International Journal of Coal Science & Technology (2025) 12:20
https://doi.org/10.1007/s40789-025-00766-5

RESEARCH

Policy coherence analysis of Türkiye's lignite production and the Paris agreement ratification: an investigation through the water-energy-climate nexus

Suleyman O. Altiparmak[1]

Received: 22 November 2023 / Revised: 10 June 2024 / Accepted: 1 February 2025

Abstract
Lignite provides energy security and contributes economically. However, it also causes dirty outcomes in terms of climate aspect. In addition to the energy and climate dimensions of the Sustainable Development Goals, there is also a water issue: lignite is usually found submerged below the local groundwater tables. Mining lignite could be exploited to achieve drinkable and agriculturally usable water. In today's literature, while the impact of lignite production on global warming and emissions are already highly discussed, the water management side of the issue is regularly omitted. However, considering the complex interlink between these three areas (the Water-Energy-Climate (WEC) nexus) is necessary within policy coherence, which is mostly ignored even though it is one of the development targets. Here in this framework, Türkiye, which aims to reduce its heavy dependency on energy imports, is worth studying because almost all of its coal, the country's largest fossil resource, is lignite. Therefore, this study examines the WEC nexus related to lignite production and combustion and seeks policy coherence between their outputs in the context of Türkiye's historical steps to climate change mitigation, specifically oriented with the Paris Agreement. This story expands from the absence of specific development policy objectives to the practicalities of politics and economics.

Keywords Türkiye · Lignite · Water-energy-climate (WEC) nexus · Paris agreement · Sustainable development goals

1 Introduction

Globally, coal is the main energy source for electricity generation, and it is expected that this supremacy will continue for decades (Melikoglu 2018). However, coal is also the largest single source of greenhouse gas (GHG) emissions, thus generating a unique problem for a global transition to lower carbon energy systems (IEA 2022a). Türkiye's approach to coal-based power generation is grounded on a strategy to reduce the country's dependence on imported natural gas (IEA 2021b). However, Türkiye imports a significant amount of the coal it consumes; the nation imported nearly 40 Mt of coal in 2020 (IEA 2021a). Coal has been an important energy source for Türkiye so far; however, its demand is expected to decrease due to constant growth in the nation's renewable energy market (Melikoglu 2018). In 2019, Türkiye produced 90 Mt of coal, out of which 96% was lignite (IEA 2021b). In the same year, Türkiye imported nearly 38.1 Mt of coal, which supplied nearly 38% of the country's electricity generation (IEA 2021b). Therefore, even though the renewable energy market is growing, coal is and will continue to be an important energy source for Türkiye.

Türkiye is a net energy importer, and the Turkish government is determined to decrease the country's dependence on imported energy sources, because Türkiye does not have significant amounts of natural gas and petroleum reserves. The country's only abundant indigenous fossil fuel reserve is coal. Thus, Türkiye, a developing country with significant economic ambitions, strongly emphasises coal utilization both for decreasing the country's huge energy bill and for reducing its dependence on imported energy sources. This policy was designed due to the concerns regarding energy security and economic independence; however, while it may have been sustainable in the twentieth century, energy policies in the twenty-first century must be redesigned to cover and provide solutions

✉ Suleyman O. Altiparmak
altipar2@msu.edu

[1] James Madison College, Michigan State University, East Lansing, MI 48825, USA

for energy-related environmental impacts. All of the coal sourced within the country, as well as substantial amounts of coal imports, are allocated to fuel the nation's coal-based electricity generation facilities. This allocation is significant, not only because it is the primary contributor (though not the sole one) to the carbon dioxide (CO_2) emissions under consideration but also due to the fact that Türkiye's coal-fired power plants, such as geothermal power stations, are widely recognized for the air pollution they produce and the social disputes they give rise to, as observed in places like Aliaga and Gerze. However, another important environmental outcome associated with coal concerns water. As the world focuses more and more on global warming and GHG emissions caused by coal production and consumption, this point is mostly overlooked in the literature.

Lignite is usually found below the local groundwater tables, which necessitates significant dewatering through pumping efforts to lower the groundwater tables below the levels of the open-pit mining activities (see Fig. 2). Here, three main points need to be considered: pollution potential, opportunities and long-term effects. First, regarding pollution potential, when the originally anaerobic water is pumped to the surface, it becomes oxygenated, which can lead to significant acidification, especially if the water contains high levels of metal sulphides (Friese et al. 1998). Due to this acidification, heavy metal compounds become soluble, causing toxification of the acid mine drainage water, which can have significant negative impacts on surrounding environments when released (Hogsden and Harding 2012; Simate and Ndlovu 2014). However, when addressing the generation of these toxic wastewater streams in holistic planning processes that include appropriate wastewater management, several opportunities arise (Simate and Ndlovu 2014). Such wastewater treatment measures can include a wide number of different processes (Maiti et al. 2019). However, they are expensive and greatly increase the costs of lignite mining. Nevertheless, when implemented correctly, the additionally gained freshwater resources can lower the need for significant transport costs for the water used in the subsequent energy generation process (e.g., cooling water) or agriculture (e.g., irrigation water), especially in water-scarce regions. Furthermore, depending on concentrations, costs could be offset by obtaining valuable compounds (e.g., metals, phosphorus) from the mining wastewaters (Simate and Ndlovu 2014). Finally, to avoid sustainability problems, lignite mining and the resulting high pumping rates of mining water over several years need to be considered in long-term water resource management plans (Grünewald 2001). Once mining operations cease and restoration to the original hydrological conditions begin, critical problems for regional water resource availability with regards to quantity and quality of groundwater and surface waters can arise, as has been the case in several regions of heavy lignite mining in Germany (Grünewald 2001).

Whether Türkiye's lignite supply policy does or does not cohere matters because Türkiye recently ratified the Paris Climate Agreement (hereinafter referred to as the Paris Agreement). The goal of this agreement is not limited to preventing global warming and helping countries reduce their carbon emissions; it aims to form two of the three main programs of the post-2015 agenda together with the United Nations (UN)—the 2030 Agenda for Sustainable Development (UNFCCC 2023). Among 17 development goals, goals 6, 7 and 13 are related to water use, clean energy and climate mitigation, respectively. In the literature, the technical aspects and environmental outputs of lignite production (Widera et al. 2022; Wan et al. 2022) have been studied, along with the aspects that concern Türkiye (Atilgan and Azapagic 2015; Şengül et al. 2016). However, lignite production efforts' meaning in terms of policy coherence, which is mostly ignored though it is one of the development targets (OECD 2015), has not been investigated yet. The climate-related outputs caused by the generation and use of the energy resource that exists in the watershed concern the three main sustainable development targets mentioned. Lignite production is connected to these three fields, which are interlinked and will be called the Water-Energy-Climate (WEC) nexus (see Sect. 2). Therefore, despite extensive research on lignite's impact on global warming and emissions, the intersection of water management, energy output and the WEC nexus-led by this remains underexplored. This study aims to fill this gap by investigating how Türkiye's lignite policies align with its commitments to the Paris Agreement. This can be achieved by elucidating the aspect of lignite production techniques overlooked in the literature, which pertains to the mentioned three Sustainable Development Goals (SDGs). Subsequently, a further discussion can be undertaken regarding the context of ratification of the Agreement. While addressing this, establishing a conceptual framework for policy coherence allows for the analysis of whether lignite production conflicts with or contradicts these goals (see Sect. 3).

With its participation in the Paris Agreement, Türkiye not only has the motivation to act internationally against climate change, but is also a developing country, which makes the SDG is important for Türkiye in this respect. The coherence between SDG attainment in a national context should be researched because it receives limited attention. Therefore, although the focus of this study is lignite production in Türkiye, its results provide a clear, generalised explanation of struggling with cleaner production. Moreover, such an analysis would also engender a theoretical debate on the potential disparities in policy coherence concerning the economic aspirations of developing nations. This study finds that the point where coherence approaches to sustainability suffer the most is where policy and politics come into contact, which is economics. Nexus approaches have been conveyed with environmental dynamics that affect each other; however, the first item of SDG is about the economy, and when three different fields, such as in the case of lignite production, do not fully match with each other, the economy factor becomes a part of the process as an indispensable factor. In other words, full integration of environmental and non-environmental realms is needed for cleaner production. These findings reveal a generalizable and argument applicable to various empirical points in the policy coherence literature, highlighting that economic concerns for developing nations create a different context compared to developed ones.

Here, this work finds two layers. First, what makes clay lignite interesting is that it is a contradictory situation for the WEC. National energy demands promote its use at the expense of climate and water impacts. The water impacts are limited because water, which is unusable before energy production, becomes usable water (drinking and agriculture) after production. Thus, its outcomes are *dirty* in terms of climate and *dirty* in terms of energy, but it is also *positive* due to its contribution to the economy and energy security. Therefore, depending on the efforts put into sustainable water management solutions, it may be either *dirty* or *clean* in terms of the water aspect. Second, political factors militate coherent approaches to sustainability because supporting decisions that do not work economically and politically do not help decision-makers and can even undermine them. Examples of this include both the case of lignite production and the relationship between that production and the ratification of the Paris Agreement.

To reach the focus of the study, one must analyse the technical characteristics of lignite production, what it means in terms of SDG and its importance for Türkiye (see Sect. 4). Moreover, the process of Türkiye's approach to multilateral climate agreements, in particular the Paris Agreement, should be followed, along with Türkiye's recent energy investment and production path (see Sect. 5). Considering Türkiye's approach to global climate mitigation efforts, it will be easier to understand how this is (in)coherent with the lignite case. Then, the conceptual framework can be operationalised to the analysis in the discussion section (see Sect. 6). This section is divided into three parts; the first examines the political context of Türkiye; the second part provides an intertwined connection between policy and politics; the third part concludes the findings.

Primary data were meticulously gathered from both Turkish and English open online resources, with Turkish government publications such as those from TÜİK (Turkish Statistical Institute) and TKİ (Turkish Coal Enterprise), as well as official gazettes (*Resmî Gazete* in Turkish) translated into English by the author, employing a rigorous qualitative analysis to ensure comprehensive and accurate interpretation within this study's framework. The data collected is employed to analyse Turkey's participation in the Agreement, elucidating the measures taken to address universal climate change mitigation and contextual factors shaping the role of lignite production within the country's market as a case study research.

2 Literature on the water-energy-climate nexus

A primary debate on the WEC nexus concerns how the production of one impacts the others (Hoff 2011). The human demand from nature's supply can either trigger problems or generate potential solutions to different sectors (Mohtar and Daher 2012; Biggs et al. 2014). In other words, this explains people's various demands from nature and what nature actually provides. For example (Mahlknecht et al. 2020; Molajou et al. 2021), water is needed to produce energy for cooling utilities, mining and creating hydropower, while water distribution and desalination can only be done with energy.

If the security of natural resources is defined as their availability, affordability, accessibility and stability (Gain et al. 2015), because of the above-mentioned complex needs, finding the security of the entire nexus becomes difficult. Under the interaction of human demand and nature supply, security orientations differ. The security of the nation, human health, livelihood and ecosystem have to be considered (Taniguchi et al. 2017), which requires a socio-ecological system that investigates the management and use of natural resources (Norouzi and Kalantari 2020). However, specific cases might create more complexity than conceptual frameworks.

The WEC triangle is based on the mutual influences among the three aspects (see Fig. 1). For example, it is applied to groundwater-irrigation intensification, electrical energy supply and climatic variability in the Mexico case (Scott 2011). The increasing temperature would raise electricity demand for cooling and water supply, while rising power demand and supply would increase emissions. There is also a negative view regarding water and wastewater infrastructures because of their contribution to climate change; moving such massive quantities of water requires significant energy (Adler 2013). Rainfall is another aspect that needs to be considered regarding climate change (Sahin et al. 2014). Population growth has enhanced the water and energy requirement; for the achievement of the SDGs, the connection between the increased need for water and energy and CO_2 emissions is worked on during the assessment of food and beverages (Leivas et al. 2020).

Concerning the WEC, China is important because of its rapid economic growth and its reliance on coal production, which is approximately 60% of the country's entire energy

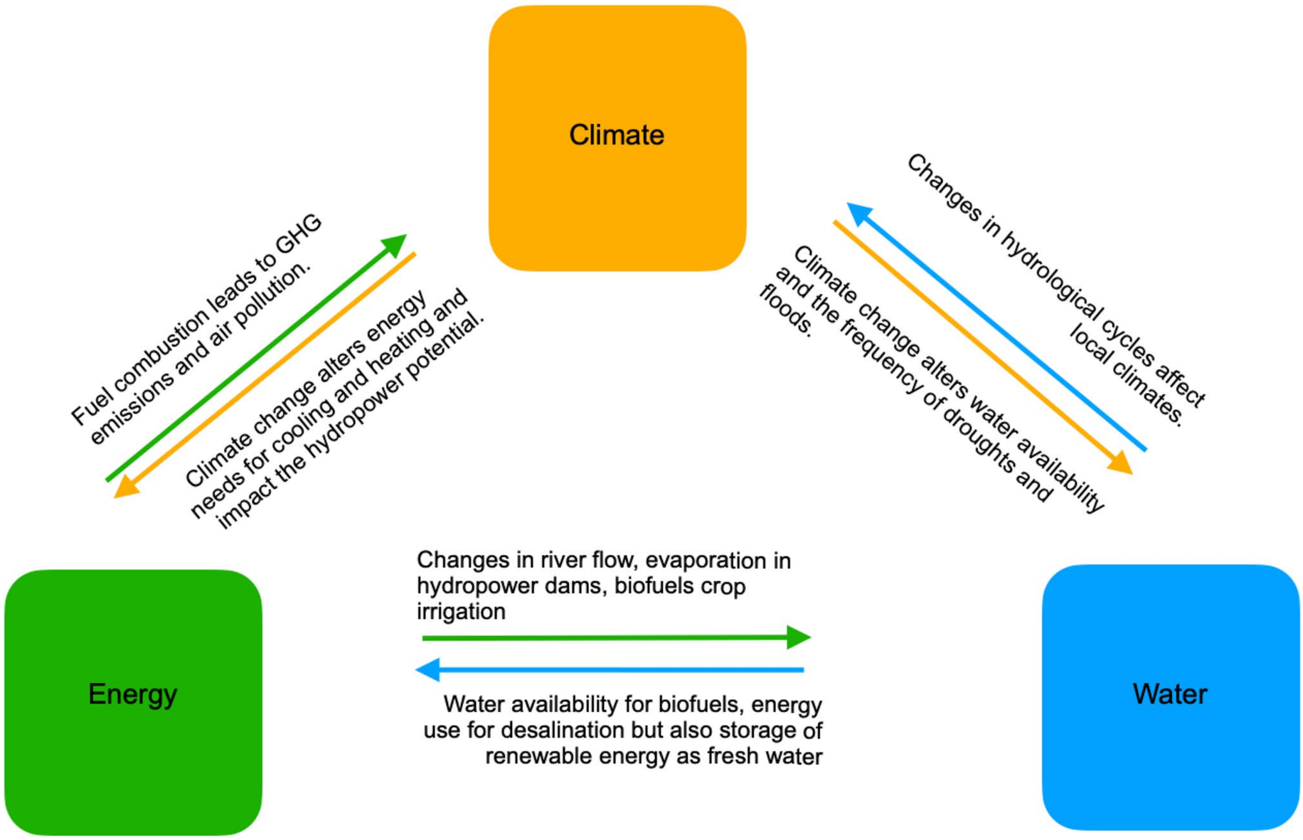

Fig. 1 The water-energy-climate nexus

share (EIA 2020). Coal production and climate change are directly linked; however, China also has a water-stressed issue in some regions that need high water intensity to produce energy via coal (Zhu et al. 2017). While coal is already an important aspect in terms of cleaner production impact on the environment, the lignite case is much more complex and thus worth examining.

Coal exploration uses large volumes of water (i.e., quantity), but the water becomes highly polluted (i.e., quality) because coal might be used for "cutting and preventing the spread of dust in extraction and transportation, washing to increase the quality of coal, regeneration of mine bed" (Molajou et al. 2021). "Higher water and air temperatures make cooling processes in coal-fired power plants less effective and potentially reduce water availability during longer dry periods; this could result in an overall reduction of power plant efficiency and higher carbon emissions" (Conway et al. 2015). However, lignite is unique among coal types, as it exists in waterwells; hence, initial dewatering is required (see Fig. 2). Water should be removed to produce energy, which impacts climate. Moreover, water should be pumped for making the mines accessible. This aforementioned water covers part of the power plants' needs, the irrigation needs of the neighbouring farms and, in some cases, even the needs for drinkable water (Tran et al. 2015). Thus, the lignite production process and outputs are complex WEC matters.

3 Conceptual framework: Coherence between Sustainable Development Goals attainment?

A universal and integrative policy agenda of the SDGs requires interactivity between participants from different layers. While aiming for national implementation, different interests and purposes should not conflict; rather, they must cohere (Persson et al. 2016). For the 17.14 target (OECD 2015), sustainable development requires the enhancement of policy coherence across environmental, social and economic goals. Here, conceptual clarity and framework on how to approach the term "policy" are needed. The concept of environmental policy has two main pillars in the literature—*integration* and *coherence* (Tosun and Leininger 2017).

On the one hand, environmental policy integration aims to balance environmental and non-environmental objectives (Lafferty and Hovden 2003). Therefore, it is an establishment of environmental concerns in non-environmental policy sectors (Runhaar et al. 2014). This normative stance

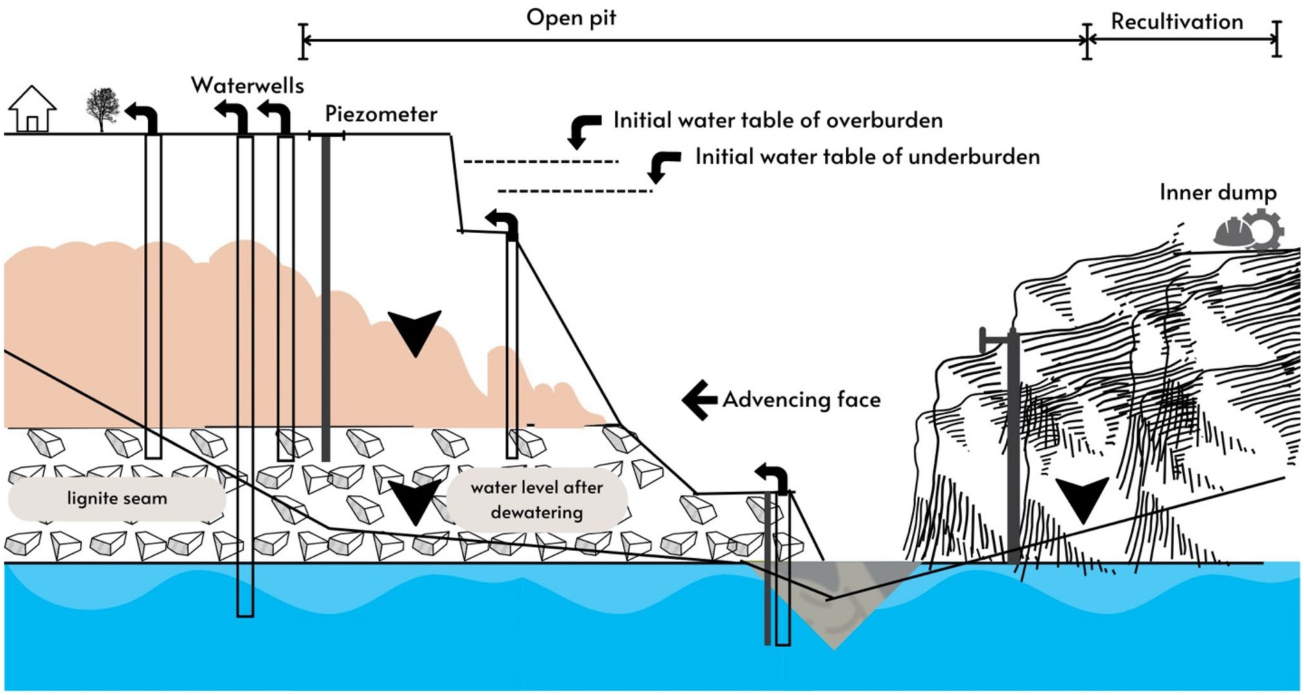

Fig. 2 Dewatering method of lignite open pits. Redrawn version of Kavouridis (2008)

is oriented to coordination, the search for win–win and the notion of reciprocity (Jordan and Lenschow 2010). Interests of stakeholders from multi-sectors and multi-levels must be coordinated; however, this cannot be achieved without political interference. The entire process of environmental policy integration, which involves decision, organisation, management and maintenance, needs the help of politics. A healthy structure should be formed as follows: the political system (institutions), the political context (politics) and the social, legal and administrative tradition of a policy (cognitive predispositions) (Jordan and Lenschow 2010). Institutional frameworks are necessary but insufficient without political leadership, will or commitment. The cognitive aspect would help to analyse the source of the actors' interests that stimulate political conflicts. In this formula, economic and financial factors should not be ignored, because politics and economics, which create tangible requirements and demands in policy mechanisms, are different from each other but are not separate. When analysing the parts of a structure, basic questions such as "what works where and why?" should be asked (Runhaar et al. 2014). The answers to these questions would reveal how relative it is to people's positions, priorities and interests.

On the other hand, policy coherence, which is development policy-oriented (Tosun and Lang 2017), did not occur with the SDGs, but it gained momentum with them. Meanwhile, policy integration studies are focused on climate and environmental policy (Tosun and Leininger 2017). There is no agreed definition of the concepts of policy coherence and, in connection with it, sustainable development, because these concepts are vague; however, they have some clear, fundamental parts (Grabel 2007; Hickel 2019). Coherence is composed of both intra- and inter-national realms. While the intra level needs both vertical (between different levels of government, from local to national) and horizontal (across key government ministries, departments and agencies) coherence, the inter level is made of transboundary coherence (UN 2018). If the efforts are not spread across a long period of time, they will be meaningless (OECD 2015; UN 2018). The stakeholders mentioned in the domestic and international fields would reveal that there is an interplay between policy and politics (May et al. 2005, 2006). Without resolving this link between policy and politics, it would be difficult to achieve policy coherence.

Tosun and Leininger (2017) provide a clear framework to analyse national implementations' policy coherence. Firstly, two different approaches are accepted; the substantive approach involves changing policy content and "goods and service production and delivery in society," whereas the procedural approach concerns altering only the policy process (Tosun and Leininger 2017). Secondly, two different interlinkages are accepted between SDGs; the intersectoral approach involves national governments announcing procedural or institutional changes to policy-making and implementation in order to attain policy coherence, whereas the multisectoral approach entails substantive policy changes

(Tosun and Leininger 2017). The Türkiye case has been found to be intersectoral and procedural under centralised authority (Tosun and Leininger 2017). However, this research aims to take Türkiye's policy coherence analysis to the next step; it examines the lignite case and discusses it within the political context. In this specific case study research, we expect the altering only the policy process approach to attract dynamics independent of the policy itself.

In policy process analysis, the subject comprises the issue of governance—public, private and hybrid policies and rules and their systemic interaction (Visseren-Hamakers 2015), whether it should be top-down, bottom-up or interactive. It is believed that a top-down approach will not always be successful (Runhaar et al. 2014) because bottom-up and interactive dynamics are more efficient and effective. Here, two basic conceptualisations should be considered—government-centred and governance-centred approaches (Tosun and Lang 2017). For the first, as mentioned above, coordination, cooperation and political leadership are necessary, while for the latter, efficiency and effectiveness of policy implementation are crucial. In the first, what is done and what is aimed for are vital, while the second also considers how and with whom it is done. Since the dynamics in Türkiye are in the first direction (Tosun and Leininger 2017), the political context analysis will be government-centred.

4 Lignite within the WEC

Lignite extraction is feasible in nearly every region of Turkey. However, particularly notable is the exceptionally high quality of lignite found in the western part of the country. Extraction areas are prevalent in locations such as Manisa-Soma, Kütahya-Tavşanlı, Kütahya-Seyitömer, Bolu-Mengen, and Erzurum-Aşkale.[1] Due to their typically low calorific value, lignite from Muğla-Yatağan, Kahramanmaraş-Elbistan, and Kahramanmaraş-Afşin is primarily utilized in thermal power plants. Almost half of the country's lignite reserves are in the Kahramanmaraş-Elbistan basin. Turkey's lignite deposits have ramifications extending beyond energy and environmental spheres that are investigated in this work, encompassing experiences and concerns related to health and safety (GBP 2018). Instances such as mine disasters, explosions, and illicit mining serve as illustrative examples of these broader concerns. Within this overarching feature, the implications of lignite production for the country can be examined. However, initially, it is imperative to elucidate the nature of lignite production techniques and their placement within the WEC framework. Subsequently, an exploration of their tangible significance for Turkey is warranted.

4.1 Lignite supply

Coal, one of the most environmentally dangerous fossil fuels, is combusted and used to generate electricity. It appears as black or brownish-black sedimentary blocks (EIA 2022). There are four major types of coal: (i) anthracite, (ii) bituminous, (iii) sub-bituminous and (iv) lignite (Melikoglu 2017). In 2019, 26.8% of global energy was supplied by coal production (IEA 2021c). Despite environmental considerations, coal is attractive because it is relatively cheap, and its mining, excavation, transportation and processing are comparatively easier than other fossil fuels (Melikoglu 2018). Moreover, the global energy crisis, triggered by the pandemic and the war in Ukraine, has put countries under pressure and even pushed the EU to reconsider coal usage (IEA 2022b). The world's coal output expanded by 5.7% (just above the 2019 pre-pandemic level), and Germany's coal production increased by 17% in 2021 (Enerdata 2023). However, the environmental impacts cannot be ignored. GHG emissions impact the local air and contribute to global warming. The types of GHG are primarily CO_2 and pollutants such as nitrous oxide (NO_x), sulphur dioxide (SO_2) and particulates (Kazanc et al. 2011). Moreover, climate is not the only sphere that could be affected. The extraction and combustion of coal could also negatively impact water and land, thereby affecting food production (Glina et al. 2022). For example, coal ash in the environment sometimes transforms insoluble metals into soluble species and leads to water and soil pollution (Polic et al. 2005).

However, lignite provides a unique case regarding coal production and its environmental outcomes. Lignite is the lowest rank of coal; it contains low amounts of energy since its carbon content is approximately only 25%–35% (EIA 2022). Since it is crumbly and has a high moisture content, it provides a relatively low heating value in comparison to other coal types. While lignite's heating value is between 3500 and 4610 kcal/kg, those of other coal types range between 4610 and 7780 kcal/kg (TKİ 2021, p. 4). Moreover, the energy content of hard coal is between 16.5–32.5 megajoule (MJ) per kilogram, but lignite has an energy content of less than 16.5 MJ/kg (HEAL 2018). A gap exists with other fossil fuels as well; for instance, coal's heating value is already much lower than that of oil and natural gas (Kavouridis 2008). However, lignite is still attractive to produce because it has a low extraction cost due to opencast mining. Additionally, pre-drying lignite can reduce CO_2 emissions (Zhu 2012); the dewatering of the mechanical treatment of waste and coal recovery may contribute to a 40% improvement in the eco-toxicity potential (Lelek and Kulczycka 2021), while burning coal with high levels of

[1] Türkiye's lignite deposit map, displaying the deposits as of their size, can be seen (Cografyaharita 2017).

moisture creates some environmental problems such as high CO_2 emissions (Pusat et al. 2015) (Oney 2020).

Since lignite usually exists slightly below regional groundwater levels, there is a need for dewatering initially to allow for open-pit mining (see Fig. 2). Water should be pumped before one can enter the mines. In case sustainable measures for water management and wastewater treatment are integrated, this aforementioned water, which was not explored as a water resource before mining (Kavouridis 2008), has the potential to cover part of the power plants' needs, the irrigation needs of the neighbouring farms and, in some cases, even the needs for drinkable water (Tran et al. 2015). Contrarily, without the correct treatment, water pumped out of lignite reserves could acidify and lead to changes in soil and water quality, which could damage the environment after extraction (Nanaki et al. 2016). Therefore, water management is crucial for sustainable lignite mining. Once operation ceases and the coal mine can be flooded, the water quality may gradually improve. Moreover, many long-abandoned coal mines discharge water of good quality (Wolkersdorfer and Mugova 2022). However, lignite combustion remains a carbon-intensive and, based on pollution potential, relatively dirty energy source (Wright 2010) because two-thirds of the mined fuel contains water and impurities (Michel 2014). Therefore, while lignite production can, if done correctly, cause positive outcomes regarding water purification and agricultural opportunities in the local environment, lignite consumption still causes significant emissions. This distinctive technical aspect of lignite production warrants examination within the framework of the WEC nexus, as it intersects with water, energy, and climate domains. Key inquiries, such as its alignment with the broader sustainable energy policy framework of the country and the extent of coherence, need to be addressed. Due to this, it is vital to analyse how nations like Türkiye, which depend on foreign energy sources, view lignite production's advantages and disadvantages.

4.2 Importance for Türkiye

One of the largest challenges that Türkiye faces in the twenty-first century is its dependence on fossil fuel imports from foreign sources (Ediger and Berk 2011). The country's oil and gas imports comprise 93% and 99%, respectively (IEA 2022b). Low oil and gas reserves have increased coal production, which comprises 38% of the entire production, whereas renewables' share (including hydro) was 54% in total energy production and 44% in total electricity generation in 2019 (IEA 2021b). At 96%, lignite has the largest share in coal production. Despite global attempts at decreasing coal production, Türkiye provides several incentives to encourage both coal mining and domestic coal use in power generation, especially since 2015 (see Fig. 3). Though its calorific value is below 2500 kcal/kg, it is still attractive to a country relying on foreign sources (MTA 2021). Türkiye holds the sixth largest proven reserves in the world; hence, the government encouraged investment in lignite production to increase the country's share in global lignite production by 2020 (BGR 2022). Currently, Türkiye is the fourth largest lignite producer in the world (BGR 2022), which will support the economic growth aims of the country. Therefore, although investment in renewable energy has increased, coal still has a significant share.

Türkiye's Vision 2023 total installed capacity has been set to 12,0000 MW, which includes the nation's tripling (×3) lignite-based installed capacity policies (TEIAS 2022). It is expected to have approximately 3,0000 MW installed capacity based on lignite, which would produce 12,0803 MWh

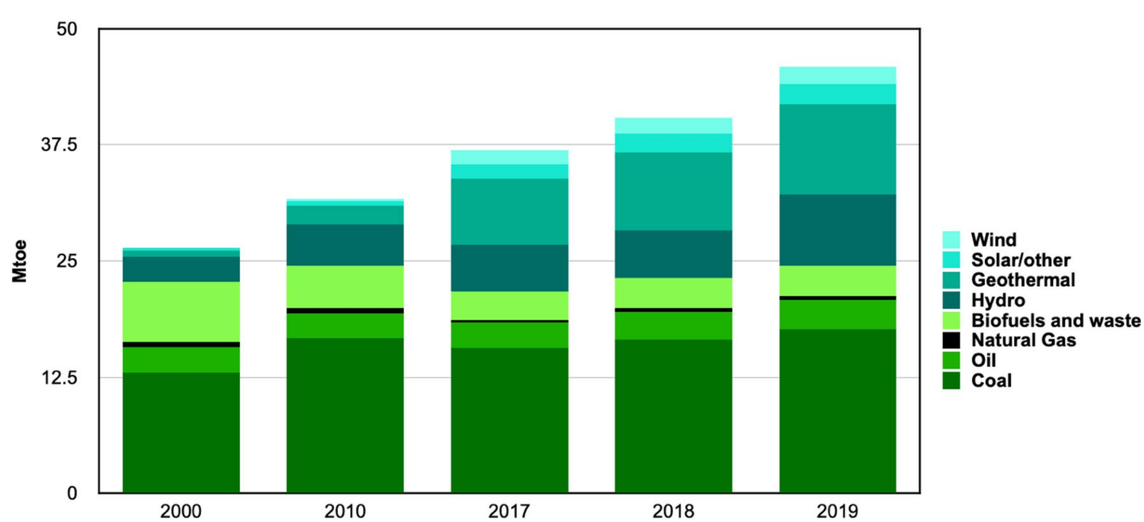

Fig. 3 Energy production by source, Türkiye, 2000–19 (IEA 2021b)

of electricity annually and provide jobs for 5,9000 people (Melikoglu 2018) (Oney 2020). However, the results will include rising GHG emissions in addition to an increase in energy production. There is already a debate on how coal power plants' environmental impact affects the health of local people (HEAL 2018). In terms of the contents of Türkiye's lignite, sulphur, fixed carbon, volatile matter, ash and moisture range between 0.2%–10.7%, 8.9%–44.1%, 18.3%–43.8%, 5.2%–56.1% and 1.2%–57.7%, respectively (Tuncalı et al. 2002). Such conventional technologies cause severe environmental pollution, proving the need for environmental legislation (Atimtay et al. 2017).

In terms of non-environmental dynamics, lignite production provides indispensable value for Türkiye. From an environmental point of view, it contributes to energy security, a helpful factor in terms of access to clean water and harmful in terms of climate change. However, the nation is pursuing sustainable solutions for climate change. For example, buildings in the district of Soma, known for rich lithium reserves, used to be individually heated by coal boilers, which led to heavy air pollution, safety problems[2] and health risks. However, the Municipality of Manisa and the Soma Electricity Production Incorporated Company entered into collaboration and invested in a district heating system that started operating in 2013 (SOG 2022). The Danish Export Credit Agency, EKF, took part in the financing of the project. By 2022, district heating in Soma, which harnesses excess heat from a municipal power plant, cost approximately half the price of the heating provided by coal boilers and individual natural gas, and a significant reduction of CO_2 emissions was observed. Hence, cleaner and sustainable energy is being ensured in a local place. There is substantial potential in the regions of Türkiye with lignite reserves for such projects (Başaran 2022), but the nation pays them insufficient attention.

5 Türkiye's ratification of the Paris Agreement: more renewables (but also more lignite)

The Paris Agreement, which is a legally binding international treaty on climate change, was adopted at the 21st Conference of the Parties (COP 21) meeting on 12 December 2015 and came into force on 4 November 2016. The focus of climate resilience is on sustainable development, poverty eradication, land-use change and GHG emission reduction (UNFCCC 2015). Since parties can only contribute their Intended Nationally Determined Contributions (INDCs) every five years, 2025 and 2030 will be vital in reducing global emission levels. At least 45% of global emissions is supposed to be reduced by 2030 (IPCC 2018). The end aim is achieving net zero emissions by 2050; some scientists even argue that it should be achieved in the early 2040s (Steffen 2020). Technology development and transfer, along with climate finance assistance to countries that are more vulnerable through voluntary contributions of other parties, will support this goal.

Turkey's engagement with global climate negotiations in general and the Paris process in particular has not been linear or coherent even before joining the treaty because lack of development policy references (Turhan et al. 2016). Türkiye's concentration on stabilizing atmospheric GHG emissions began with the UN Framework Convention on Climate Change (UNFCCC) treaty established in 1992. Broader understanding of sustainable development was mentioned in the 7th National Development Plan in 1996 (SP 1996). As one of the Annex-I countries, Türkiye ratified the UNFCCC in 2004 and the Kyoto Protocol in 2009 (DB 2022a). Countries in this group are obliged to limit their GHG emissions, protect and develop their GHG sinks, report the measures they take and the policies they follow to prevent climate change and transmit their current GHG emissions data. Annex-II countries, however, are encouraged to reduce their GHG emissions, cooperate on research and technology transfer and protect their GHG sinks, but they are not under any specific obligations. Here, Türkiye is in a unique position as it is the only country within the scope of Annex-I due to its OECD membership, which does not have a transition economy and whose "special conditions" were later supposed to be accepted by the resolutions of the conference of the parties in the 2010, 2011, 2012 and 2014 COP decisions. During the time of Türkiye's ratification to the UNFCCC, Türkiye had no historical responsibility for its GHGs in 1992 despite being included in Annex-I.

On 20 September 2015, Türkiye announced the "Intended National Contribution" (INC) statement, which is expected to be realised by 2030, to reduce the GHG emissions' increase by up to 21% (DB 2022b). After the Turkish parliament ratified the agreement on 7 October 2021, the Paris Agreement came into force for Türkiye on 10 November 2021 (Resmî Gazete 2021). According to it, the country would adopt net zero emissions by 2053.[3] Türkiye is set to receive $3.157B from the Green Climate Fund to support projects related to climate change (AA 2021). However, the

[2] On May 13, 2014, in Soma, Manisa, Türkiye, a devastating coal mine explosion and fire took place, marking one of the deadliest mining accidents. This tragic event claimed the lives of 301 miners and left many others injured.

[3] 2053 is the sixth anniversary of the fall of Constantinople, which was the was the capture of the capital of the Byzantine Empire by the Ottoman Empire in 1453.

carbon trading mechanism of the UNFCCC aims to achieve the end of coal use. At least 23 nations made new commitments to phase out coal power at the COP26 meeting (UNFCCC 2022). For the plan, global coal use in electricity generation must fall by 80% below 2010 levels by 2030″ (UNFCCC 2021a). In 2019, coal accounted for 38% of total production despite rapidly increasing renewables (IEA 2021b). Türkiye currently ranks 5th in Europe and 12th in the world in terms of renewable installed capacity (UNFCCC 2021b).

According to Türkiye's 2021 INDC report (UNFCCC 2021c), "Türkiye achieved a 230 per cent increase in GDP between 1990 and 2012. Its population has increased more than 30 per cent since 1990." The industrialisation and urbanisation factors increase Türkiye's energy demand by 6%–7% annually. As a result of the increasing demand, energy has the largest share of CO_2 production at 87.4% (TÜİK 2021), although the GHG emissions per capita is one of the least among the OECD countries. Türkiye's average is 6.2 t CO_{2e}/capita, while the OECD average is 11.5 t CO_{2e}/capita (OECD 2021). Although environmental considerations reflect national energy policies in parallel to INDC responsibilities (e.g., 10th National Development Plan, National Strategy on Climate Change, National Climate Change Action Plan, National Strategy on Industry, Strategy on Energy Efficiency, National Strategy and Action Plan on Recycling, National Legislation on Monitoring, Reporting and Verification of GHG emissions and National Smart Transportation Systems Strategy Document [2014–2023] and its Action Plan [2014–2016]) (UNFCCC 2021c), the energy demand should be met.

Türkiye's renewable electricity generation has nearly tripled in the last decade and reached 44% in 2019 (IEA 2021b), which is above the level required by the Eleventh Development Plan (2019–2023) (SBB 2019). In five years (2014–18), major private investments increased generation capacity by 38%, mostly driven by renewables (16.8 GW) and coal (6.5 GW). Therefore, in addition to renewables, coal mining and coal-fired generation have been included as energy supplies because of the nation's sizeable coal reserves (see Fig. 3). The Turkish government has been trying to boost the domestic production of coal reserves since 2005 (see Fig. 4). Lignite, in particular, is a priority area because of its 96% share in total coal production; the government aims to add 7.5 GW of lignite power generation (IEA 2021b). In 2005, within the scope of the "Development of Lignite Reserves and Exploration of Lignite in New Fields Project" conducted by the General Directorate of Mineral Research and Exploration (MTA) under the Ministry of Energy and Natural Resources, positive results were obtained from the cooperation studies of MTA, Turkish Coal Enterprise (TKİ), Eti Maden and Electric Power Resources Survey and Development Administration (EİE). The project was thus expanded (DPT 2009a) and has helped to increase lignite reserves and, thereby, supplies.

However, coal production-oriented policies could not be sustained until 2015 because of landslides in the Afşin-Elbistan lignite basin and mining accidents in the Soma and Ermenek basins (TKİ 2021). Since 2015, Turkish Hardcoal Authority (TTK) and TKİ, two state-owned companies, have increased production. Additionally, the government encouraged further privatization of the coal mining sector and promoted increased domestic coal production by transferring non-production areas of public companies to private companies through a tender system. As of January 2020, installed electricity capacity to use domestic coal was 11317 MW, of which 10101 MW was held by lignite (IEA 2021b, p. 109). Moreover, the government encourages the market via the purchases option. For example, government-owned Electricity Generation Corporation (EÜAŞ, 2020), the

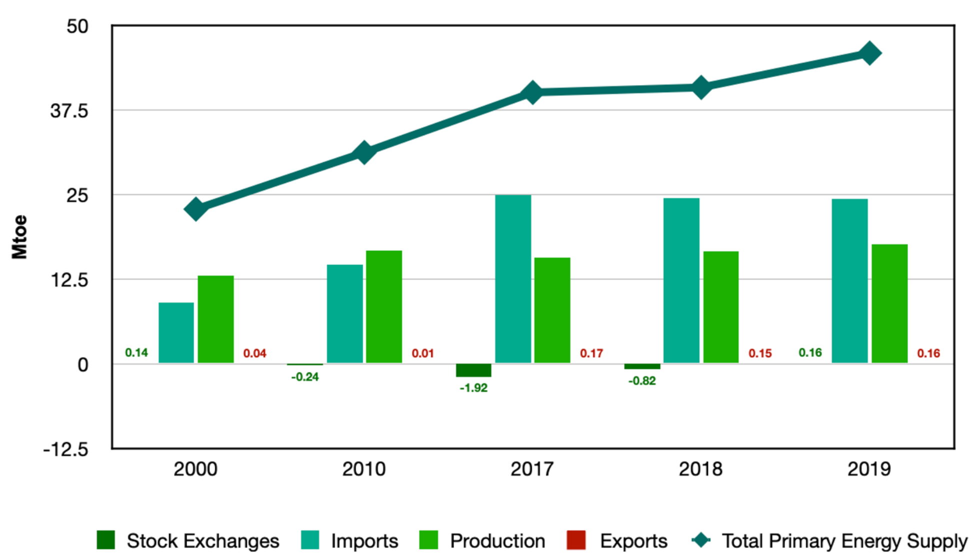

Fig. 4 Coal supply by source, Türkiye, 2000–2019 (IEA 2021b)

largest electric power company in Türkiye, purchases electricity from coal power plants that generate electricity using domestic coal, at a guaranteed price of 5.0–5.5 US cents/kW (50–55 USD/MW, revised quarterly). Outcomes have been reflected in lignite production in Türkiye (see Fig. 5).

Coal is responsible for 81% of the CO_2 added to the Earth's atmosphere since 1870 and comprises approximately 40% of global CO_2 emissions annually (Burke and Fishel 2020). Therefore, the Paris Agreement has been expecting to see divestment from coal with the help of the carbon pricing mechanism (UNFCCC 2018). In Türkiye's case, coal-related emissions have increased by nearly one-third in the last decade (IEA 2021b), causing local air pollution. Although technological dependency on the outside still exists, technological progress in clean coal and carbon capture and storage ensures the government will invest in coal production. Domestic coal production is far cheaper than imported ones. As the "Electricity Energy Market and Supply Security Strategy" document (DPT 2009b) claims, the government would be utilizing "known lignite resources and hard coal resources until 2023".

Some facts have emerged from the data so far: (i) Türkiye has significant economic growth target and potential, (ii) economic growth is difficult to be achieved without energy consumption, (iii) Türkiye is heavily dependent on fossil fuel imports, (iv) investing in renewable energy is a solution to the issue in the third point and an environmentally friendly method and (v) lignite has a non-negligible share in Türkiye's reserves but has environmentally negative outputs, (vi) Türkiye's adaptation to international climate agreements did not have any coherence in itself. Regarding the fourth and fifth points, investment in renewable energy sources provides returns in the long-term compared to fossil fuels. From an economic point of view, continuing to invest in both areas is not a contradiction.

6 Discussion: Is lignite production coherent with the Agreement?

Despite the recent economic downturn and soaring inflation, Türkiye's real GDP grew by 7.5% in the first half of 2022 (year-on-year), one of the fastest growth rates in the OECD (OECD 2022). Energy is needed to drive this growth, though energy is still the largest cause of the Turkish trade deficit. Although investments in renewable energy are increasing, environmental damage cannot be overlooked as the share of fossil fuels in current energy consumption is dominant. The level of warming in Türkiye (0.07 °C/year) between 2000 and 2020 is far beyond the world average (0.03 °C/year) (IEA 2022c). What Türkiye is currently experiencing is reminiscent of many developing countries; to catch up with developed countries, economic growth is needed, which is achieved through energy supply and consumption. Energy supply, in the case of Türkiye, relies heavily on imports, which has always been a problem for Türkiye. However, in a period when a dollar rate is 26.75 Turkish lira, any activity that will reduce costs is a necessity. All available energy resources should be used as much as possible. Primarily, in the discussion of "should be", the main question is, "for whom?".

6.1 Intra-level: Türkiye's political context

Whether Türkiye's policies in the field of energy or the environment are examined, what ultimately needs to be analysed

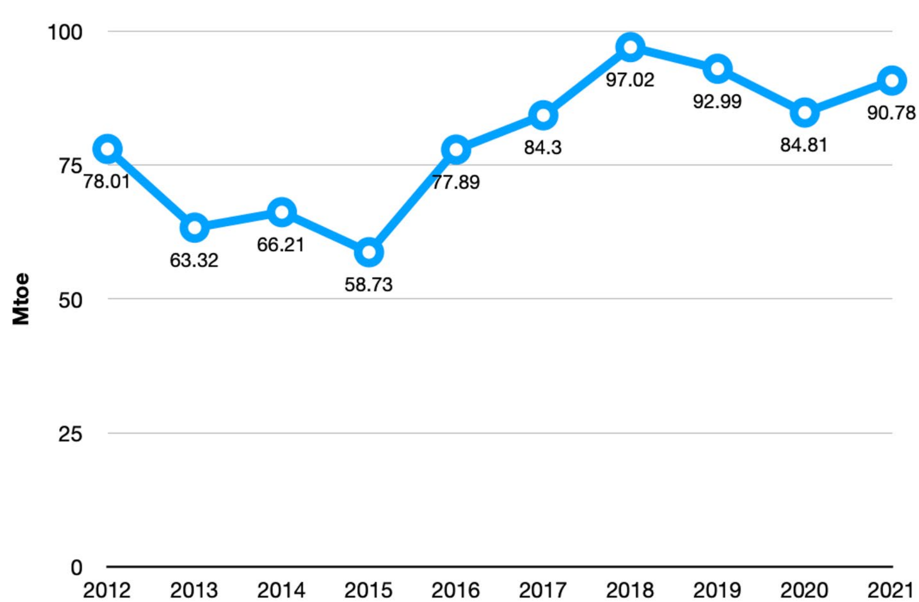

Fig. 5 Lignite production in Türkiye between 2012 and 2021 (TKİ 2021) (RTMENS 2022)

is the role of politics in policymaking. Since this relationship occurs in the institutional field, it should be examined first.

Until the millennium, governments in Türkiye were mostly formed by coalitions; this revealed differences of opinion in the ministries that had to work together. In addition to the inconsistency in governments, frequent military coups, memorandums and political crises also prevented infrastructure investments in any field. The Erdogan government's awareness of this fact has won it the sympathy of the people. The words 'power' and 'stability' are frequently mentioned during the election period. The Justice and Development Party (AK Party) garnered heightened public favour and sympathy during this period because they took steps to improve almost all material areas (e.g., economic growth, highways, railways, airports, schools, hospitals, universities) that can be considered as development criteria. However, in institutional terms, the search for order and stability, which developed and strengthened against the disorder in the twentieth century, reached a different point with the 2017 referendum (Resmî Gazete 2017)—transition from a parliamentary system to a presidential system. Rather than the understanding of inter-ministerial decision-making and acting together, a decision-making mechanism that proceeds with the decision and will of the president has moved to the centre.

The emphasis on modernization rather than environmental concerns has always been more dominant in Turkish policy (Turhan et al. 2016). However, other political facts related to the AK Party government must also be considered. Since its establishment, it has stood for an ideology called centre-right. It is an accepted fact that this ideology is less interested in environmental policy integration than the centre-left (Jordan and Lenschow 2010). In a place where economic growth is much more central, especially with the goal of entering the top ten economies of the world (TCCB 2022), the political will deems it important. Until very recently, environmental considerations had not clearly been integrated into the political scope.

What makes the case of Türkiye even more interesting is that its government not only undertakes the task of coordination but also provides empowerment. For example, Türkiye did not have domestic automobile production until recently; however, the government formed a consortium with the incentive and support packages of the presidency to create Türkiye's domestic electric vehicle, Türkiye's Automobile Joint Venture Group Inc. (TOGG). Relations between the public and private sectors in Türkiye are generally shaped by the fact that the public plays a much more central role, which is approved by not only the public but also the private sector because getting a public guarantee means facing less risk in a country that has been politically and economically unstable. Naturally, the question arises as to who from the private sector will benefit from the public guarantee. This raises concerns about corruption, which is an important criterion of development. Türkiye is ranked 96th in the 2021 Corruption Perceptions Index (CPI) (Transparency International 2023). When factors such as the welfare of the democrat and the inequality of income distribution are added to this, Türkiye meets the development criteria at a point far from its economic power in the world; Türkiye is ranked 29th in the 2021 Commitment to Development Index (CGD 2022).

6.2 Integration with inter-level: policy or politics?

Now, the technical outputs of lignite production within the WEC nexus and ratification of the Paris Agreement can be located in the Turkish political context. If lignite production is to be examined in terms of policy coherence, this should be done in two different fields. First, the integration of different policies should be analysed; then, the combined policy should be examined with regard to politics. However, there are already complicating factors in the field of policies. Türkiye is currently experiencing a lack of institutional capacity in intergovernmental affairs, as a result of trying to participate late in the development policy process (Mazlum 2017).

The *dirty* effect of encouraging lignite production and consumption on climate is already known. In the local areas where lignite is produced, the impact is negative enough to affect human health (HEAL 2018). However, the effect of lignite production on the water basin in the region and the surrounding land where the lignite is located potentially has both negative (*dirty)* and positive (*clean)* implications. What happens in the energy field has a *positive* reflection as it strengthens energy security. In normal conditions, UN SDGs set specific targets for water use, clean energy and climate action, which should support each other; however, the lignite supply policy does not fit it entirely. When three different policy areas interact in this way, it is necessary to examine the priority of politics, since it might militate against coherent approaches to sustainability.

In the field of politics, priorities are clearer even though they contain paradoxical characters. For example, what governments prioritise in the democratic mode is to be re-elected in the next term. Although environmental issues create an expectation, fields that appeal to a comparatively everyday perception, such as the economy, are areas where the public creates greater pressure. Of course, this does not mean that civil society in Türkiye has no expectations regarding the environment (Knudsen 2016; Yüksel and Sandalci 2011). Apart from the job opportunities created by lignite production in the local region, its contribution to the country's economy is extremely high. The lignite case is unsuitable for both the development goals and tackling climate change, but the need for energy supply creates a substantial trigger for both lignite and renewable energy production, meeting expectations and demand rather than seeking 'priority' compliance for the government. Hence, in our analysis of policy coherence, it is evident that the Turkish government has pursued procedural and intersectoral measures. While these actions may seem primarily driven by political gains, it is crucial to acknowledge their close entanglement with economic factors. Consequently, political gains prioritizing economic outcomes over the socio-economic ramifications of specific productions have come to the forefront.

The interplay between policy and politics is mediated by economic considerations, with the pursuit of policy coherence often overshadowed by political imperatives in developing nations. These countries, while endeavouring to enhance their infrastructure capacity and sustain economic growth, grapple with the challenge of striking a balance between modernization goals and political exigencies. Good policy and good politics do not always match (Altiparmak 2021). Regarding policy implementation and coherence in the SDGs, the economy cannot be ignored and should even be considered as a significant factor in the process (see Fig. 6). However, the diamond depicted in this figure represents the 4-node reciprocal relationship within lignite production. The inclusion of the economy as a fourth sphere arises from the government's prioritization of its role in the policy process, which cannot be visually represented in the figure. This inclusion underscores the government's involvement in the process, driven by the association of economics with politics in terms of policy coherence. If the dynamic of economy, which is especially emphasised in the policy coherence, is not included in the nexus approaches, it will always be one step behind the practice in achieving the SDG targets. Again, the historical absence of environmental integration within the political framework has given rise to this policy coherence challenge. While policymakers' trade-off between economic aspirations and protecting the climate is already known in Türkiye's conditions (Turhan et al. 2016), this study has positioned it within the policy coherence debate.

The motivations for the Paris Agreement's ratification are also evaluated through the themes of policy and politics. Türkiye's efforts to be included in the above-mentioned universal environmental efforts existed before. However, in the international community, where the government is accused of moving away from democratic governance, Türkiye's involvement in multilateral agreements also has a political necessity. There is also a historical basis behind this political necessity. Since the beginning of the Cold War, Türkiye has been mostly involved in western-based international formations, including organisations with environmental concerns. Additionally, there are some economic gains to be gained from being included in the Paris Agreement. Thus, the incoherency is found when the lignite production is examined in terms of SDGs; in the second step, when considering the output of this picture together with the process of the Paris Agreement, which directly concerns climate mitigation, a contradiction emerges, which is also a matter of policy coherence.

Türkiye wants to be included in the global 'development' wave and benefit from it, which can be seen in the increase in its share of renewable energy. However, the main target is not cleaner production. Investing in renewable energy provides cleaner production, but more importantly, it satisfies an economic need. Until now, lignite was not sufficient enough for cleaner production.

7 Conclusions and policy implications

In arguing for the need for greater policy coherence in SDG attainment, this paper has used the example of the WEC in Türkiye to identify political challenges to coherence, in order to develop potential solutions. Lignite production is a strong example, as national energy demands promote its use at the expense of climate and water impacts. While this study reveals the picture that lignite production draws in terms of SDGs, taking into account the wastewater management aspect of lignite production, it has revealed what priorities prevail in the policy coherence process. Examining lignite production in terms of SDGs and analysing the accession process to the Paris Agreement, which is one of the post-2015 agendas, reveal the importance of political and economic factors that have been ignored in nexus approaches so far.

However, there is a possibility to bring together technology, economic factors and environmental dynamics to ensure cleaner production in the lignite case. As mentioned, significant economic investment has been made in the district heating method, which has proven its usefulness. However, this is the output of the agreement between the local municipality and international investment. Türkiye has a critical district heating potential not only in the mentioned region but also in several other regions with lignite deposits. The central government can increase and/or encourage investments in these areas within the framework of policy coherence in line with cleaner production. The lignite incident, with the orientation to the district heating area, has the potential to create coherence in terms of the WEC. It remains to be seen whether the essentiality of economic factors and the potential solutions they entail, as elucidated by the analysis of Turkey within the policy coherence framework as a developing nation, will spawn an entirely new field of study and novel research topics in the policy coherence literature in the future. Therefore, the theoretical findings drawn from this study, centred on lignite production in Turkey, hold promise for broader application beyond the confines of this particular nation and

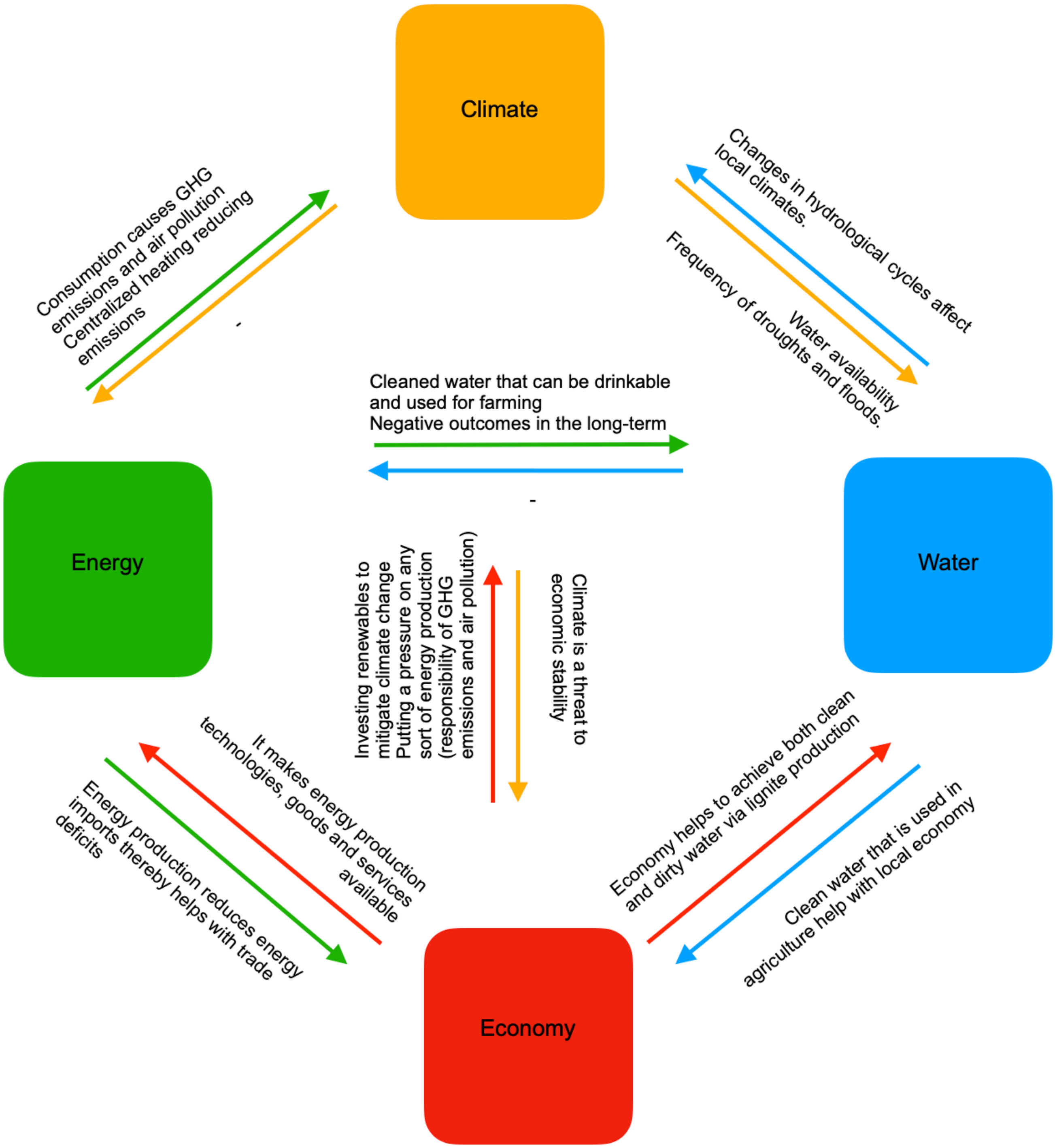

Fig. 6 Incoherence of lignite supply policy: The water-energy-climate-economy diamond

empirical context. Discussions on whether governments prioritize their political gains aligned with economic growth rather than focusing on socio-economic outcomes, and the implications of this for sustainable growth, hold the potential for adaptation to diverse empirical cases.

Acknowledgements I would like to thank Uli Klümper, and the reviewers for their helpful comments.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations

Competing interests The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

AA, (Anadolu Agency) (2021) Turkey to receive $3.157B from Green Climate Fund: Erdogan. https://www.aa.com.tr/en/environment/turkey-to-receive-3157b-from-green-climate-fund-erdogan/2404478#. Accessed 31 May 2022

Adler RW (2013) Water and wastewater infrastructure in the United States: the clean water-energy-climate nexus. J Energy Environ Law Summer 2013:1–21

Altiparmak SO (2021) Arctic Drilling in the United States energy revolution context: an accumulated story in environment vs energy contradiction. Energy Policy 156:112459

Atilgan B, Azapagic A (2015) Life cycle environmental impacts of electricity from fossil fuels in Turkey. J Clean Prod 106:555–564

Atimtay AT, Kayahan U, Unlu A, Engin B, Varol M, Olgun H, Atakul H (2017) Co-firing of pine chips with Turkish lignites in 750 kWth circulating fluidized bed combustion system. Biores Technol 224:601–610

Başaran M (2022) SOMA TERMİK SANTRALI VE BÖLGESEL ISITMA. https://enerji.gov.tr/Media/Dizin/BHIM/tr/Duyurular//3%20MB_S_202206301707.pdf. Accessed 5 Jan 2023

BGR (2022) BGR Energy Study 2021. https://www.bgr.bund.de/EN/Themen/Energie/Downloads/energiestudie_2021_en.pdf?__blob=publicationFile&v=3. Accessed 3 Jan 2023

Biggs EM, Boruff B, Bruce E, Duncan JMA, Duce S, Haworth BJ, Horsley J et al (2014) Environmental Livelihood Security in South-East Asia and Oceania: a nexus-livelihoods approach for spatially assessing change. Colombo, Sri Lanka,: In: IWMI-CGIAR White PaperInternational Water Management Institute

Burke A, Fishel S (2020) A coal elimination treaty 2030: Fast tracking climate change mitigation, global health and security. Earth Syst Gov 3:1–9

CGD (2022) THE COMMITMENT TO DEVELOPMENT INDEX 2021. https://www.cgdev.org/cdi#/. Accessed 3 Jan 2023

Cografyaharita (2017) Turkiye Linyit Madeni Hatirasi. https://s.milimaj.com/others/image/harita/turkiye-linyit-madeni-haritasi.png. Accessed 10 Jun 2024

Conway D, Archer E, van Garderen D, Deryng SD, Krueger T, Landman W, Lankford B et al (2015) Climate and southern Africa's water–energy–food nexus. Nat Clim Chang 5:837–846

DB, (T.C. Dışişleri Bakanlığı) (2022a) BM İklim Değişikliği Çerçeve Sözleşmesi (UN Framework Convention on Climate Change). https://www.mfa.gov.tr/bm-iklim-degisikligi-cerceve-sozlesmesi.tr.mfa. Accessed 31 May 2022

DB, (T.C. Dışişleri Bakanlığı) (2022b) United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. https://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa. Accessed 31 May 2022

DPT (2009a) T.C. Başbakanlık Devlet Planlama Teşkilatı, Dokuzuncu Kalkınma Planı 2007–2013; Madencilik Özel İhtisas Komisyonu (TR Prime Ministry State Planning Organization, Ninth Development Plan 2007–2013; Mining Specialization Commission). https://www.sbb.gov.tr/wp-content/uploads/2018/11/09_Madencilik_Enerji-HammaddeleriLinyit-Taşkömürü-Jeotermal.pdf. Accessed 30 May 2022

DPT (2009b) T.C. Başbakanlık Devlet Planlama Teşkilatı, Elektrik Enerjisi Piyasası ve Arz Güvenliği Strateji Belgesi (T.R. Prime Ministry State Planning Organization, Electricity Energy Market and Supply Security Strategy Document). 21 May. https://ww4.ticaret.edu.tr/enerji/wp-content/uploads/sites/79/2015/11/Elektrik-Enerjisi-Piyasası-Ve-Arz-Güvenliği-Strateji-Belgesi.pdf. Accessed 30 May 2022

Ediger VŞ, Berk I (2011) Crude oil import policy of Turkey: historical analysis of determinants and implications since 1968. Energy Policy 39(4):2132–2142

EIA (2020) China. https://www.eia.gov/international/analysis/country/CHN. Accessed 22 Dec 2021

EIA (2022a) Coal explained. https://www.eia.gov/energyexplained/coal/. Accessed 3 Jan 2023

Enerdata (2023) Coal and lignite production. https://yearbook.enerdata.net/coal-lignite/coal-production-data.html. Accessed 3 Jan 2023

EÜAŞ, (Electricity Generation Corporation) (2020) Yerli Kömür İle İthal Kömür Yakıtlı Elektrik Üretim Santrallerini (Santral) İşleten Özel Şirketlerden (Şirket) Elektrik Enerjisi Satın Alımı. https://api.euas.gov.tr/file/6d733a29-5020-4a7e-bcf6-9fea2c765746?download. Accessed 31 May 2022

Friese, K., M. Hupfer, and M. Schultze. 1998. "Chemical Characteristics of Water and Sediment in Acid Mining Lakes of the Lusatian Lignite District." In *Acidic Mining Lakes*, edited by Walter Geller, Helmut Klapper and Wim Salomons, 25–45. Heidelberg: Springer Berlin.

Gain AK, Giupponi C, Benson D (2015) The water–energy–food (WEF) security nexus: the policy perspective of Bangladesh. Water International 40(5–6):895–910

GBP (2018) TURKEY MINING 2018. https://www.gbreports.com/files/pdf/_2018/Turkey_Mining_2018_-_Web_Version.pdf. Accessed 10 Jun 2024

Glina B, Mendyk Ł, Piernik A, Nowak M, Maier A, Inselsbacher E, Glatzel S (2022) Local weather conditions determine DOC production and losses from agricultural fen soils affected by openpit lignite mining. CATENA 211:1–10

Grabel I (2007) Policy coherence or conformance? The New World Bank—International Monetary Fund—World Trade Organization rhetoric on trade and investment in developing countries. Rev Radical Polit Econ 39(3):335–341

Grünewald U (2001) Water resources management in river catchments influenced by lignite mining. Ecol Eng 17(2–3):143–152

HEAL (2018) Lignite coal - health effects and recommendations from the health sector. December. https://www.env-health.org/wp-content/uploads/2018/12/HEAL-Lignite-Briefing-en_web.pdf. Accessed 26 Apr 2022

Hickel J (2019) The contradiction of the sustainable development goals: growth versus ecology on a finite planet. Sustain Dev 27(5):873–884

Hoff H (2011) Understanding the Nexus Background paper for the Bonn2011 Nexus Conference. Stockholm Environment Institute (SEI)

Hogsden KL, Harding JS (2012) Consequences of acid mine drainage for the structure and function of benthic stream communities: a review. Freshw Sci 31(1):108–120

IEA (2021a) Coal 2021. https://www.iea.org/reports/coal-2021. Accessed 24 Oct 2022

IEA (2021b) Turkey 2021 Energy Policy Review. https://www.iea.org/reports/turkey-2021. Accessed 26 Apr 2022

IEA (2021c) Statistics report Key World Energy Statistics 2021. September. https://iea.blob.core.windows.net/assets/52f66a88-0b63-4ad2-94a5-29d36e864b82/KeyWorldEnergyStatistics2021.pdf. Accessed 26 Apr 2020

IEA (2022a) Coal. https://www.iea.org/fuels-and-technologies/coal. Accessed 3 Jan 2023

IEA (2022b) Coal 2022: Analysis and forecast to 2025. https://iea.blob.core.windows.net/assets/91982b4e-26dc-41d5-88b1-4c47ea436882/Coal2022.pdf. Accessed 3 Jan 2023

IEA (2022c) Level of warming in Turkey, 2000–2020 . https://www.iea.org/data-and-statistics/charts/level-of-warming-in-turkey-2000-2020. Accessed 3 Jan 2023

IPCC (2018) Intergovernmental Panel on Climate Change, Geneva, Switzerland

Jordan A, Lenschow A (2010) Policy paper environmental policy integration: a state of the art review. Environ Policy Gov 20:147–158

Kavouridis K (2008) Lignite industry in Greece within a world context: Mining, energy supply and environment. Energy Policy 36(2008):1257–1272

Kazanc F, Khatami R, Crnkovic PM, Levendis YA (2011) Emissions of NOx and SO_2 from coals of various ranks, bagasse, and coal-bagasse blends burning in O_2/N_2 and O_2/CO_2 environments. Energy Fuels 25(7):2850–2861

Knudsen S (2016) Protests against energy projects in turkey: environmental activism above politics? Br J Middle Eastern Stud 43(3):302–323

Lafferty W, Hovden E (2003) Environmental policy integration: towards an analytical framework. Environ Polit 12(3):1–22

Leivas R, Laso J, Abejón R, Margallo M, Aldaco R (2020) Environmental assessment of food and beverage under a NEXUS Water-Energy-Climate approach: application to the spirit drinks. Sci Total Environ 720:1–13

Lelek L, Kulczycka J (2021) Life cycle assessment of opencast lignite mining. Int J Coal Sci Technol 8(7):1272–1287

Mahlknecht J, Gonzalez-Bravo, Loge FJR (2020) Water-energy-food security: a Nexus perspective of the current situation in Latin America and the Caribbean. Energy 194:1–17

Maiti D, Ansari I, Rather MA, Deepa A (2019) Comprehensive review on wastewater discharged from the coal-related industries – characteristics and treatment strategies. Water Sci Technol 79(11):2023–2035

May PJ, Jones BD, Beem BE, Neff-Sharum EA, Poague MK (2005) Policy coherence and component-driven policymaking: arctic policy in Canada and the United States. Policy Stud J 33(1):37–63

May PJ, Sapotichne J, Workman S (2006) Policy coherence and policy domains. Policy Stud J 34(3):381–403

Mazlum SC (2017) Turkey and post-Paris climate change politics: still playing alone. New Perspect Turk 56:145–152

Melikoglu M (2017) Vision 2023: status quo and future of biomass and coal for sustainable energy generation in Turkey. Renew Sustain Energy Rev 74:800–808

Melikoglu M (2018) Clean coal technologies: a global to local review for Turkey. Energ Strat Rev 22:313–319

Michel JH (2014) Lignite power provides bargain-priced pollution. Acid News 3:10–12

Mohtar RH, Daher B (2012) Water, energy, and food: the ultimate nexus. In: Encyclopedia of agricultural, food and biological engineering. Taylor & Francis, Abingdon, UK, pp 1–15

Molajou A, Afshar A, Khosravi M, Soleimanian E, Vahabzadeh M, Variani HA (2021) A new paradigm of water, food, and energy nexus. Environ Sci Pollut Res. https://doi.org/10.1007/s11356-021-13034-1

MTA (2021) KÖMÜR ARAMA ARAŞTIRMALARI. https://www.mta.gov.tr/v3.0/arastirmalar/komur-arama-arastirmalari. Accessed 26 Apr 2022

Nanaki EA, Koroneos CJ, Xydis GA (2016) Environmental impact assessment of electricity production from lignite. Environ Prog Sustain Energy 35(6):1868–1875

Norouzi N, Kalantari G (2020) The food-water-energy nexus governance model: a case study for Iran. Water-Energy Nexus 3:72–80

OECD (2015) Policy Coherence for Sustainable Development in the SDG Framework Shaping Targets and Monitoring Progress. https://www.oecd.org/governance/pcsd/Note%20on%20Shaping%20Targets.pdf. Accessed 3 Jan 2023

OECD (2021) Regional Outlook 2021 - Country notes Turkey Progress in the net zero transition. https://www.oecd.org/turkey/. Accessed 31 May 2022

OECD (2022) Türkiye Economic Snapshot. https://www.oecd.org/economy/turkiye-economic-snapshot/. Accessed 4 Jan 2023

Oney O (2020) The significance of using lignite as a fuel in electricity generation in Turkey and its application facilities in clean coal technologies. Energy Sources Part a: Recov Util Environ Effects 42(1):17–30

Persson Å, Weitz N, Nilsson M (2016) Follow-up and review of the sustainable development goals: alignment vs. internalization. RECIEL 25(1):59–68

Polic PS, Ilic MR, Popovic AR (2005) Environmental impact assessment of lignite fly ash and its utilization products as recycled hazardous wastes on surface and ground water quality. Handb Environ Chem 5(2):61–110

Pusat S, Akkoyunlu MT, Erdem HH, Dagdas A (2015) Drying kinetics of coarse lignite particles in a fixed bed. Fuel Process Technol 130:208–213

Resmî Gazete (2017) TÜRKİYE CUMHURİYETİ ANAYASASINDA DEĞİŞİKLİK YAPILMASINA DAİR KANUN. https://www.resmigazete.gov.tr/eskiler/2017/02/20170211-1.htm. Accessed 3 Jan 2023

Resmî Gazete (2021) CUMHURBAŞKANI KARARI (DECISION OF THE PRESIDENT). https://www.resmigazete.gov.tr/eskiler/2021/11/20211104-11.pdf. Accessed 31 May 2022

RTMENS (2022) Coal. https://enerji.gov.tr/english-info-bank-natural-resources-coal. Accessed 3 Jan 2023

Runhaar H, Driessen P, Uittenbroek C (2014) Towards a systematic framework for the analysis of environmental policy integration. Environ Policy Gov 24:233–246

Sahin O, Stewart RA, Richards RG (2014) Addressing the water-energy-climate nexus conundrum: a systems approach. In: Proceedings - 7th International Congress on Environmental Modelling and Software: Bold Visions for Environmental Modeling, iEMSs 2014, San Diego, CA, USA

SBB, (Presidency of Strategy and Budget) (2019) DECISION OF THE GRAND NATIONAL ASSEMBLY OF TURKEY Decision on the approval of the Eleventh Development Plan (2019–2023). https://www.sbb.gov.tr/wp-content/uploads/2021/12/Eleventh_Development_Plan_2019-2023.pdf. Accessed 31 May 2022

Scott CA (2011) The water-energy-climate nexus: resources and policy outlook for aquifers in Mexico. Water Resourc Res 47(W00L04):1–18

Şengül H, Bayrak F, Köksal MA, Ünver B (2016) A cradle to gate life cycle assessment of Turkish lignite used for electricity generation with site-specific data. J Clean Prod 129:478–490

Simate GS, Ndlovu S (2014) Acid mine drainage: Challenges and opportunities. J Environ Chem Eng 2(3):1785–1803

SOG (2022) Sustainable conversation of lignite coal fired power plants to district heating. https://stateofgreen.com/en/solutions/sustainable-conversation-of-lignite-coal-fired-power-plants-to-district-heating/. Accessed 5 Jan 2023

SP (1996) 1996–2000 Yedinci Kalkınma Planı. http://www.sp.gov.tr/upload/xSPTemelBelge/files/2Ot9M+plan7.pdf. Accessed 3 Jan 2023

Steffen W (2020) Labor's climate policy is too little, too late. We must run faster to win the race. https://theconversation.com/labors-climate-policy-is-too-little-too-late-we-must-run-faster-to-win-the-race-132263. Accessed 31 May 2022

Taniguchi M, Endo A, Gurdak JJ, Swarzenski P (2017) Water-energy-food nexus in the Asia-Pacific Region. J Hydrol Reg Stud 11:1–8

TCCB (2022) Türkiye'nin sergilediği performans bizi dünyanın en büyük 10 ekonomisine girme hedefimize adım adım yaklaştırıyor. https://www.tccb.gov.tr/haberler/410/134196/-turkiye-nin-sergiledigi-performans-bizi-dunyanin-en-buyuk-10-ekonomisine-girme-hedefimize-adim-adim-yaklastiriyor. Accessed 4 Jan 2023

TEIAS (2022) Turkey's installed capacity. https://www.teias.gov.tr. Accessed 26 Apr 2022

TKİ, (Turkish Coal Enterprise) (2021) 2020 Kömür [Linyit] Sektör Raporu. https://bit.ly/3rC9eoJ. Accessed 31 May 2022

Tosun J, Lang A (2017) Policy integration: mapping the different concepts. Policy Stud 38(6):553–570

Tosun J, Leininger J (2017) Governing the Interlinkages between the Sustainable Development Goals: Approaches to Attain Policy Integration. Global Chall 1:36

Tran CKT, Rose MT, Cavagnaroc TR, Patti AF (2015) Lignite amendment has limited impacts on soil microbial communities and mineral nitrogen availability. Appl Soil Ecol 95:140–150

Transparency International (2023) CORRUPTION PERCEPTIONS INDEX. https://www.transparency.org/en/cpi/2021. Accessed 4 Jan 2023

TÜİK, (Turkish Statistical Institute) (2021) TURKISH GREENHOUSE GAS INVENTORY 1990 - 2019. https://unfccc.int/documents/271544. Accessed 31 May 2022

Tuncalı E, Ciftci B, Yavuz N, Toprak S, Koker A, Gencer Z, Aycık H, Sahin N (2002) Chemical and technological properties of Turkish tertiary lignites. MTA Publication, Ankara

Turhan E, Mazlum SC, Şahin Ü, Şorman AH, Cem Gündoğan A (2016) Beyond special circumstances: climate change policy in Turkey 1992–2015. Wires Clim Change 7:448–460

UN (2018) SDG Indicator 17.14.1. Number of countries with mechanisms in place to enhance policy coherence of sustainable development. https://www.oecd.org/gov/pcsd/Concept%20Note%20on%20Methodology%20for%20SDG%20indicator%2017.14.1.pdf. Accessed 3 Jan 2023

UNFCCC (2015) Paris Agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf. Accessed 31 May 2022

UNFCCC (2018) Paris Agreement Triggers Divestment from Coal - Study. https://unfccc.int/news/paris-agreement-triggers-divestment-from-coal-study. Accessed 31 May 2022

UNFCCC (2021a) UN Chief Calls for Immediate Global Action to Phase Out Coal. https://unfccc.int/news/un-chief-calls-for-immediate-global-action-to-phase-out-coal. Accessed 31 May 2022

UNFCCC (2021b) Proposal from Turkey to amend the list of Parties included in Annex I to the Convention: /CP/2021/INF.2. https://unfccc.int/sites/default/files/resource/cp2021_inf02_0.pdf. Accessed 31 May 2022

UNFCCC (2021c) REPUBLIC OF TURKEY INTENDED NATIONALLY DETERMINED CONTRIBUTION. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Turkey%20First/The_INDC_of_TURKEY_v.15.19.30.pdf. Accessed 31 May 2022

UNFCCC (2022) COP26 Outcomes: Finance for Climate Adaptation. https://unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact/cop26-outcomes-finance-for-climate-adaptation#eq-7. Accessed 31 May 2022

UNFCCC (2023) Action on Climate and SDGs. https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs. Accessed 4 Jan 2023

Visseren-Hamakers IJ (2015) Integrative environmental governance: enhancing governance in the era of synergies. Curr Opin Environ Sustain 14:136–143

Wan K, Xiao Y, Fan J, Miao Z, Wang G, Xue S (2022) Preparation of high-capacity macroporous adsorbent using lignite-derived humic acid and its multifunctional binding chemistry for heavy metals in wastewater. J Clean Prod 363:132498

Widera M, Glacová V, Marschalko M (2022) "Origin of clastic partings and their impact on ash yield in mined lignite: a case study from middle Miocene of central Poland. J Clean Prod 378:134401

Wolkersdorfer C, Mugova E (2022) Effects of Mining on Surface Water. In: Mehner T, Tockner K (eds) Encyclopedia of Inland Waters, 2nd edn. Elsevier, Amsterdam, pp 170–188

Wright J (2010) Lignite and climate change: The high cost of low grade coal. The Parliamentary Commissioner for the Environment

Yüksel I, Sandalci M (2011) Climate change, energy, and the environment in Turkey. Energy Sources Part A 33:410–422

Zhu Y, Zhao Y, Li H, Wang L, Li L, Jiang S (2017) Quantitative analysis of the water-energy-climate nexus in Shanxi Quantitative analysis of the water-energy-climate nexus in Shanxi The 15th International Symposium on District Heating and Cooling Province, China Province, China. Energy Procedia 142:2341–2347

Zhu Q (2012) Update on lignite firing, IEA Clean Coal Centre, 1–75. https://usea.org/sites/default/files/062012_Update%20on%20lignite%20firing_ccc201.pdf. Accessed 3 Jan 2023