GLOBAL RELATIONS FORUM YOUNG ACADEMICS PROGRAM
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THE INTERCONNECTION OF THE TURKISH AND CONTINENTAL EUROPEAN POWER NETWORKS: IMPLICATIONS AND POTENTIALS

ANGÉLIQUE PALLE

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This paper, entitled *"The Interconnection of the Turkish and Continental European Power Networks: Implications and Potentials"* is authored by Angélique Palle as part of the GRF Young Academics Program Policy Paper Series.

GRF convened the following group of distinguished members to evaluate and guide Angélique Palle's paper:

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About the Author

Angélique Palle holds a Ph.D. in geography from the University of Paris 1 Panthéon Sorbonne, which she did on the integration of European power networks and the building of an energy union. Angélique worked on the technical, political, normative and policy aspects of this project, within her university but also with other research teams from different academic fields, whom she visited for a few months each: political scientists at the Oxford Institute for Energy Studies (UK) and engineers at the School of electrical and computer engineering of Cornell University (USA). Angélique completed her academic training with a postdoc at the French Institute of Petroleum and Renewable Energies (IFPEN) on the integration of variable energy sources into power networks and she is now a research fellow at the Research Strategic Institute (IRSEM), where she works on both energy and strategic materials aspects.

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The Interconnection of the Turkish and Continental European Power Networks: Implications and Potentials

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Abstract

In 2010, the European Network for Transmission System Operators for Electricity (ENTSO-E) started testing the possibility of a network and market coupling of the Turkish power network with the European one. In 2015, a long-term agreement has been signed between the ENTSO-E and TEIAŞ, the Turkish TSO. This interconnection implies quite a lot for both Turkey and the EU. But while most of the political attention is focused on the gas connection, power connections attract much less attention and controversy and seem to stay at commercial and technical levels. This paper aims to assess and map the political, economic and technical consequences of this integration for Turkey and the 36 ENTSO-E countries, showing how the electrical interconnection builds ties that might well be as important as the gas ones.

1. Introduction

In 2010, the European Network of Transmission System Operators for Electricity (ENTSO-E), which gathers representatives of all the transmission system operators of the European power network, started testing the possibility of a network and market coupling of the Turkish and European power networks. In 2015, a long-term agreement was signed between TEİAŞ (Turkish Electricity Transmission Corporation) – the Turkish transmission system operator (TSO) – and the ENTSO-E. This agreement comes after 15 years of technical collaboration between the two parties, with TEİAŞ becoming the first observer member of the ENTSO-E. This observer status entails participation in some of the groups and task forces of the ENTSO-E and is the first step towards full integration into the European network and market.

The prospect of such interconnection and integration implies quite a lot for both Turkey and the EU. While most of the political attention in the energy sector is focused on the gas connection and gas pipeline projects (TANAP, Blue Stream, Turkish Stream), the power connection attracts much less attention and controversy and seems to stay at the commercial and technical levels. Nevertheless, this other type of energy connection between the Turkish and the European power grids is important for both actors.

On the Turkish side, it means, first of all, a possibility to join the European market, benefit from the solidarity of neighbors in case of an incident, and trade higher amounts of power (though the existing network does currently allow for small exchanges). It also means adaptation to ENTSO-E's norms and governance in order to maintain the stability of the network and the security of supply: common processes for connection or disconnection of power plants to the network, similar management and timing of market auctions, common emergency procedures in case of an incident, etc. This is because in an integrated network the production/consumption situation of neighboring countries needs to be considered when monitoring your own national network. The point is to avoid domino effects affecting neighbors in case of an incident or imbalance, as both spread across an integrated network. Lastly, the Turkish electricity consumption profile shows a rapid increase in the last decade, which comes with a geographic imbalance between production and consumption zones. As a result, the future of the power transportation network has become a very strategic aspect of Turkey's future economy and security. This new opportunity for power trading and network stability raises broader questions for Turkey as well, including that of electricity relations with its southern and eastern neighbors (e.g., with Iran and Syria) in a possible regional strategy.

On the ENTSO-E side, integrating such a big network is both an opportunity, as the ENTSO-E is aiming at interconnecting all countries around the Mediterranean area, and a challenge, as recent integrations have concerned much smaller states, such as Latvia, Estonia, and Lithuania.

This paper assesses and maps the impacts of this integration for Turkey and the 36 ENTSO-E countries. It explores the challenges lying ahead from technical, political, and financial perspectives. Comparing the somehow quiet and technical matter of electricity interconnection to the very political – and more heated – topic of gas, the aim is also to show how electrical interconnection builds ties that are just as important as those related to the transport and sale of gas.

2. Why electrical cooperation matters and how it is done

The rise of power grids and their importance for both economies and societies

Power grids are vital to the infrastructure of today's industrialized societies. Electricity has progressively extended to most economic and social activities in the last decades, powering communications, hospitals, homes, digital devices, water, and food supply chains, along with most industrial sectors. Power grids were labeled "critical infrastructure" by European countries and the USA in the early 2000s, and the impacts of recent blackouts (2006 in Europe, 2003 in the USA, 2019 in Venezuela) have drawn special attention to their importance. They have been targeted as part of military interventions, physically since the First World War,[1] and more recently through cyberattacks (Russia in Ukraine, 2015). The 2019 blackout in Venezuela[2] showed how social structures, political power, and state sovereignty can be destabilized by an electricity shortage lasting more than a few days.

Like most countries in the Euro-Mediterranean region during the last century, Turkey has progressively moved from small local networks to an integrated network at a national level.[3] Increasing urbanization, along with growth in population and the economy, have driven a corresponding rise in consumption over the last decades. The International Energy Agency (IEA) and the Turkish electricity operator, TEİAŞ, foresee a continuous increase in demand in the coming years.

Technical aspects of the European and Turkish grids

The European power network is made of five different synchronous networks.[4] They were inherited from different technical pasts and were built after the Second World War. Specific direct current connections nevertheless allow for exchanges between these different zones, and the European Union has set the integration of the European markets as one of the aims of its energy policy.[5] The Turkish network is technically synchronous with the continental European one, but has not yet fully joined the European market.

Through interconnection and market integration, the aim of the European Union has been to:

• seek possible complementarity from different energy sources within the EU, especially as far as renewable sources are concerned (hydro in the North, solar in the South, wind on the coasts, biomass in central Europe)
• increase solidarity between members as interconnection diminishes the need for investments in operational backup reserves
• seek an overall lower price of electricity within the EU to increase economic competitiveness

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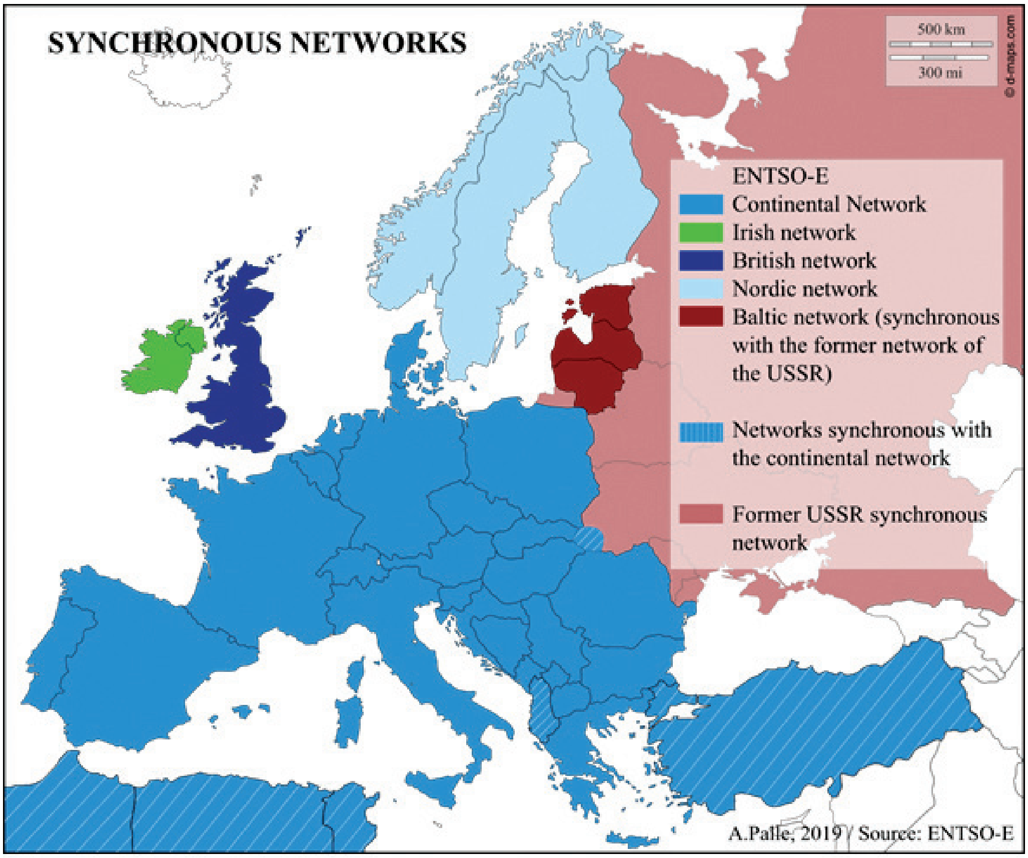
[1] Thomas E. Griffith, *Strategic Attack of National Electrical Systems*, (Maxwell Air Force Base/Alabama: Air University Press, 1994)

[2] In 2019, Venezuela was hit by major power outages lasting several days, which altered food supply, transportation, and health facilities and led to major social unrest. *"No End in Sight to Venezuela's Blackout, Experts Warn"*, New York Times, 11 March 2019, https://www.nytimes.com/2019/03/11/world/americas/venzuela-blackout-maduro.html

[3] Vincent Lagendijk, *Electrifying Europe: The Power of Europe in the Construction of Electricity Networks* (Amsterdam University Press, 2008).

[4] The conventional production of electricity is generally achieved through rotating machines powered by gas, nuclear, water, coal, etc. To maintain the stability of an interconnected network, they must rotate synchronously.

[5] This aim has been formalized in the various European "energy packages" (1996-1998, 2003, 2009, and 2015).



Context of the current collaboration

Turkey has raised the issue of its possible interconnection to the European continental power system since 1970. In 2000, a project to technically and commercially integrate the Turkish power system into the continental European one started with the support of the European Network of Transmission System Operators. The main purpose was to create compatibility with the Greek and Bulgarian networks. Funds from the Instrument for Pre-Accession Assistance (IPA-I, 2007-2013) have been used to address the following important points:[6]

• synchronizing the markets, which is now complete, with commercial exchanges taking place
• improving the capacity of TEİAŞ, especially the IT structure and the capacity to perform live work on the power network,[7] by training Turkish teams of engineers
• aligning the Turkish power code and regulations with those of the ENTSO-E in order to have similar emergency measures, solidarity procedures, and connection and exchange rules

[6] Delegation of the European Union to Turkey's website, 2019, https://www.avrupa.info.tr

[7] This allows work and repair on the power system while it is in operation, without having to disconnect the lines affected by the work going on; this is especially useful when a network has few redundant lines.

As a concrete result of the successful implementation of these three projects, Turkey signed a long-term agreement with the ENTSO-E in April 2015 and became an observer of the ENTSO-E in January 2016. As of 2019, the interconnection capacity is 650 MWh from Greece and Bulgaria to Turkey, and 500 MWh the other way. Since 2015, Turkey has been trading around 6 TWh per year, which represents 2% of its annual consumption.[8]

3. Objectives and methodology

Paper objectives, exploring the impacts of the Turkey-EU electrical interconnection

The main objective of this paper is to explore the impacts of this electrical interconnection and of the synchronization of the Turkish power system with the continental European one. Though the amount of exchanged energy is small compared to Turkey's consumption (2%), it carries important economic, policy, technical, and diplomatic consequences.

From the economic side, it is a potential source of security of supply, especially for the Istanbul region, which is close to the border. Because it reinforces network resilience, the interconnection might increase trust among investors, as norms and market rules come closer to those of Europe amid two global trends: the electrification of final uses and growth in the share of electricity in the energy mixes of many countries. From a policy perspective, the interconnection might help diversify the power supply of the Istanbul region and reinforce the Turkish network, both in terms of capacity and in terms of standards to support the connection of renewable sources, which have a strong potential for development in Turkey. From the technical side, this interconnection has to be monitored carefully; it will have an impact on network management, opening Turkey's network to information exchange with neighbors. As the digitalization of networks is accelerating in industrialized countries, concerns about the possibility of hacking are also on the rise. An interconnected network also comes with potential cascading effects when an incident occurs, and this has to be taken into account. Finally, from a diplomatic perspective, electricity ties require lower levels of strong technical cooperation, with less heated political and geopolitical implications than gas.

The following parts explore these impacts and how Turkey could exploit or mitigate them.

Methodology

From a conceptual perspective, the analysis in this paper draws from the French Yves Lacoste school of geopolitics,[9] which seeks to envision a question at different scales and from the perspective of different actors, in order to map the challenges, oppositions, and dynamics attached to it. The point is to create a non-linear vision of the question which does not follow one single storyline from one single actor, acknowledging that one element may have various implications at different scales. In the case of the Turkish connection to the Continental European power market, appropriate scales for analysis might be the Istanbul and Bosphorus region; the national Turkish power system; a wider

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[8] ENTSO-E, Statistical factsheet, 2018; ENTSO-E, Statistical factsheet, 2017; ENTSO-E, Statistical factsheet, 2016

[9] Yves (dir.) Lacoste, *Dictionnaire de géopolitique* (Paris, France: Flammarion, 1993); Yves Lacoste, "La géographie, la géopolitique et le raisonnement géographique," *Hérodote* n° 146-147, no. 3 (November 15, 2012): 14–44; Yves Lacoste, "En guise d'éditorial: Les différents niveaux d'analyse du raisonnement géographique et stratégique," *Hérodote: Revue de géopolitique de l'agriculture*, no. 18 (1980): 3–15.

region including Greece and Bulgaria which are the main exchange partners; and the entire ENTSO-E region which encompasses more than just the EU (see map 1). World trends are also taken into account for the purpose of comparison. In this perspective, mapping is used as a tool for analysis.

Sources include primarily technical reports and data from the transmission system operator of Turkey, TEİAŞ, and the European network of transmission system operators, ENTSO-E. They are backed by consumption and production trends from the International Energy Agency. Fieldwork results on the topic originate from a 6-month collaboration of the author with the ENTSO-E in the context of her Ph.D. as a member of the System Development team, for the drafting of the Ten Year Network Investment Plan 2014.[10] A former engineer of the French transmission system operator (RTE), who participated in the European delegation sent to help train TEİAŞ's teams from 2007 to 2013, was also interviewed for technical insights specific to the Turkish power system.

4. Economic impact: balancing production at a national level or opening options for exportation

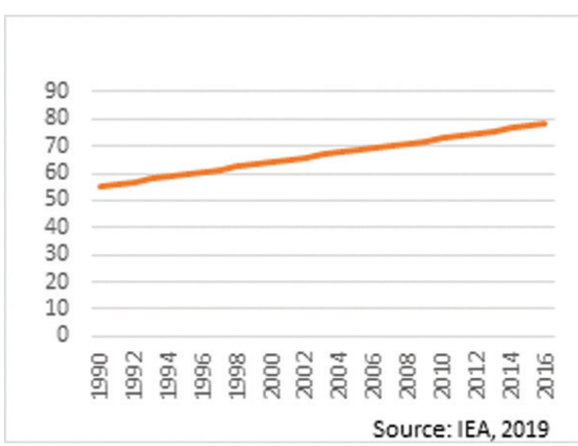
Balancing production at a national level, the challenge of eastern production and western consumption

Population growth, urbanization, and economic growth have driven electricity consumption in Turkey for the last decade.

However, the geography of production and consumption brings imbalances and losses to the system at a national level. The European connection raises the scale of the Turkish power system to a more regional level, which brings balancing potentialities.

Between 2004 and 2014 Turkey almost doubled its electricity generation capacity, reaching 258.2 TWh in 2018. This increase has been mostly driven by privatization dynamics and foreign investment (energy has been the third most attractive sector for foreign direct investment in Turkey over the last decade, with almost 14 billion USD received).[11]

Chart 1. Turkish population 1990-2016 (million people)

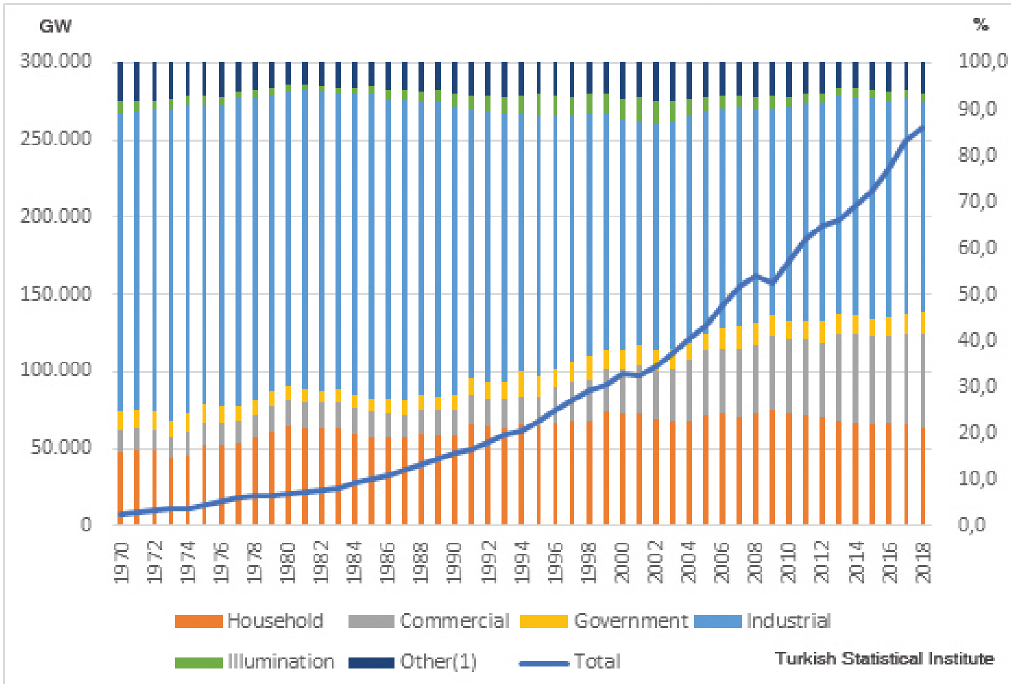


[10] This plan required by the European Commission aims at mapping every two year the projects and investments that will be needed for the European grid in the upcoming ten years.

[11] IEA, Turkey 2016 Review; Selahattin Murat Şirin, "Foreign direct investments (FDIs) in Turkish power sector: A discussion on investments, opportunities and risks," *Renewable and Sustainable Energy Reviews*, Elsevier, vol. 78(C) (2017): 1367-1377.

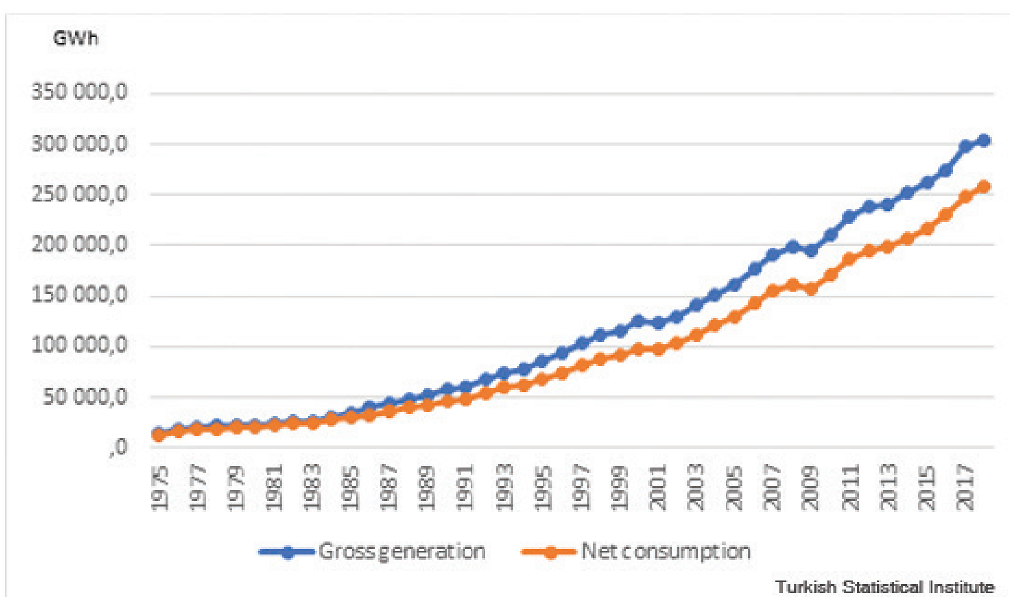
This growth has been driven by the commercial sector along with a growing population (see charts 1 and 2).

Chart 2. Net electricity consumption by sector in Turkey



However, at the same time, the discrepancy between gross production and net consumption has also risen (see Chart 3.)

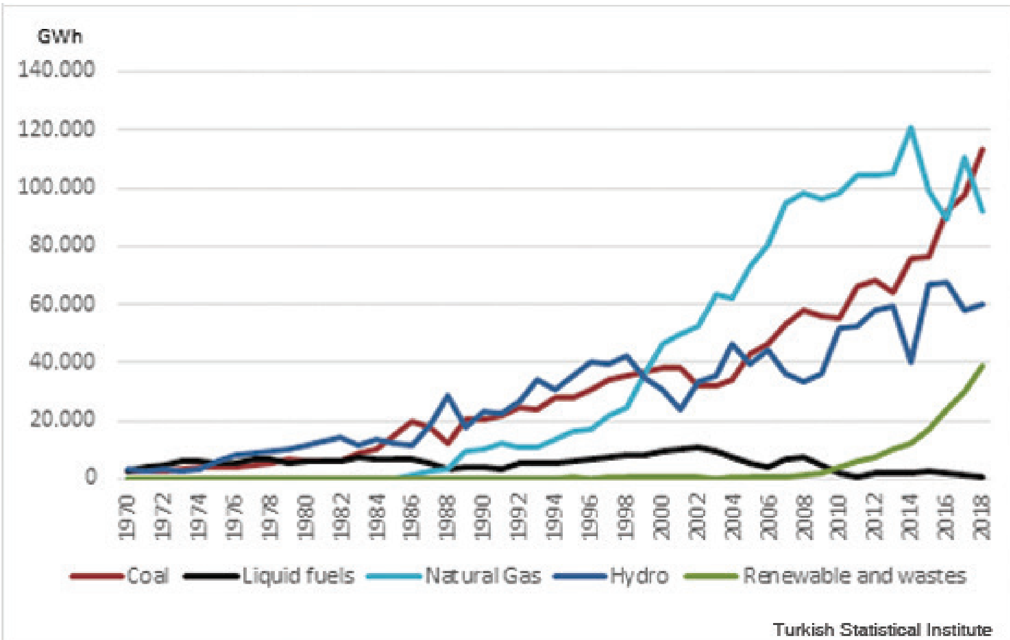
Chart 3. Power gross generation vs. Net consumption in Turkey



One of the main causes of this discrepancy is the geography of Turkey's production and consumption zones. Turkey's main consumption zones are located in the western part of the country, close to the economic activity hubs that exist in and near the main western cities and ports. Now, if we look at the electricity generation profile of Turkey

(Chart 4 below) three main sources come up: natural gas, coal, and hydro. While coal and gas power plants' implantation can be chosen according to economic criteria, hydro production is located along rivers. Thus, in Turkey most of the hydro facilities are located in the eastern part of the country, where the main rivers are. This necessitates transporting some of the electricity produced in the east to the western part of the country.

Chart 4. Electricity generation by source in Turkey



The Turkish network is therefore oriented east-to-west. Bringing electricity across long distances (1000 km in this case) creates losses, averaging 8% of the production in Turkey, (see Annex 1 and 2).

Opening the national network to regional perspectives

This context of geographical imbalances between production and consumption is partly linked to the national scale of the Turkish network. While connections with neighbors are currently low, they may bring regional balance.

The national dimensioning of the Turkish network increases the potential risks of this imbalance, making these long-distance east-west lines very strategic for the security of supply of the country. The 2015 blackout, Turkey's biggest electric incident in 15 years, which lasted a bit less than 10 hours, was caused by a maintenance incident on this east-west axis.[12]

Opening up the Thrace region to exchanges with the European system would lower the vulnerability of the region to this national imbalance (for technical aspects, see Part 5) by raising the possibility of regional cross-border balancing. Changing scale from a national to a regional level is also an evolution in the strategic thinking of the security of supply, where the notion of national independence is still very present. This regional

[12] TEİAŞ and ENTSO-E, 2015, Report on Blackout in Turkey on 31st March 2015

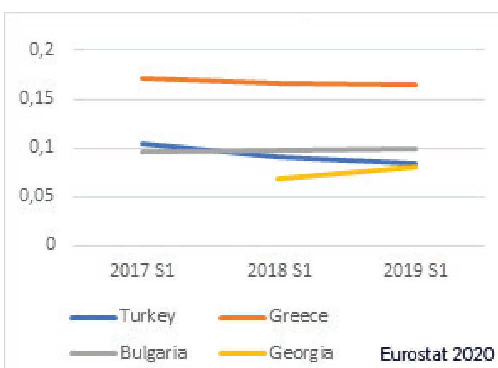
cross-border strategy does not apply only to the European neighbor. The Turkish system is synchronous with Greece and Bulgaria and asynchronous with all its other neighbors.[13] This means that converters are needed at the border to allow exchanges of power, which makes exchanges more complex and costly. Even though Turkey has built lines with most of its neighbors, the one with Armenia is not in operation, exchanges with Syria and Iraq ceased in 2012 and 2015, and Turkey is mostly exporting to Georgia through a 400 kV line. The two principal remaining partners are Iran, with whom two 400 kV lines have been in operation since 2015, and the ENTSO-E network, mainly Greece and Bulgaria. Together, the exchange capacity with these three neighbors amounts to around 3% of Turkey's production. This is a rather low number compared to ENTSO-E standards, which aim at an exchange capacity of 15% for each of the member states.

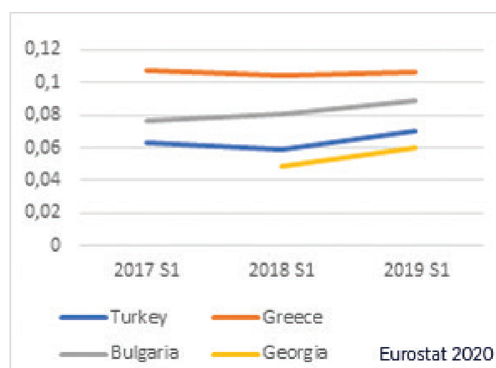
Exporting electricity

Along with the diminution of capacity needed for frequency control, regional interconnection also brings the prospect of exports.

In its 2017 regional investment plan for the southeast region and its 2018 Ten Year Network Development Plan, the ENTSO-E already projects some congestion with the Turkish border due to the ongoing market integration. The projections for 2040 show in every scenario that the exchange capacity between Turkey and Greece and between Turkey and Bulgaria need to triple in both cases to avoid congestion. The recent prices of electricity observed in Greece, Bulgaria, Georgia, and Turkey show potential export opportunities, especially with Greece.

Chart 5 and Chart 6. Electricity prices for households *(on the left)* and non-households *(on the right)* (EUR per kWh)





Connections with Iran and Iraq occur in areas where production is higher than consumption in Turkey, while these two neighbors have high electricity demand and have expressed need for regional balancing and interconnection to increase the stability of their networks.[14]

[13] The machines producing the electricity rotate at different frequencies.

[14] Call for Higher Electricity Prices in Iran, *Financial Tribune*, 25 July 2016, https://financialtribune.com/articles/energy/46253/call-for-higher-electivity-prices-in-iran

Investment in the development and reinforcement of the grid

Besides the technical advantages of connecting to neighbors, which may reduce the need for investment in peak unit production, one of the positive side effects of this market integration might be to attract more investors for the Turkish grid. To address the challenges of both integration and transition dynamics in the EU, the ENTSO-E is aiming at 114 billion euros of investments in the European power grid by 2030.[15] Turkey is facing the same investment challenge. The International Energy Agency[16] notes that though small local renewable production is developing (as it does not necessarily need grid connection), bigger projects face grid access competition and high connection prices, which undermines their development. Added to the growing demand for power in Turkey, this investment need currently contrains the development of the network, for both a renewable/greenhouse gas reduction policy and the development of accessible electricity for industry and households. While overall electricity prices and the share of the network's cost within them have gone down in Turkey in the last few years, the 2015 blackout, which lasted for almost 10 hours and was caused by a hydropower oversupply in the context of a transmission shortage, underscored the need for grid upgrade and reinforcement.

In this respect, joining the ENTSO-E as an observer member, and progressively enforcing the technical norms and market regulations it entails, provides a strong signal for investors.

5. Policy impact: Paving the way for renewable development?

Under its 'Vision 2023' development targets, Turkey set the goal of reaching a 30% share of renewable sources in its electricity mix by 2023. This is to be accompanied by a greenhouse gas reduction to 21% below the country's current trend, which was pledged in the context of the COP 21 (Paris Climate Conference) and should be completed by 2030. In line with these two targets, renewable production has developed in Turkey and almost tripled in ten years, from 34.4 GWh in 2008 to 96.9 GWh in 2018,[17] for a total production of 300 GWh. This means that the country is nearing its 30% renewable generation target.

Renewable policy: integrating variable renewable sources into the grid

Two-thirds of Turkey's renewable production comes from hydropower, yet the development of the potential for solar and wind energy sources remains important. Integrating variable energy sources such as wind and solar into existing power systems is challenging for network stability, mostly because production is intermittent and cannot be fully controlled.[18] Thus, many countries investing in this type of production also need to invest in reinforcing their power network. Interconnection with neighbors is one way to balance the system and to export production when it cannot be fully absorbed by local demand. This is one of the reasons why the EU aims at an interconnection capacity[19] of 10% for each member state by 2020 and 15% by 2030.[20]

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[15] ENTSO-E, Ten Year Network Development Plan, 2018.

[16] IEA, Turkey Review, 2016.

[17] Worldbank data and ENTSO-E 2018 factsheet.

[18] Emmanuel Hache and Angélique Palle, "Renewable Energy Source Integration into Power Networks, Research Trends and Policy Implications: A Bibliometric and Research Actors Survey Analysis," *Energy Policy* 124 (January 2019): 23–35, https://doi.org/10.1016/j.enpol.2018.09.036.

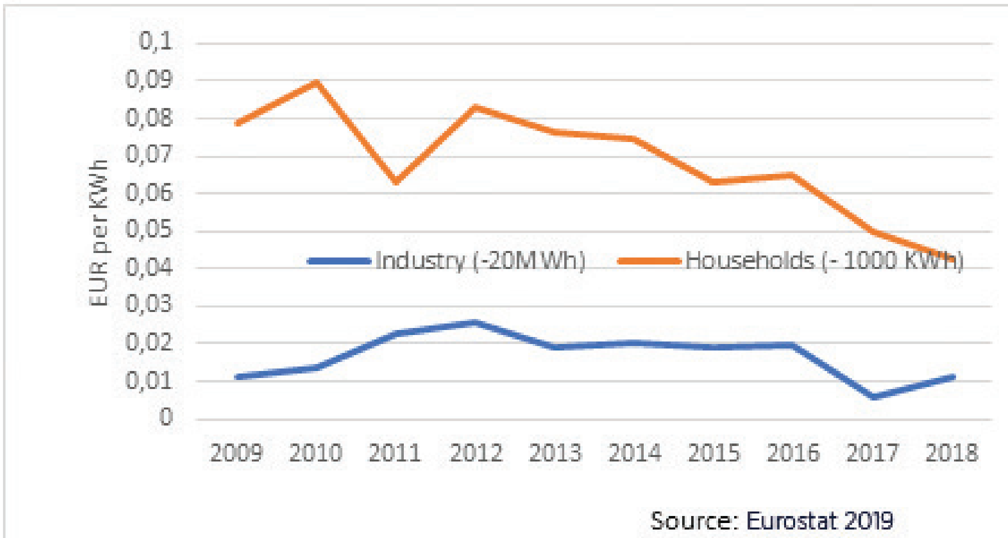
[19] The interconnection capacity is the percentage of a country's installed electricity production that the network allows to be traded at borders.

[20] European Commission, Communication on Strengthening Europe's Energy Network, Brussels, COM(2017) 718 final, 23 November 2017, Brussels.

Coping with Istanbul's growing demand and air quality

The map of Turkish power plants shows that in the area of Istanbul, which is densely populated and where demand growth is high, most of the current power plants are conventional thermal ones, powered by either gas, coal, or other fossil fuels. This is problematic for the air quality of a city that is already trying to lower its pollution level.[21]

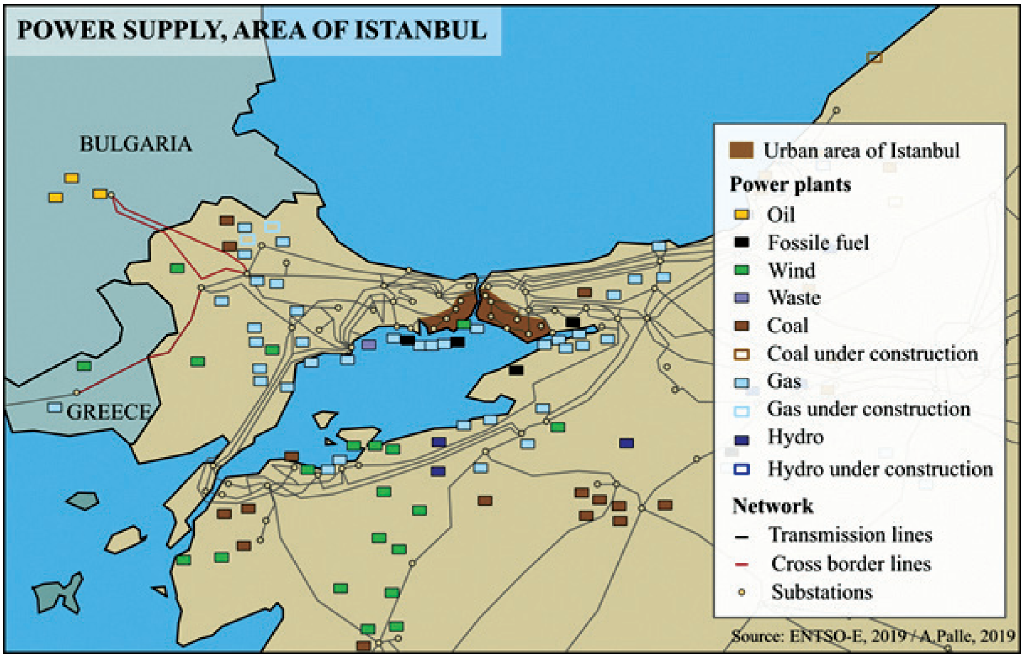
Chart 7. Network costs in electricity prices in Turkey



Renewable energy could present a solution to growing demand and eventually replace conventional power plants in the area. In these perspectives, the interconnection with the ENTSO-E continental European network might prove beneficial for Turkey in balancing production in the region. The transmission system operators in the ENTSO-E area are also facing challenges in the integration of renewables into their power networks and are working on common sets of standards to improve grid capacity and accommodate larger shares of renewables.[22]

[21] International Energy Agency, Turkey Review, 2016.

[22] EU Regulation 714/2009.



6. Impact on the security of supply: Between dependence reduction and technical interdependence

Interconnection and renewable policy contribute to the diversification of the electricity mix and the mitigation of a growing dependence

The development of a renewable energy policy in Turkey reflects concerns about the climate and environment, but is also linked to another preoccupation: the growing dependence of the country on energy imports. In this respect, enforcing a renewable-oriented policy for power production, based on a strong and regionally interconnected network, is also an asset for supply security through the diversification of sources.

Between 2000 and 2017, Turkish energy imports more than doubled, going from 52,000 toe[23] in 2000 to 124,000 toe in 2017.[24] It is worth noting that in this time frame, the share of electricity in Turkey's transformed energy (which includes mostly the refining and petrochemical industries) jumped from a quarter of all the transformed energy in 2000 to a third in 2017 (see Annex 1), thus following the global trend of world electrification.[25]

Oil has been almost excluded from this electricity production during the last decade, while hydro, gas, and coal have made up for most of the growth in demand. The share of gas and coal versus renewables consumption on a yearly basis thus strongly depends on the watersituation of the country, as hydro amounted for 32% of the total net generating capacity of Turkey in 2018.[26]

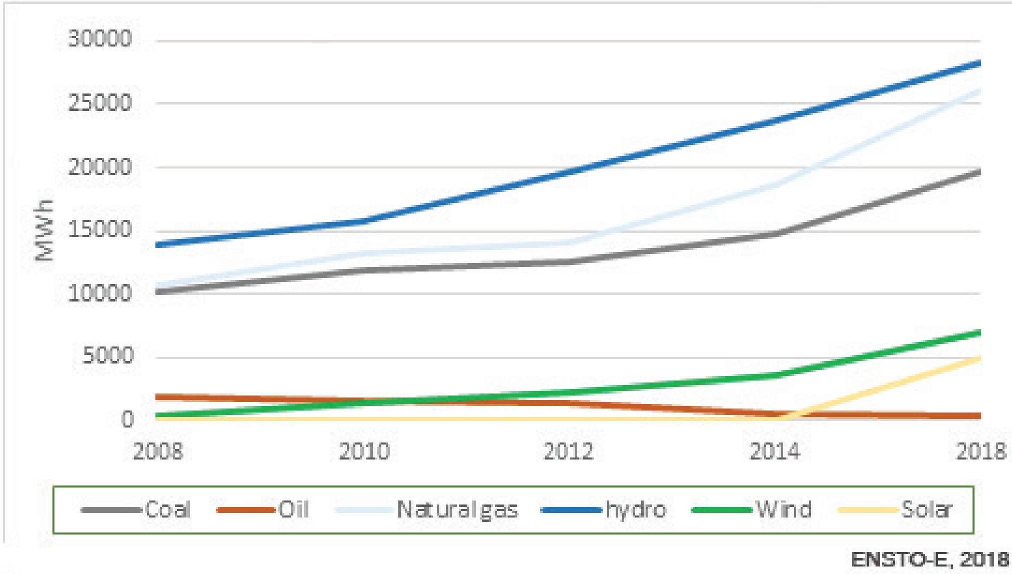
[23] Tonne of oil equivalent.

[24] Eurostats, 2019.

[25] International Energy Agency, World Energy Outlook 2018.

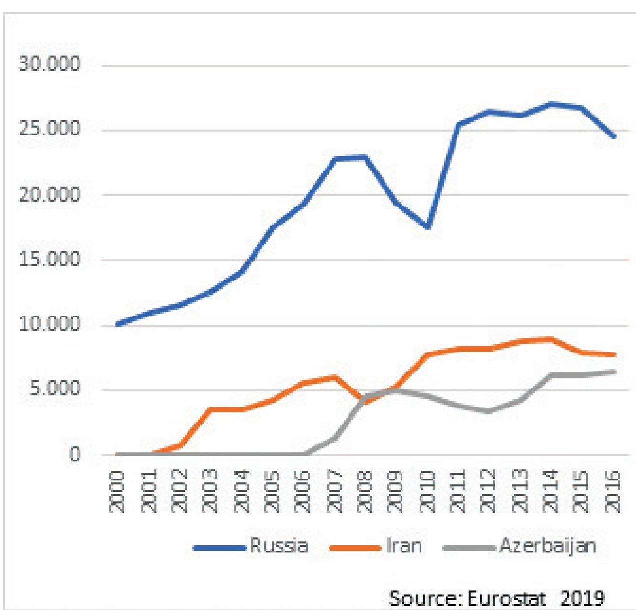
[26] ENTSO-E, Factsheet 2018.

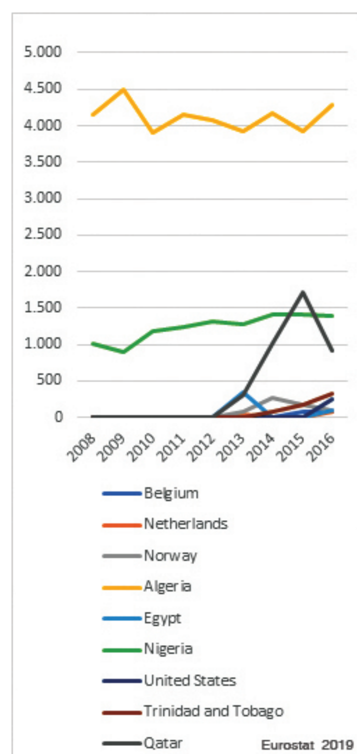
Chart 8. Installed capacity for power production in Turkey



Within these capacities, hydro is nationally produced. Turkey domestically produces around 38% of the coal it consumes (IEA, 2017). As for imports, the coal market is a global one supported by seaborne shipped products with many suppliers, which allows for little dependency. Though Turkey's investment in coal capacity is still on the rise despite its climate commitments, a climate- and environment-friendly policy – even minimal – will lead the country to prefer alternative sources of generation when possible. In this respect, the consumption of gas, which is considered a lower greenhouse gas-emitting source of energy, has heavily increased since 2000. Contrary to coal, the gas market is a regional one, and Turkey relies on fewsuppliers, mainly Russia, Iran, and Azerbaijan.

Chart 9. Gas imports (pipeline) in Turkey (bcm) *(on the left)*
Chart 10. LNG imports in Turkey (bcm) *(on the right)*





A trend of diversifying gas imports via liquefied natural gas (LNG) has appeared in the last few years. However, it remains a small share of Turkey's imports.

Alongside the stability provided by a strong network of regional interconnection, further decarbonizing the electricity mix through a renewable policy is yet another option for ensuring supply security through the diversification of sources.

Technical interdependence gives rise to cooperation, as it brings both solidarity and common vulnerability

If, from a supply point of view, the interconnection and integration of Turkey's power market and networks into the ENTSO-E area allow for an easier renewable policy by strengthening both its network architecture and operational standards, it also brings a certain level of technical interdependence. It is a vector of solidarity but also of common vulnerability.

In the interconnected network of the ENTSO-E area, solidarity applies in case one member faces a sudden network frequency drop.[27] Other parts of the network can help compensate for half an hour at most, and thus give time to adjust the generation, for example by starting some backup units. This is an advantage for network resilience in case of an incident because it allows for a reduction of the dimensioning of the backup units needed to secure network operation.[28]

This potential solidarity has as a downside the possibility of snowball effects, should an incident occur. In 2006, the tripping of a line in Germany, caused by a ship that was too high passing underneath, led to a blackout which affected 15 million European consumers in ten different countries. The networks' operators came up with mitigation measures and new standards to avoid the problem in the future, by creating two network cooperation initiatives, Coreso (Coordination of Electricity System Operators) and TSC (Transmission System Operator Security Coordination), which watch over an area of several national interconnected networks, and by creating and enforcing common network codes, among which one specifically concerns the emergency restoration of the network in case of a blackout.[29] If these mitigation measures prove efficient, they also highlight the high level of technical interdependence of these interconnected networks. More recently, in March 2018, a dispute between the network operators of Serbia and Kosovo over a balancing[30] issue led to a small global imbalance in the ENTSO-E interconnected system which caused all the electric clocks steered by the power system in continental Europe to run up to 6 minutes late.[31]

What does this mean for the Turkish system? Integration in the ENTSO-E continental area implies a certain level of vulnerability to new hazards which can only be mitigated by real cooperation between neighboring interconnected networks. It means on the one side that

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[27] Frequency is an indicator of the balance between generation and demand, and the stability of the network. If the frequency diverges too much from the standard balance point (50 Hz in the ENTSO-E continental network), some areas of the network might disconnect from the others and ultimately lead to a black out.

[28] Interview with a former RTE engineer responsible for the training of Turkish TEİAŞ units.

[29] Commission regulation (EU) 2017/2196 of 24 November 2017 establishing a network code on electricity emergency and restoration.

[30] Balancing concerns the equilibrium between injection and withdrawal of power in the network.

[31] "Europe's digital clocks back to speed after grid operators fix lag," *Reuters*, 3 April 2018.

Turkey has to take the standards of the ENTSO-E quite seriously, and on the other side that the European networks are strongly committed to a real integration process when they open to interconnection, because, if the process goes wrong, it might affect them significantly. This is even more the case now that the trend of digitalization includes power systems, making them more efficient from a technical, commercial, and environmental point of view, but also exposing them to cybersecurity risks.[32]

7. Potential diplomatic impact

The implications of the integration of the Turkish system into the ENTSO-E are therefore quite serious, as they affect the entire European power system. Though not emphasized by the media coverage, this is a strategic diplomatic event. It is a strong move in one of the most promising chapters of Turkey's accession to the EU, the energy chapter, but it is also more than that. In the diplomatic relationship between Turkey and the EU, which has been characterized by many ups and downs over time, the integration of power networks ensures the maintenance of permanent and long-term low-level cooperation on a technical topic. Contrary to the more politically heated question of gas, electricity is a strategic topic that often stays below the radar of traditional geopolitics while still contributing to the building of strong regional ties.

Ushering in the energy chapter

Turkey and the EU started negotiating the former's full membership in 2005. Sixteen chapters out of 35 have so far been opened, but the process has encountered obstacles. Since 2016, the pace of the accession process has been questioned on both sides.[33] Energy is one of the rare chapters which keeps moving forward. Along with chapter 18 (Statistics), chapter 20 (Enterprise and industrial policy), and chapter 21 (Trans-European networks), the energy chapter (chapter 15) is one of the few for which "good progress" has been achieved, according to the Commission's "2019 Communication on EU Enlargement Policy."[34] Among these other chapters, statistics is not a strategic domain and half of chapter 21, on Trans-European networks, is dedicated to energy networks. This means that energy is, in fact, one of the two main domains where cooperation between Turkey and the EU is truly progressing. This lends real diplomatic importance to the topic.

In the abovementioned document, the EU places the emphasis on gas, mostly because it concerns its own security of supply and diversity of sources and routes, and because Turkey is seen as an emerging potential regional gas hub. However, the electricity interconnection is also mentioned, and while it may not be a major topic for European supply security, it could nonetheless be of importance for that of Turkey.

[32] Miron Abramovici and Paul Bradley. *Integrated Circuit Security: New Threats and Solutions*, in: Sheldon F., Peterson G., Krings A., Abercrombie R., Mili A. (Eds.), "Proceedings of the 5th Annual Workshop on Cyber Security and Information Intelligence Research: Cyber Security and Information Intelligence Challenges and Strategies" (CSIIRW '09), New York: ACM, 2009.

[33] Both Turkey's president and the Council of the European Union have across 2018 and 2019 made declarations highlighting a standstill in the accession process. Council of the European Union, Conclusions on Enlargement and Stabilisation and Association Process, doc 10555/18, 26 June 2018, Brussels; "Erdoğan calls on EU to halt accession talks if Turkey unwanted in union," *Turkish Minute*, 28 April 2019.

[34] European Commission, Communication on EU Enlargement Policy, COM(2019)260, Brussels, May 29, 2019.

Maintaining regional ties at a technical level

Electricity is a highly technical domain that has long been more a matter of engineering than politics,[35] even though this is currently changing in light of energy transition policies. Interconnected power networks require a long-lasting daily exchange of information and constant cooperation. The EU has invested 2.5 million euros under the IPA-I to contribute to the integration of the Turkish network into the continental European system. It has also financed several missions of delegated electrical engineers over the last ten years to contribute to the training of the Turkish network operator TEİAŞ in operations and maintenance.

From a political point of view, this daily technical cooperation, sparked by the integration of the Turkish network and market into the continental European one, corresponds to the "de facto solidarities created by tangible realizations"[36] theorized by Jean Monnet and Robert Schuman, who rank among the founding fathers of the EU. Outside of the sole EU accession program, which is highly political, dynamics leading to the building of regionally integrated systems need not be political. The literature on regional integration, regionalization, and regionalism, born in the 1950s with the beginning of the European project,[37] has started with State cooperation, a focus on commercial exchanges, and a linear vision of an integration made step by step.[38] However, the constructivist approach of regional integration envisions broader types of integration dynamics, involving non-state actors[39] and taking into account the development of infrastructure.[40] In this respect, electrical technical cooperation is one of the tools that could lead to stable, permanent, low-level cooperation and integration, relatively untouched by the political ups and downs of Turkey-EU relations.

Strategic cooperation under the radar of geopolitics

A low level of technical cooperation is nonetheless a matter of strategic importance. Electricity systems lie at the core of industrialized societies and states, as they are essential to the food and water supply, the flow of information, economic and financial activity, and the daily activities of most citizens. Cooperation and integration in this area, while still considered more a technical than a political topic, touches on a fundamental aspect of what characterizes the European Union's societies. Though most of the geopolitics of energy in the region focus on gas, some recent papers have brought up the geopolitical[41] and strategic dimension of cross-border powerlines and market interconnections.

[35] Angelique Palle, "European electrical flows, from policy enforcement to politicisation?" *Géocarrefour* 91, no. 91/3 (April 7, 2017), https://doi.org/10.4000/geocarrefour.10229.

[36] Robet Schuman, French Minister of Foreign Affairs, Speech of the 9th of May 1950.

[37] Ernst B. Haas, "The Challenge of Regionalism," *International Organization* 12, no. 04 (September 1958): 440–458.

[38] Bela Balassa, *The Theory of Economic Integration*, Homewood (Illinois : Richard D. Irwin, 1961).

[39] Raimo Väyrynen, "Regionalism: Old and New," *International Studies Review* 5, no. 1 (March 1, 2003): 25–51.

[40] Björn Hettne and Fredrik Söderbaum, "The New Regionalism Approach," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, 1998), 2.

[41] Thijs Van de Graaf and Benjamin K. Sovacool, "Thinking Big: Politics, Progress, and Security in the Management of Asian and European Energy Megaprojects," *Energy Policy* 74 (November 1, 2014): 16–27, https://doi.org/10.1016/j.enpol.2014.06.027; Itay Fischhendler, Lior Herman, and Jaya Anderman, "The Geopolitics of Cross-Border Electricity Grids: The Israeli-Arab Case," *Energy Policy* 98 (November 1, 2016): 533–43, https://doi.org/10.1016/j.enpol.2016.09.012.

Turkey is already playing the geopolitics of gas, as it has become a key transit player for the EU gas supply in the past few years. It is also positioning itself as a regional gas hub, a development that has been acknowledged by the European Council.[42] Still, despite interesting prospects, the electrical portion of this regional energy strategy has so far been left behind.

8. Conclusion and recommendations

The interconnection of the Turkish and continental European power systems and markets opens a window to both opportunities and challenges for Turkey, far beyond the mere possibility of exchanging electricity.

The interconnection with neighbors introduces an opportunity for a change of scale in Turkey's strategy for security of supply, in a context where imbalances between production and consumption areas bring challenges for the stability of the national power transport network. Switching from a national vision to a regional, cross-border one, by opening or strengthening exchange possibilities, could lead to more stability for the Turkish power network.

Most Turkish neighbors are interested in such exchanges. Iran has recently considered synchronizing its network with its neighbors, while the EU has financed 10 years of technical exchanges leading to the recent synchronisation of the Turkish network with the ENTSO-E network. The current price difference between Turkey, Greece, and Bulgaria could lead to export options in a context where Turkish consumption has decreased in the last few years. The ENTSO-E's future scenarios already forsee that the interconnection with Turkey will suffer from congestion in its current dimensioning and that additional transfer capacity will be needed.

These exchanges and the network interdependence that synchronization brings have a long-term diplomatic effect. Opening the power network to regional synchronization, as Turkey and the European network are currently doing, also requires sharing common vulnerabilities and increasing the likelihood of snowball effects in case of an incident. Policymakers should be particularly aware of this point, since it is one of the reasons why ENTSO-E member states are so strict in the enforcement of common standards and information-sharing.

This also means that the integration of the Turkish power system in the ENTSO-E continental network is a strong gesture toward cooperation. Electricity is becoming an increasingly strategic asset in industrialized states, powering many of their vital functions. Though gas has traditionally been the dominant factor in energy relations between Turkey and the EU, with this interconnection, electricity becomes a new card for cooperation. It concerns a very strategic but technical sector where politics and geopolitics seem to play a lesser role and which could ensure long-lasting cooperation on a daily basis, as well as regional integration, unharmed by the ups and downs of Turkey's accession to the EU.

Financing such interconnection is also a challenge. It could prove more interesting, from an economic point of view, to invest in short cross-border interconnections than to strengthen the long-distance transport network that links the eastern production of Turkey with the western consumption. The ENTSO-E's member states already foresee congestion along the existing lines between Turkey and Greece and Bulgaria, and the price difference between Turkey and these two neighbors also provides investment incentives.

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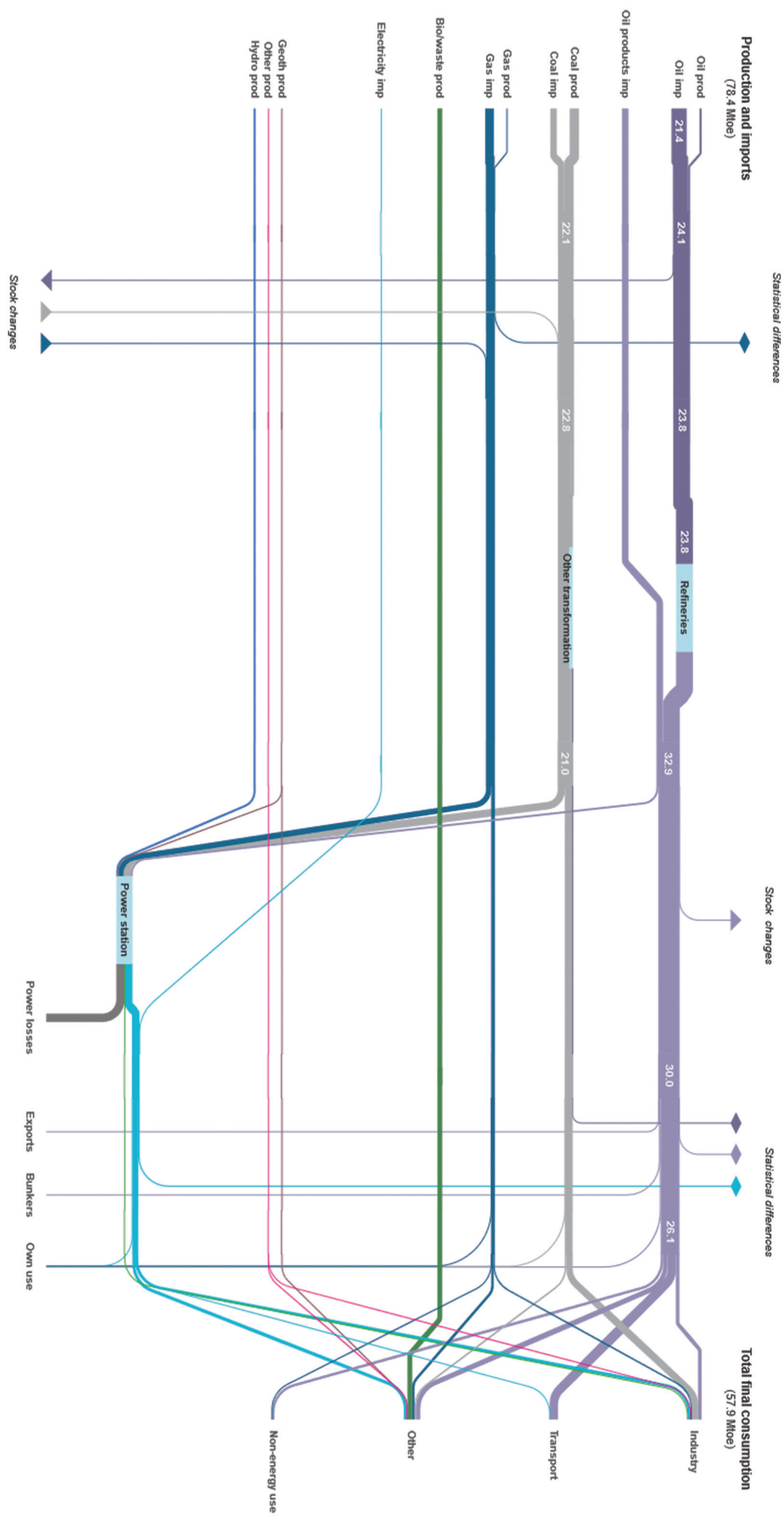
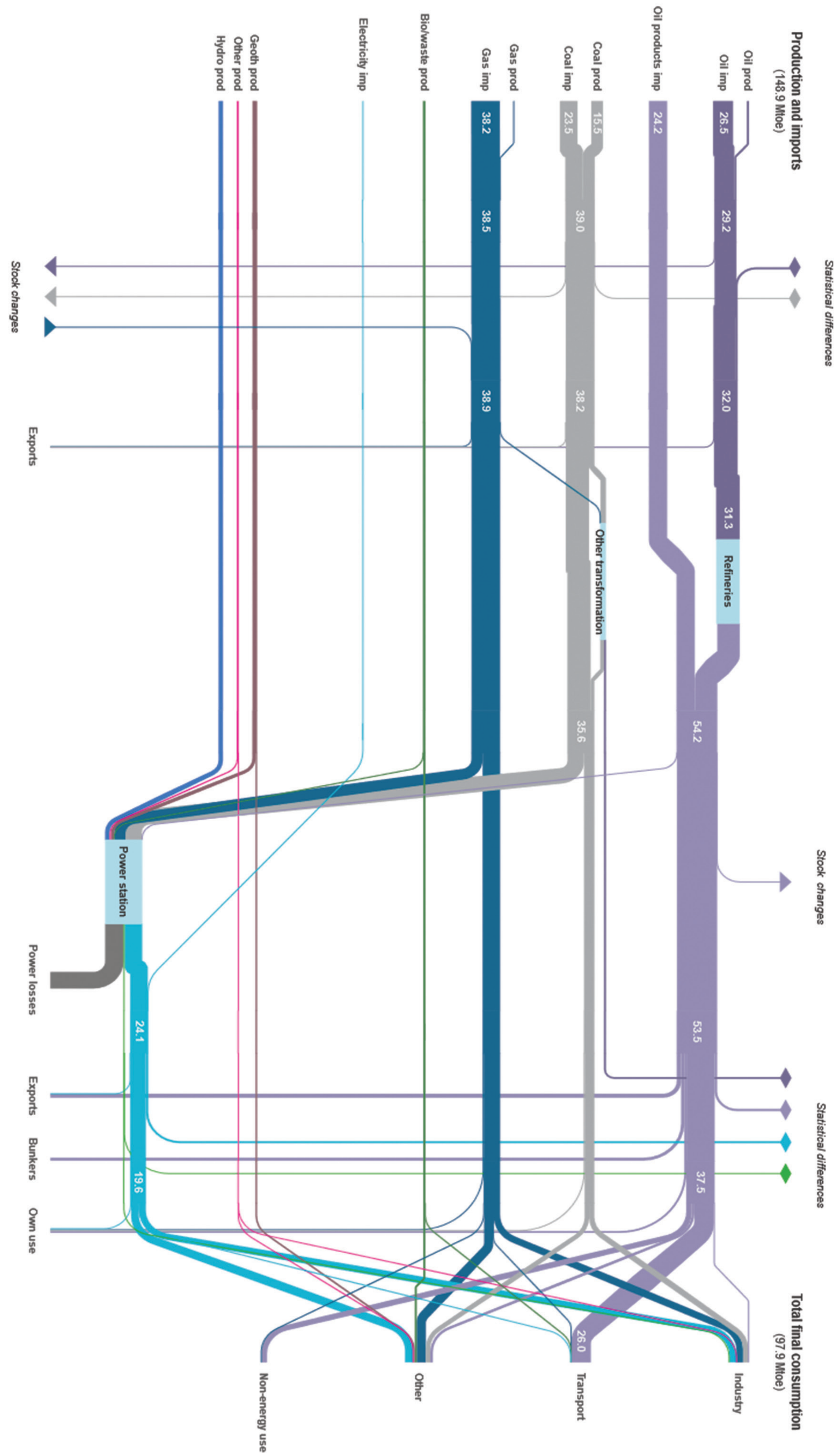
[42] Council of the European Union, doc 10555/18.

Annexes

Annexes: Sankey Diagrams of the Turkish energy flows, IEA, 2000.




Production and imports
(148.9 Mtoe)
Oil prod
Oil imp
Oil products imp
Coal prod
Coal imp
Gas prod
Gas imp
Bio/waste prod
Electricity imp
Geoth prod
Other prod
Hydro prod
26.5
24.2
15.5
23.5
38.2
29.2
39.0
38.5
32.0
38.2
38.9
31.3
Statistical differences
Stock changes
Exports
Refineries
Other transformation
54.2
35.6
Power station
Power losses
Stock changes
53.5
24.1
Statistical differences
Exports
Bunkers
Own use
37.5
19.6
26.0
Total final consumption
(97.9 Mtoe)
Industry
Transport
Other
Non-energy use

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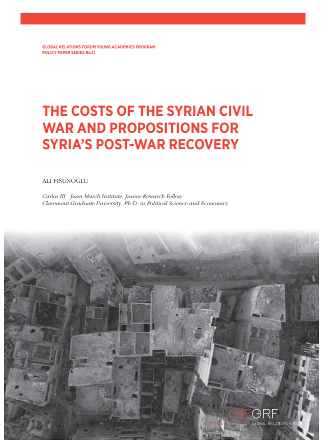

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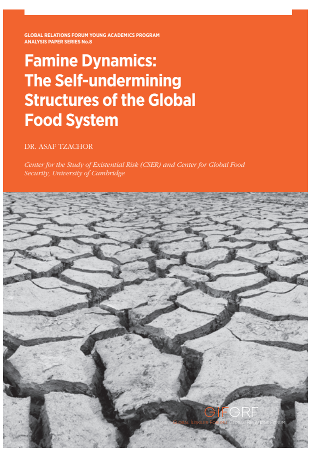

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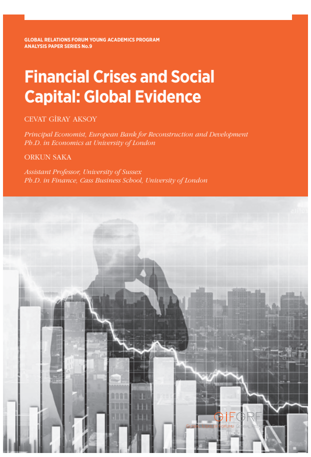

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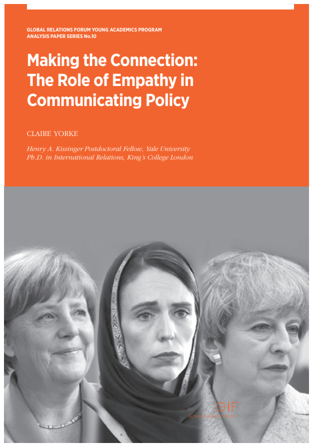

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