a move would expose the country to a significant risk of lock-in and stranded assets, which already poses a threat to Algeria's energy infrastructure (Hill et al. 2022).

With a total planned capacity of 36 GW from gas-fired power plants by 2028 potentially impeding the growth of renewable energy in Algeria, this paper aims to answer the following research question: What are the drivers behind this expansion? What factors contribute to fossil gas lock-in? What are the opportunities to overcome these obstacles and aid the transition into renewable energy?

The analysis presented in this paper reveals Algeria's historical and continuous economic dependence on oil and fossil gas. It also highlights the significant influence of oil and gas actors in Algeria, whose interests drive governmental support for fossil gas. The lack of a coherent long-term energy strategy and the absence of serious political commitment to halting gas overconsumption are also major contributing factors, as are gas and electricity subsidies—the main element blocking the country from turning to other energy alternatives—and a monopolized power market dominated

by a state-owned company. Still, it is worthy to note that, in similar circumstances, a state monopoly in the resource sector has proven efficient in driving innovations (Marin et al. 2017). Despite the described "high level of expertise in electricity generation from gas" gained by Sonelgaz that "justifies the company's bold opposition to the deployment of new technologies. While heatwaves are prompting considerable capacity planning, energy policy formulation often overlooks climate change issues due to their lack of centrality in political or societal mono-debates.

This article is organized into seven sections. Section one reviews the important political occurrences from Algeria's independence in 1962 through 2022, with additional information provided in the appendix. Part two analyses the key research on carbon lock-in, followed by a discussion of carbon lock-in in energy systems theoretical framework in part three. Methodologies are presented in part four, and key findings are summarized in part five. The final section briefly discusses how the war in Ukraine has affected the Algerian gas sector and presents our main conclusions on the risks of gas lock-in in the Algerian energy system.

2 Literature review

Co-evolving technologies and institutions have enabled a fossil fuel-based infrastructure to persist despite its negative externalities. To explain this, Unruh proposed the concept of carbon lock-in (Unruh 2000)—that is, the phenomenon whereby technologies, institutions, and behaviours become deeply entrenched and resistant to change, thereby perpetuating the use of carbon-intensive systems like fossil fuels. In this paper, we use the concept of carbon lock-in to explain the persistence of gas-fuelled power plans in Algeria despite their recognized negative externalities and the availability of greener alternatives.

Seto et al. (2016) delve deeper into the mechanisms of carbon lock-in by exploring how technological, institutional, and behavioral inertia can individually and interactively limit the rate of systemic transformations via a path-dependent process. They conceptualize four major types of carbon lock-in: infrastructural, technological, institutional and behavioral lock-in. These main types can serve to clearly categorize the lock-in mechanisms in Algeria's electricity sector. Additionally, the meta-theoretical framework proposed by Cherp et al. (2018) for analyzing national energy transitions integrates three co-evolving layers: techno-economic, socio-technical and political action systems. While they agree that a clear understanding of these systems can only be obtained through a holistic approach that integrates all three layers, no such review has yet been published. These layers are directly relevant to Algeria's situation and can be used to define the various political, sociotechnical, and techno-economic systems that support the country's continued use of gas-fired power plants and the different interactions between them.

Several empirical studies on the contested fossil gas lock-in can serve as a template to guide our research on Algeria. For instance, the study by Fitzgerald et al. (2019) seeks to explain the underlying factors through which political processes support fossil gas despite its high global warming potential. The authors analyze actors, networks, interests, politics, and narratives within the institutional regimes. This case study analysis can cast needed light on the broader political support for fossil gas in Algeria. Additionally, Brauers et al. (2021) offer a detailed analysis of the causes driving support for fossil gas in Germany despite the advanced energy transition development. The authors identify four main causes driving support for liquefied natural gas (LNG) in Germany: geopolitical influence from the United States, concerns over the security of supply, resistance from existing regimes, and infrastructural lock-in. This research can provide insights into the international and national influences on Algerian gas practices.

In conclusion, these studies provide well-developed theories and case studies that can serve as a basis for our research. However, existing research presents a noticeable gap regarding research on fossil-fuel rich countries in the Global South. By addressing the phenomenon of lock-in in the Global South, our study offers a valuable contribution to empirical studies on this topic.

3 Theoretical framework: revisiting carbon lock-in in energy systems

This section outlines an analytical approach developed by Trencher et al. (2020) for examining socioeconomic and technical lock-in. The framework aims to identify, understand and address diverse forms of lock-in, serving as a ready-to-use analytical tool for investigating the fundamental roots of techno-institutional lock-in. In so doing, it incorporates key scientific research on carbon lock-in path dependency and sustainability transitions.

Material factors, human actors, and non-material factors are three interconnected aspects of socio-technical systems. When the linkages and interactions between these dimensions generate system stability, lock-in occurs, making it difficult to incorporate environmentally friendly solutions. This framework or approach also recognizes how socio-technical 'regimes'—represented by incumbent players and institutions—serve to replicate and sustain the system's material and non-material interests, thus maintaining lock-in. The framework also includes a fourth dimension, the exogenous context, which refers to factors at the landscape level which can either facilitate change by straining socio-technical

regime actors, or hinder change. Thus, cultural, political, geographic, and economic variables that exist outside of the socio-technical system constitute the exogenous context. Trencher et al. differentiate between various different factors: (a) technologies, assets and infrastructure, (b) actors and agency, c) formal institutions, (d) informal institutions, (e) knowledge and competences, (f) micro-economic factors, and (g) societal, geographical, technological and environmental conditions. To maintain stability, these factors may hinder the development of new technologies.

Research on fossil fuel dependency in the Global South is still limited, mainly due to a lack of data, the complexity of the system, and significant differences in socio-economic and political factors between the Global South and the Global North. In this regard, the framework developed by Trencher et al. offers a useful analytical tool for our own study. It pays particular attention to embodied connections among the lock-in components, which is crucial for revealing system complexity and particularity. Additionally, it does not limit the researcher's ability to investigate the connections between and significance of the many sources of lock-in that emerge from the finer details of our case study. For these reasons, we have chosen to use this framework as a tool to structure our own research and address our main research question for this study.

4 Methods

This section outlines the methodology we used for data collection, data analysis, and presentation of the results, based on the framework of Trencher et al. (2020). A mixed-method approach was used during data collection and analysis. In our preliminary research phase, we conducted a comprehensive examination of policies and regulations pertinent to the electricity, gas and renewable energy sectors in Algeria, aiming to identify the primary stakeholders. This involved utilizing various tools, such as academic databases, official government publications and industry reports. The criteria used to compile a list of interviewees were based on their expertise, involvement in policy-making and their roles within key energy-related organizations. Our efforts in this preliminary phase allowed us to identify and engage with knowledgeable individuals representing diverse perspectives within the energy landscape in Algeria. After the preliminary data and literature search, a list of interviewees was developed.

Subsequently, a total of twenty virtual and three in-person interviews were conducted in Algeria between October 2021 and February 2022.[1] The interviewees represented various institutions, including the Ministry of Energy and Mines (interviews 4, 8, 15), Ministry of Energy Transition (19), Ministry of Environment and Renewable Energies (2, 14), the state-owned utility provider Sonelgaz (5, 13), renewable energy companies (1, 11, 18), international cooperation agencies (6, 9), universities, experts and research centers (3, 10, 12, 16, 17), civil society organizations (7, 21), and activists (20).

The interviews were held in Arabic, French or English and lasted from 30 to 90 min. The interview guide consisted of 10 open-ended questions, which served as a starting point for the conversation. During the data collection phase, respondents were invited to identify other relevant players who could contribute to the study by answering the interview and research questions. Through this snowballing technique, we identified and included in the study several individuals who initially had not been listed as major participants. To extract relevant information from documents like national electricity plans and utility reports, of which the country had many, we then used a document review technique that involved skimming, reading, interpretation, and content and thematic analysis (Bowen 2009). A data extraction sheet was utilized to synthesize the obtained data.

Qualitative data from key informant interviews and documents was transcribed and imported into the MAXQDA tool, where unique themes in each interview were coded. Following the transcription from the original language, each interview transcript underwent translation into English. Subsequently, the interviews were coded in English using MAXQDA. This coding process involved the identification of unique themes across interviews. After coding, the generated codes were organized into subcategories and categories within MAXQDA. Furthermore, each category was then associated with pre-existing themes aligned with the Trencher et al. (2020) approach. This meticulous process ensured that the themes derived from the interviews were systematically linked to the established framework proposed by Trencher et al. (2020). This approach enabled a comprehensive analysis of the interviews within the framework's established themes.

Reflexive thematic analysis (RTA) facilitated the data analysis process. RTA is a conceptually simple, adaptable, and interpretative qualitative data analysis approach that facilitates the identification and comprehension of themes and patterns within a data pool (Braun and Clarke 2012). Reflexive thematic analysis reflects the researcher's interpretive data analysis at the intersection of: (1) the dataset;

[1] Unfortunately, after several failed attempts to interview members from the national electricity and gas regulatory agency, we could not include their personal perspective in our research. Having, however, included a wide variety of other actors` voices as well as many public documents of the regulatory bodies, we believe that this does not have any effect on our analysis.

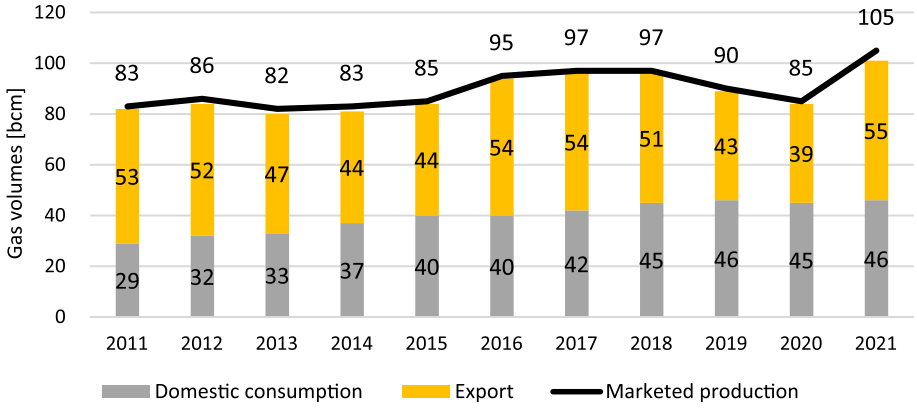

Fig. 2 Algeria gas production, consumption and exports (2011–2021) based on (Remadna et al. 2021) (Minor differences between overall production volumes consisting of consumption and exports amounts are due to losses or storages across years.)

(2) the theoretical assumptions of the study; and (3) the researcher's analytical skills/resources (Braun and Clarke 2019). For ethical reasons, personal information such as names and job titles were removed at the data analysis stage. Furthermore, no identifying information about respondents was made when quoting their statements.

5 Results

5.1 Overview of the gas sector

The oil and gas industry continues to dominate Algeria's economy, accounting for 19% of the gross domestic product (GDP), 93% of product exports, and 38% of budgetary receipts between 2016 and 2021. Moreover, Sonatrach the national state-owned oil and gas company which plays a crucial role in the country's economy, employed over 66 000 workers during this period (World bank 2023; Sonatrach 2022).

Figure 2 illustrates Algeria's gas balance over the past decade. Domestic consumption has steadily increased since 2011, mostly as a result of population increase and widespread gas use. Marketed output and export show a similar fluctuating trend. Exports were already on the rise before the war and rose even further in 2022. About 9 bcm (billion cubic meters) of gas were flared in 2020, positioning Algeria as the world's fifth-largest flarer and second-highest in global flare intensity (Global Gas Flaring Reducation Partnership 2022).

Fossil gas generated 95% of the electricity in Algeria in 2019 (Direction Analyse et prévision 2020). The country's installed capacity is expected to rise from approximately 20 GW (gigawatts) in 2018 to 36 GW in 2028, representing an annual growth rate of 6%. Given Algeria's slowness to implement measures on renewables and efficiency, we can expect this heavy reliance on gas for power generation to persist until at least the end of the decade.

This projection raises two concerns. First, there may be an excess of capacity unless scientists predict large power peaks or a rise in regional electricity exports. Second, the planned expansion of gas-fired capacity could significantly hinder the development of renewables. This situation highlights the risk of a gas lock-in scenarios within the Algerian electricity system. In the next section, we will organize the results of our analysis based on the identified lock-in categories identified in the framework of Trencher et al. (2020).

5.2 Technologies assets and infrastructure

The Algerian electricity grid provides extensive coverage throughout the country, which allows it to maintain its own power balance (Solar Power Europe 2021). The country also has well-developed connectivity systems with neighboring countries. In 2019, it exported a total of 6.5 GWh to Morocco and 135.5 GWh to Tunisia (Direction Analyse et prévision 2020).

Regarding consumption, in 2019 the residential sector was the country's largest customer, accounting for 33% of all power usage. The second largest consumer was industry, which accounted for 27% of total power usage (excluding the energy industry, which accounted for 11%). The commercial sector ranked third, accounting for 14% of consumption. However, significant losses of approximately 12% of total energy production were registered in the transformation and transmission of power (Direction Analyse et prévision 2020). These losses point to inefficiency within the electrical network, which is a technical obstacle for emergent technologies.

The expansion of gas-fired power plants from 1970 to 2010 (see Fig. 3) was justified by the goal of achieving universal electricity access. Indeed, the national electrification rate increased from 63% in 1980 to 97% in 2012 (Saiah and Stambouli 2017). Since the 2000s, Algeria has invested mainly in gas and combined cycle turbines, as steam turbines necessitate large amounts of water. Algeria's power

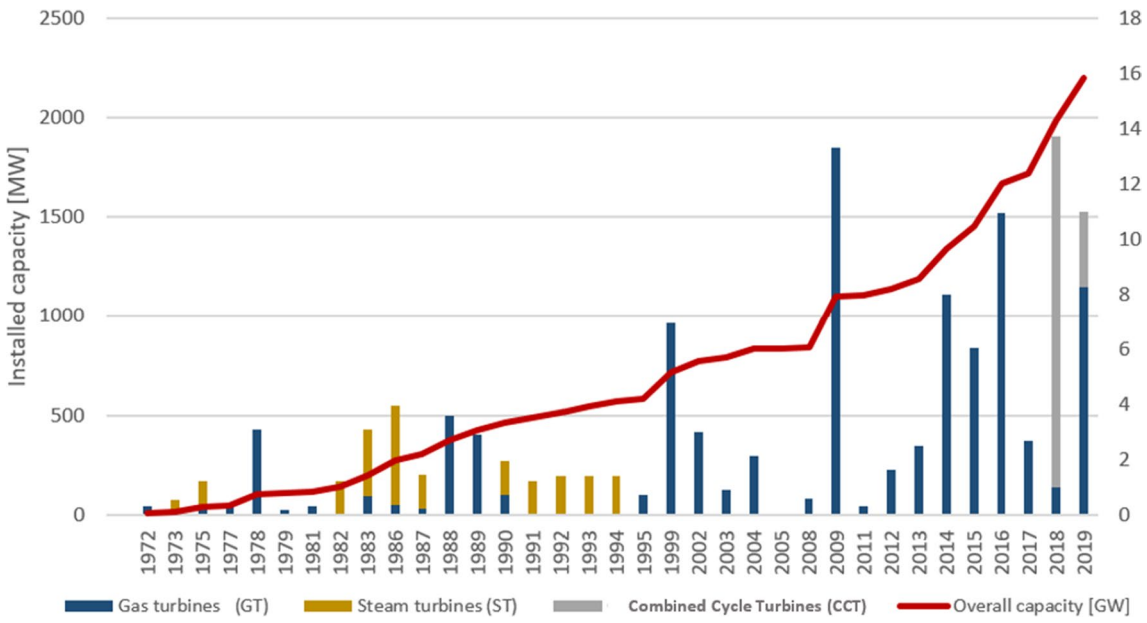

Fig. 3 Age of existing fossil gas-powered infrastructure (own illustration based on (Direction Analyse et prévision 2020))

plant fleet has expanded spectacularly since 2010, partially driven by the growing use of air conditioners.

Large CCGT's capacities were mobilized to satisfy the demand at the peak of summer, which is 40% higher than the average annual demand. Additionally, Sonalgaz and General Electric France have established the General Electric Algerian Turbine (GEAT), which produced the first CCGT in 2020 (Algérie Presse Servise (APS), 2021). This collaboration highlights Algeria's technological mastery of gas turbine technology, which further encourages the expansion of gas technologies in the country. However, these large investments in CCTG's have been interpreted as a result of lobbying (interview_01).

5.3 Actors and agency

In this section, we examine the various human actors involved in the gas lock-in.

5.3.1 Composition and power balances

Energy policy in Algeria is decided within the top echelons of the state, with significant technical input from oil and gas elites and little societal input. The absence of Algeria's highest decision-making body for the energy sector, the National Energy Council (NEC), during president Bouteflika mandate (1999–2019), enabled the private companies Sonelgaz and Sonatrach to exert technical influence over decision-making and further expand gas-fired power facilities. A regime-level energy body responsible for developing a national energy plan based on resources, foreign commitments, and long-term objectives,[2] the NEC has been inactive for the past two decades (Ouki 2019). The High Energy Council (HCE) was recently reestablished[3] to replace the NEC under the leadership of the President of the Republic and with participation from high government and military representatives.[4] Until recently, however, private sector and civil society organization (CSO's) representatives have been absent from the energy sector (interview_06). The limited number CSOs can be attributed to bureaucratic difficulties, as many of these movements remain un-institutionalized (interview_21).

5.3.2 Actor networks

The perpetuation of gas-fired power plants in Algeria is mainly supported by the oil and gas elites, who are potent energy sector players. However, weaker opposition from small renewable energy companies advocating for a reduction in planned gas capacity is also present (interview_01). Ministry personnel also frequently exchange positions with state-owned monopolies at all levels of management (interview_07), demonstrating the close relationship between

[2] Décret présidentiel n° 95–102 du 8 avril 1995 portant création du conseil national de l'énergie.

[3] Décret présidentiel n° 22–112 du 12 Chaâbane 1443 correspondant au 15 mars 2022 portant création du Haut conseil de l'énergie.

[4] Ministers of Defense, Foreign Affairs, Interior, Local Authorities and Regional Planning, Finance, Energy, Energy Transition and Renewable Energies, Scientific Research, Prime Minister or Head of Government.

state-owned companies like Sonatrach and Sonelgaz and the ministry of energy (interview_01). Unfortunately, the energy sector has witnessed large-scale corruption, which has weakened the sector's institutional capacity (Ouchene 2021). Furthermore, our analysis highlights a lack of transparency and communication from certain regulatory bodies. Added to its role in regulating electricity and gas sectors, the Regulatory Commission on Electricity and Gas (CREG) is mandated to publicly publish a bi-yearly capacity projection (interview_07). However, its latest accessible report dates back to 2008.,[56] Lastly, centralized top-down governance means that the local representatives are quite marginalized within the energy policymaking process (interview_13) (interview_12).

5.3.3 Vested interests

In terms of vested interests, the continued use of gas-fired power plants aligns with the interests of Sonelgaz, the utility company that benefits financially from being Algeria's sole electricity provider. Any competition from alternative energy sources would be detrimental to them. This situation has given rise to a "lobbying for gas" phenomenon, in which certain actors protect their interests while blocking any attempts to reform the system or to revise subsidies. In addition, industry is heavily reliant on subsidized fossil gas supply: gas accounts for 80% of industrial energy consumption (Drenkard and Mirakyan 2021). Thus, maintaining the subsidies supports the interests of industry owners: "*The parties or interests that would be mostly affected by a fundamental reform of Algeria's energy scene are private sector industries and businesses that have for a very long time benefitted a lot from the supplies of heavily subsidized sources of energy (and water as well).*" (interview_16).

All in all, Algeria's main source of power and financial interests lies in the rent generated by oil and gas exports. The oil and gas elites, who are influential participants in the energy sector, are the principal supporters of the country's continued use of gas-fired power plants. On the other hand, there is opposition from small renewable energy businesses and few CSOs and activists. The technical influence of oil and gas firms, their close connections to the energy decision-making bodies, an absence of transparency, and a centralized top-down governing paradigm all contribute to the current gas inertia. Additionally, Sonelgaz and business owners stand to benefit the most from maintaining the lock-in situation.

[5] CREG website: https://creg.dz/programmes-indicatifs/

[6] Unfortunately, we were unable to recruit any participants from the commission despite multiple attempts, therefore it is not represented in our study.

5.4 Formal institutions

In this section, we will analyze the major policies, regulations and commitments contributing to gas lock-in within the Algerian electricity system. In the second half of the 1970s, Algeria underwent a shift towards gas production after developing its oil industry during the 1960s and 1970s (Albinyana and Mañé-Estrada 2018). Since then, the government has committed to meet all industrial and household needs with gas (interview_04). While this domestic gas policy has not been updated to reflect the drastic technological changes in the global energy scene since the early 2000's, Algerian legislation[7] does prioritize meeting the country's gas needs while protect the right of future generations to hydrocarbon resources (Ghellal 2008). The absence of a long-term energy policy or serious political will to implement diversification policies have massively contributed to the current lock-in situation. In 2011, Algeria passed its first national renewable energy and energy efficiency program (PNEREE) with the objective of deploying 22 GW of renewable energy by 2030, accounting for 27% of the total energy mix (CEREFE 2020). However, the implemented capacity was limited to 475 MW, only 11% of the program target (Zahraoui et al. 2021). Algeria's national energy policy favored combined-cycle power technology, which allows for a 30% reduction in gas use in power generation (Ouki 2019). Implemented by GEAT, the local production of this technology started in 2019. Sonelgaz is obligated to purchase all of the factory's turbines for the next ten years. Since production capacity exceeds national demand, the company is implementing an export-oriented approach (interview_02).

Our analysis reveals that formal gas domestic policies and regulations are either absent, outdated or unimplemented, which is an important gas lock-in mechanism. Algeria's domestic energy strategy has strongly prioritized satisfying domestic gas demand with fossil gas, resulting in an uncontrolled gas consumption. This policy reasoning has not been updated since the early 1970s. Furthermore, CCGT and the renewable energy program are two supply-side measures that the Algerian government has used to control the gas usage. While the development of CCGT has been effectively achieved, the growth of renewables is still constrained due to a lack of political commitment.

5.5 Informal institutions

In this section, we will focus on the cognitive factors that resist change and thus cause gas lock-in in Algeria's electrical system. Such factors include beliefs, guiding principles and codes of conduct. The perception that Algeria is a

[7] Act N.05–07 of April 28, 2005.

gas-rich nation with sizable reserves significantly influences policy development, despite scientific predictions contradicting this viewpoint (see introduction). The widespread myth that gas expansion is beneficial for the energy transition is another lock-in factor. This misunderstanding has hindered the power generation industry from discussing environmental concerns (Kemfert et al. 2022), resulting in a lack of initiatives to cut emissions from electricity sectors. At the same time, fundamental sustainability principles are rarely considered when formulating national energy policy (interview_19). For example, the expanding capacity of the gas-fired power plants clearly indicate a future shale gas exploitation despite deep social opposition to unconventional gas (interview_21). The mismatch between political proclamation and actual implementation is another factor affecting the public engagement due to a lack of trust in political statements (interview_03).

In conclusion, we find that certain prevailing conceptions, like the non-depletion of gas resources in the country and the sustainability of gas as a transition fuel, underlie Algeria's overwhelming support for gas. On the other hand, the business sector's support for renewable energy sources has been hampered due to a gap between political declaration and practical diversification strategy implementation. For this reason, gas is still favored at all levels of energy policy decision-making.

5.6 Knowledge and competences

This section of our analysis will illustrate how Algeria's power sector lock-in is significantly influenced by its accumulated intellectual capital in gas technologies. Since its establishment in 1969, Sonelgaz has gained a high level of expertise in electricity generation from gas. This technical mastery justifies the company's bold opposition to the deployment of new technologies. Considering technological advancements like the use of renewable energy sources would demand an extensive and time-consuming requalification of all human resources. At the same time, the latest successful 2000 MWc solar energy call initiated by Sonelgaz initiated by Sonelgaz pertain to the exploration of the potential for a state-led transition (Energy magazine 2023). Besides it is worth noting Algeria's effective resource management. Amidst the turmoil of the early 2010s Arab Spring, Algeria, a major fossil fuel producer, subsidized essential food items like bread and grains. Consequently, this approach helped address the challenges of increasing food prices and food insecurity, both of which were significant causes of discontent in the MENA region. Thus, highlighting Algeria's approach could serve as an illustrative example of effective resource allocation. In addition, there are limited synergies between research institutes and governmental agencies in Algeria, such that research centers have only a modest influence on the energy sector. As such, research organizations play a minor role in the development of the country's energy policy (interview_15). By contrast, the country's technological development is primarily decided by Sonelgaz and Sonatrach: "Given the focus of their businesses (hydrocarbons for Sonatrach and electricity for Sonelgaz), each of these state-owned energy companies would in theory influence the policy making process in their respective sector of interest" (interview_16).

5.7 Micro-economic conditions

In this section, we will focus on two specific microeconomic factors that heavily restrain the adoption of new technologies: the power market and the electricity price subsidies.

5.7.1 Electricity market reforms

Sonelgaz[8] the state-owned utility provider, has held a vertically-structured power monopoly in Algeria since its establishment in 1969[9] (Solar Power Europe 2021). In 2002, the country began implementing a plan to transition into a market economy in the electricity sector,[10] leading to the conversion of Sonelgaz into a holding corporation. As part of this transformation, the statute called for the privatization and sale of enterprises in potentially competitive subsectors. These changes gave Sonelgaz monopoly over the market (Dyllick-Brenzinger and Finger 2013), preventing other private investors from entering the electricity market and giving Sonelgaz control over almost the entire Algerian power and gas market. Despite numerous attempts to liberalize the market and market production, which seemed the most practical approach (interview 04), objections of certain decision-makers have precluded any appreciable changes from occurring (interview 01).

5.7.2 Price and subsidies

Algeria's significant increase in domestic gas consumption is largely driven by heavily subsidized domestic gas pricing. With a domestic gas price estimated to be US$0.50/MMBtu, well below the cost of production, transmission, and distribution (Aissaoui 2016), Algeria has one of the lowest domestic fossil gas prices in the world after Turkmenistan and Venezuela. These subsidies amounted to over US$ 8 billion in 2018, accounting for more than 4% of the country's GDP, with fossil gas price subsidies comprising about 50% of the total (Ouki 2019). In 2019 alone, all state subsidies for

[8] Société Nationale de l'Electricité et du Gaz.

[9] https://www.sonelgaz.dz/fr/category/qui-sommes-nous

[10] with the passage of Law 01–02.

energy and gas cost the treasury 18 billion DA (120 million USD) (Drenkard and Mirakyan 2021).

Distributing national resources among the population is the main rational behind energy subsidies. Subsidies are unquestionably good in terms of promoting specific economic sectors or supporting specific social groups, but they also have a number of drawbacks. For instance, low electricity prices discourage energy savings. In addition, this pricing eliminates any possibility of alternative energy sources: "The heavily subsidized price of fossil gas used to generate electricity that renders any other source(s) of energy, including RE, non-competitive and continues to cause a wasteful consumption of Algeria's declining fossil gas reserves" (interview_16). Besides, subsidies fail to reach the poorest members of the population, who cannot afford electrical appliances. Thus, removing subsidies is a delicate decision, as it could jeopardize the country's national stability and security. However, revising energy prices to address the overconsumption of gas is a top policy priority. While subsidies for gas and electricity remain a significant obstacle to the adoption of alternative energy sources, the residential sector emerged as the largest consumer of power representing 33% of total usage. Encouraging a shift in consumer behavior towards renewable-focused providers, supported by subsidies, could potentially drive a positive change in Algeria's energy landscape. Encouraging households to procure electricity from smaller, renewable-focused companies, accompanied by gradual adjustments to subsidized gas prices, presents an interesting avenue for promoting sustainability. In conclusion, the monopolized electrical sector and the massively subsidized price of gas and electricity render any attempt to invest in other resources or compete with gas technology futile.

5.8 Context

This section will examine particular environmental and societal aspects that, despite existing outside the socio-technical regime, can significantly influence the lock-in synergy between gas and electricity. Heat waves and increasing electricity demand due to air-conditioning units are the fundamental environmental reasons underlying the rapid expansion of gas-fired power plants in Algeria. However, climate change variables are never included in energy policy design, particularly in the electrical sector (interview_08). The predicted increasing gas capabilities will prevent the country from deploying 22,000 MW of renewable energy by 2030, which would allow for a decrease of 350 metric tons of carbon dioxide equivalent (MtCO2) (Sahnoune and Imessad 2017). In this regard, the recent gas expansion does not align with the nation's climate objectives.

In terms of social conditions, civil war in the 1990s has left Algeria's civil society weak and fractured. Primary social demands center on fair distribution of rents¸ social justice, employment, and freedom of expression (interview_19). Environmental and energy concerns are not at the forefront of social demands, although the few interviewees who mentioned Ain Salah protests against shale gas fracking (see the gas section) demonstrate a certain level of environmental awareness among Algerians. Others see the anti-fracking protests as a rally cry against extractivism and the unfair distribution of rents (interview_20). Furthermore, the Hirak protests in 2019 (see Appendix) have been linked to a small claim for renewables (interview_08). In conclusion, the environmental aspect is overlooked in Algerian energy and electricity policies, with the population raising no environmental concerns regarding the country's use of gas to generate electricity. Thus, no pressure or opposition will impede the capacity expansion of gas-fired power plants.

6 Discussion

6.1 Discussing major gas lock-in mechanisms in Algeria

This section discusses the major gas lock-in mechanisms in Algeria, before taking a closer look at the impact the Ukrainian conflict on the energy transition in Algeria in the second subsection. Gas industry actors who derive their power from gas rents are the primary causes of institutional and behavioral gas lock-in. Indeed, they either influence policies and regulations at a design phase or prevent their implementation by mobilizing informal institutions. These actors influence energy policies to safeguard their own political, business and individual interests. While the political elites seek to buy social peace through cheap electricity prices, the businesses benefit from the low operation costs of highly subsidized electricity and gas. Large-scale corruption provides evidence that personal interests are prioritized over public interest (Table 1).

Another major behavioral lock-in factor is the absence of significant opposition against gas-fired power facilities, with the exception of small-scale renewable energy businesses. The private sector and CSOs are not effectively involved in the nation's energy policy formulation. This can be attributed to various context-related elements, such as the fragmented character of CSOs and a lack of confidence in the announced policies due to disconnect between declared formal institutions and actual implementation.

The context and microeconomics of the Algerian case are particular socio-economic forms of gas lock-in. Algeria's violent civil war is historically responsible for the country's deteriorated state of activism and weakened levels of social engagement. As a result, limiting the consumption of fossil gas is not a major priority for the public. Furthermore, any

Table 1 Fossil gas lock-in factors within the Algerian energy sector

Category	Factors
Technologies, assets and infrastructure	The electrical grid is optimized for existing central gas power plants The young age of infrastructure, esp. the sunk costs for gas fired power plants. The expansion of gas fired power plants from 1970 to 2010 is due to the government's initiative to provide electricity access to a rapidly rising population
Actors and agency	Composition and power balances: Oil and gas rents are a major source of income State bureaucrats and business class are the biggest benefiters from the oil and gas rents. This leads to strong oil and gas elites Top-down energy decision making with little input from society Actor networks: The perpetuation of gas fired power plants receives support from the oil and gas elite Weak opposition comes from small renewable energy companies Sonelgaz and Sonatrach have technical influence over energy decision-making Challenges due to large scale corruption in the sector Bureaucratic blocking of renewable energy initiatives Observed lack of transparency and communication Centralized top-down model of governance Vested interests Sonelgaz benefits from being the only electricity provider in the country Industry owners are benefiting from the heavily subsidized electricity and gas
Formal institutions	Prioritizing the domestic gas demand Answering all the energy needs with gas Weak political commitment to diversification effort CCGT is favored by the energy policy to reduce domestic gas use
Informal institutions	Algeria's informal energy policy norm prioritizes gas expansion as indispensable for the country's energy transition Sustainability principles like environmental impact, public health, and local community opposition hold minimal influence within Algeria's informal energy policymaking practices Within Algeria's energy policy landscape, a prevailing informal trend is the diminishing trust stemming from the from the discrepancy between political proclamations and their implementation
Knowledge and competencies	The historical expertise in gas technologies The absence of more progressive or independent research institutions with the ability to influence technology and political change
Micro-economic factors	Electricity market monopoly Heavily subsidized electricity and gas sector
Societal, geographical, technological and environmental conditions	Summer heat waves increasing overall electricity demand Weakened civil society movements

attempt to compete with gas resources in a monopolized market dominated by a state-owned monopoly has been rendered impossible by the logic of sharing the riches of gas among the populace through subsidies.

In both the planning and execution stages of national gas policies, informal institutions can also contribute to behavioral lock-in. On the one hand, prevailing attitudes and beliefs that conventional gas supplies are environmentally friendly and non-depleting discourage people from reducing consumption and delay the switch to cleaner sources. On the other hand, unfavorable administrative practices like non-transparent and bureaucratic obstruction, among others, prevent the implementation of energy diversification strategies.

Moreover, the gas turbine fleet is relatively new, which poses a serious infrastructural lock-in risk. Any short-term decision to transition to other energy sources would result in a large loss of capital due to possible sunk costs in the infrastructure. Furthermore, technological lock-in resides in the human capital. Skill requalification may increase the financial burden of adopting alternative technologies. The limited number of research and development centers aggravates this technological lock-in.

It is obvious that the hydrocarbon industry as a whole and the gas industry in particular have an impact on the power of the Algerian government. Thus, Algeria appears strong and powerful during times of high gas prices, but incredibly weak and vulnerable during times of low hydrocarbon prices. As a result, in contrast to domestic policies that discourage gas conservation, export policies tend to increase profit by aiming for high gas prices rather than higher gas volumes.

6.2 Discussing the effects of the war in Ukraine on the Algerian gas sector

The following section will explore how the Russian invasion of Ukraine in 2022 may potentially impact on the Algerian gas sector, either directly or indirectly. Despite the challenges posed by its domestic gas balance, Algeria has taken the opportunity to showcase the reliability of its gas exports to Europe, consequently enhancing its position in the European market. Export capacity has surged by 1/5 in 2022 (Energy (2022 ,(الطاقة), with significant export increases to countries like Italy, which in 2021 reached 21 (bcm), with a 4 bcm increase in 2022 and up to a 9 bcm annual increase over the next two years (NEWS WIRES 2022) (Algeria to Increase Natural Gas Exports to Italy by 50%—Middle East Monitor 2022). Such gas agreements enabled Italy to secure its supplies for the upcoming winter without having to rely on Russian gas (Bloomberg 2022) Similar gas deals are under discussion with other European countries, such as France and Spain.

On the one hand, the gas industry in Algeria appears to benefit from these gas deals with Europe. First, the Algerian oil and gas company Sonatrach has discovered three significant oil and gas deposits, including two gas reservoirs and a crude oil site, in its collaboration with the Italian oil company Eni. During the test phase, these resources produced 513,000 m^3/day of gas and 1300 barrels/day of oil and 51,000 m^3/day of associated gas (Komminoth 2022). Second, after decades of fruitless attempts to attract foreign investors, European oil and gas companies are now more inclined to invest in Algeria's hydrocarbon industry due to the energy crisis. Third, the European gas crises have given Algerian authorities an opportune chance to revise gas prices in long-term gas export contracts.

On the other hand, despite the temporary benefits brought by soaring gas prices, the situation will have several detrimental effects on Algeria's long-term transition pathways. The recently concluded long-term gas agreement will require the country to supply the agreed-upon volumes to avoid international sanctions. As a result, it will allocate significant public spending to support the oil and gas industry, thereby prioritizing the gas sector over the development of other sustainable alternatives. Furthermore, it is highly likely that Algeria will turn to its shale gas reserves if its conventional supplies are insufficient to satisfy both the long-term gas agreement and the nation's expanding domestic demand. This investment in conventional and unconventional resources will expose the nation to lock-ins and stranded assets, as the gas demand from Europe is expected to decline in the mid- and long-term. It will also have clear negative environmental effects. Continued social opposition to fracking might threaten social stability and impede the pace of economic diversification and energy transition in Algeria.

Historically, moreover, during times of crisis EU governments have not prioritized climate measures over other socioeconomic and political concerns, which makes their commitment to international climate policies questionable. This approach has adversely affected Algeria's engaged commitment to decarbonization efforts. Additionally, the Ukrainian conflict has intensified the political and military dimensions of energy, which will make any effort to transform the energy systems more challenging.

7 Conclusions

This paper has analyzed the gas lock-in mechanisms in Algeria's electricity sector and potential risks of lock-in associated with the country's domestic energy transition.

Our findings reveal that several key factors expose the gas and electricity sector to risk of a lock-in. First, we find significant political involvement in Algerian gas sector, driven by the need to safeguard various national and international stakes. In particular, Sonatrach has historically contributed to the country's economic development and sovereignty through export returns. The lucrative and political power of these oil and gas elites make them very powerful actors who wield significant influence over the country's energy decision-making. That influence drives formal energy policies to favor gas expansion, creating a techno-institutional inertia that leads to lock-in.

Our analysis also points to a major technological gas lock-in mechanism within Algeria's electricity system. This mechanism is primarily observed in the sector's intellectual capital, since any requalification of the technical employees would be expensive. A close examination of the fleet of Algerian power plants also reveals that the CCGT and gas turbines are relatively new. Because of the sunk costs in the gas infrastructure, adopting new technologies in the short term would expose the public utility to significant losses.

Subsidies are another factor contributing to socioeconomic lock-in, by locking-out other alternatives at the microeconomic level. While subsidies aim ensure an equitable allocation of gas resources, business owners appear to benefit more from subsidies than low-income individuals. Yet heavily subsidized electricity also contributes to social harmony, making subsidy revisions a very delicate topic in political debate.

Finally, despite Algeria's flourishing oil and gas industry, the country may not benefit from the Ukrainian conflict long-term. The war has increased the pressure for new gas investments, including long-term trade commitments, and these commitments pose a lock-in risk that will hinder and

slows the pace of Algeria's needed energy transition towards renewables and economic reform.

In light of these results, we can propose some policy recommendations. First, economic diversification is necessary to reduce the risk of gas lock-in. Reducing the country's reliance on the gas exports profits would dissipate the concentration of power within the industry, thus reducing the function of the gas industry to an element of an energy sector. In addition, implementing effective managerial techniques would improve the economic performance of state-owned monopolies. This would make it necessary to revise gas subsidies; however, such revisions should be carefully considered in order to protect the affected population.

Furthermore, when formulating gas policies, it is important to consider ecological damage, health implications, and—particularly in the case of shale gas extraction—future generations' right to use gas resources. Energy governance could also benefit from adopting more bottom-up initiatives, such as participatory governance, communication and transparency, as well as energy democratization. These measures would play a vital role in bridging the existing trust gap between public energy institutions and the population.

Europe's high gas demand presents a timely opportunity for Algeria. Nevertheless, Algeria's international gas strategy must be mindful of Europe's goals for carbon neutrality, carbon taxes, and the phase-out of fossil fuels, since a drastic demand decline is expected within the next 25 years. In these circumstances, expanding its gas production would expose Algeria to a risk of lock-in and stranded assets. Rather than prioritizing gas production expansion, Algeria should focus on lowering emissions from the gas industry. By actively engaging in global efforts to reduce methane emissions, through the sustainable use of natural gas and renewable energy, Algeria has the potential to become a major proponent and catalyst for a more sustainable future. Algeria may encourage the use of clean technology and renewable energy sources, promote regional cooperation, and support international efforts to combat climate change.

This paper has described gas lock-in Algeria's electricity system. Expanding our research focus to include the residential and industrial sectors is crucial for developing targeted strategies and interventions. By investigating consumer behavior, identifying barriers to alternative energy adoption in the residential sector, and exploring the structural causes of gas lock-in in industry, further research can pave the way for successful policy interventions and contribute to sustainability and climate goals. To properly grasp the country's overall gas lock-in, a further macro-level analysis of the international stakes in the Algerian gas sector is needed. Finally, additional global lock-in studies are essential to creating a framework for the planning of oil and gas phase-outs within the context of just transitions and achieving global carbon emissions reduction targets.

Appendix

The development of the oil and gas sector from independence in 1962 until 2023

To understand Algeria's gas lock-in, it is important to grasp its political and historical underpinnings. A brief overview is followed by description of the major events that have shaped Algeria's oil sector from the discovery of the first oil and gas fields until 2022: The late 1950s saw the discovery of significant oil and gas reserves in Algeria's Sahara. In 1961, the field of *Hassi R'Mel* started producing gas. In spite of Algeria's independence from France in 1962, hydrocarbons remained under bilateral French-Algerian administration. The state-owned oil and gas company SONATRACH[11] (National Company for the Transport and Marketing of Hydrocarbons) was established in 1963 (Albinyana & Mañé-Estrada 2018). In Arzew,[12] the Algerian company CAMEL[13] (Algerian Liquid Methane Company) developed the world's first commercial gas liquefaction facility a year later, delivering LNG to the United Kingdom and eventually to France (Aïssaoui 2001). Hydrocarbon resources were nationalized in 1971, and the government seized command of the industry through SONATRACH, which controlled gas production and delivery (Mañé Estrada, 2009).

Hydrocarbon development has been priority in the country's economic plans. This planning has included providing vital services to improve living circumstances as well as subsidizing the creation of new industries. External energy policy was directed with a logic that higher export income could be obtained by higher pricing rather than increasing export volumes (Aïssaoui 2001).

Major political events shaping oil and gas sector

Increasing hydrocarbon exports financed an industrialization program launched by president Boumediene (1965–1978). Gas export infrastructure was well developed during this period. Then, president Chadli Benjedid (1979–1992) abandoned the industrialization strategy in favor of agriculture and education while the hydrocarbon sector remained firmly in the state's hands (Aïssaoui 2001). SONATRACH played a critical role in increasing oil and gas production

[11] Societé Nationale pour le Transport et la Commercialisation des Hydrocarbures.

[12] Coastal city in northern Algeria.

[13] Compagnie Algerienne de Methane Liquide.

by cooperating with major oil companies. The national oil company provided the government with the required funds to address the rising social demands of the population but also preserving state control in general (Entelis 2011). The country then had an Islamic revolution in the late 1980s, which resulted in a decade-long civil war. President Liamine Zeroual's (1994–1997) has progressively replaced the communist economy with a market-oriented one, with the exception of hydrocarbons, which the government still held (Entelis 2011). The elected president Abdelaziz Bouteflika (1999–2019), introduced a different approach to halt the conflict: During his campaign in 1998, he urged Algerians to "forget and forgive" (Zeraoulia 2020). Bouteflika's presidency had the potential to rehabilitate Algeria's regime on the international scene, which had been damaged by severe human rights violations during the civil war that costed the lives of more than 200,000 people.

In January 2013 happened a terrorist assault on hydrocarbon site operated by Sonatrach, BP and Statoil in Tiguentourine. The attack increased the risk assessment component of future foreign ventures operating in the Sahara region (Aissaoui 2013). The Algerian military has invested many resources to the protection of hydrocarbon assets (Aissaoui 2016).

In 2014, Equinor, Sonatrach, and Shell were awarded the first shale gas licence (Ouki 2019). However, the operation enraged local residents, who were concerned about environmental consequences. The demonstrations forced the exploratory efforts to be halted (Algerie Focus, 2015). Five years later, massive protests from all socioeconomic strata took place on 28 February 2019 against Abdelaziz Bouteflika's candidacy for a fifth mandate (Zeraoulia 2020). Through legislative changes and staged elections Abdelmajid Tebboune became president of Algeria in 2019 (Ghebouli 2022).

The development phases of oil and gas in Algeria

Around 80% of the oil and gas production in Algeria is controlled by SONATRACH. The remaining 20% is split between two dozen International Oil Companies (IOCs) (US International Trade Administration 2021). The following section summarizes the key phases that have marked Algeria's oil and gas development. Three separate periods correlate to institutional changes introduced by successive oil and gas investment regulations.

Algeria took full advantage of the nationalization of the sector's activities in 1971 through the mid-1980s. Maintaining strong national control over hydrocarbon activities with an exclusive recourse to service contracts increasing its income share through competition. A second phase was started by the country's political and economic crisis since the mid-1980s: A collapse of revenues, a decline in oil reserves and an explosion of foreign debt in 1991 obliged the country to adopt a much more conciliatory economic policy, as symbolized by successive debt consolidation agreements with the International Monetary Fund (IMF). The hydrocarbon sector was negatively impacted by these events (Hamodouche & Khelif 2016).

In an attempt to attract foreign oil corporations, the government changed its policies and adopted a more open approach to upstream oil and gas with the establishment of the "production sharing" attractive contractual formula allowing IOC's to recoup the "cost of oil" and the "profit of oil" (Hamodouche & Khelif 2016). With the resulting influx of foreign companies, the hydrocarbon sector's activities are now organized around two poles: i) a public pole, centered around Sonatrach, where the state defines the orientations, and ii) a pole of foreign companies, whose weight is growing. The public pole must supervise activities of the pole of foreign countries through contractual terms, while ensuring conditions that still encourage them to invest and stay in the country (Hamodouche & Khelif 2016).

Since the early 2000s, Algeria increasingly followed the logic of independent growth, marking the latest phase of the hydrocarbon sector's history. One focus is sectoral growth, and the other improving the position in global oil and gas markets (Hamodouche & Khelif 2016).

Renewable energies in Algeria

Programs and actors

In 2011, Algeria passed its first national renewable energy and energy efficiency program (PNEREE). It aimed to have 22 GW of renewable power generation capacity by 2030, with 10 GW destinated for export. (Ministère de l'Énergie | Algérie, n.d.). Due to significant changes in the production prices of energy based on diverse renewable resources, the first edition of the PNEREE was revised in 2015 with an objective to deploy 22 GW of renewable energy by 2030, accounting for 27% of total energy mix (CEREFE 2020). The program goals was to install 4,395 MW between 2015 and 2020 but only 475 MW (11%) were actually built (Zahraoui et al. 2021). This delay of implementation is mainly due the lack of political will, which doesn't prioritize the energy transition. Besides the monopolized energy market dominated by Sonelgaz, the unstable regulatory framework and the current investment climate is not attractive for local private and foreign investors.

The switch to renewable energy was the driving force behind the establishment of numerous regulatory bodies, commissions, and research centers. The private sector, on the other hand, was focused on assisting the government

with its programs, resulting in the creation of a number of renewable energy firms in addition to the state-owned ones.

Barriers of renewable energy capacity expansion in Algeria

In 2016, the renewable energy fund titled "National Fund for energy management, renewable energy, and cogeneration," received the first inflows of funds reflecting the portion of the oil tax (1%) and the tax on gas flaring (55%), totaling US$ 209 million. Prior to this date, no money has been deposited into this account since its establishment in 2009 (Yaïci 2020).

In 2014, the feed-in tariff (FiT) program fixed 20-year contract to buy electricity from solar and wind power plants ranging from 1 to 10 MW.[14] The lack of thorough planning for the FiT caused by resistance to change among key stakeholders, has prevented its implementation. As a consequence, not a single investment proposal has been made under this initiative (CEREFE 2020).

Three years later a tender procedure for renewable energy generation replaced the FiT[15] in which investors had to satisfy an industrial component in addition to renewable energy generating. Requiring PV modules, cables, and mounting structures to be purchased in Algeria. In addition, there are no import fees on raw materials used in module production. This approach strives to reduce investment costs by producing equipment locally, while simultaneously creating jobs and stimulating economic growth. Solar photovoltaic systems deployed in Algeria have an average investment cost that is more than 30% higher compared to the global average. This is due to several factors, such as the remoteness of the construction sites, present weather conditions, and the distinctiveness of the applications such as the electrification of remote areas in the Algerian Sahara where high temperatures and frequent sand storms can damage the solar technology. Consequently, the tenders including the industrial component have not been successful in attracting sufficient investors. The 4050 MW project by the ministry of energy has never been the subject of any request for investors and only one-third of the projected capacity 150 MWc by CREG[16] was able to find a buyer (CEREFE 2020).

In 2020, a plan was proposed to generate renewable energy with a capacity of 16,000 MW by 2035. (CEREFE 2020) However, the "49/51 regulation" within the 2020 Finance Law limited foreign investment in Algerian companies to 49%. This accounted for "strategic" areas, including the upstream energy industry (Solar Power Europe 2021). Since early 2020s renewable energies are receiving more political attention. In December 2021, the Minister of Energy Transition and Renewables issued a 1GW tender in Algeria, (Ministère de La Transition Energétique et Des Energies Renouvelables—Ministère de La Transition Energétique et Des Energies Renouvelables, n.d.), with PPAs lasting 20 to 25 years. The Algerian Renewable Energy Company (SHAEMS), a joint venture of Sonatrach and Sonelgaz, would keep a 25% stake in the selected projects' SPVs.[17] To reassure international investors and attract more established IPPs,[18] the awarded PPAs[19] will be built to international standards, making it easier for investors to repatriate profits in international currency (Hayes 2022). Furthermore, for the initial tender, no local content will be required (PVMagazine, 2021). In 2022, this 49/51 sovereignty investment rule was abolished to encourage foreign investments

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[14] Order of February 2, 2014, OJ No. 23 of April 23, 2014.

[15] Executive Decree No. 17–98 of February 26 2017.

[16] Regulatory commission for electricity and gas.

[17] Special Purpose Vehicle: is a subsidiary that a parent business establishes to insulate itself from financial risk It might have been formed to take on a high-risk project while keeping the parent company safe(*Special Purpose Vehicle Definition (SPV)*, n.d.).

[18] Independent Power Producer's.

[19] Power Purchase Agreements.

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