

TRADING AT THE EDGE: THE ROLE OF GREEN TECHNOLOGIES IN TURKEY-GERMANY TRADE

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1. EXECUTIVE SUMMARY

At the end of September 2021, Turkey announced that it will ratify the Paris Agreement which it had signed in 2016. Domestic and international developments, including the European green deal, makes it inevitable for Turkey to discuss its policy choices to converge to the green transformation process that is taking place globally.

This paper aims to evaluate Turkey's potential in green economy from a trade perspective. In doing so we hope to have provided a new methodology for Turkey in measuring green economy. To our knowledge this has not been utilized elsewhere. Special attention is given to Germany which is the largest trading partner of Turkey in our definition of green products. 41 products that fell under the broad sectors of Renewable Energy and Green Infrastructure, Transport Technologies, and Green Friendly Construction were analyzed during the trade analysis.

Following the trade analysis, this paper presents two additional chapters to deepen the discussion on the Green Economy. First, it employs a recent methodology developed by Neave O'Clery, Muhammed Ali Yıldırım, and Ricardo Hausmann. These scientists have created a productive ecosystem map based on the Ricardian Comparative Advantage theory. With the help of the ecosystem map, this paper provides a group of products and their related HS codes that Turkey can have a comparative advantage to produce and export. Secondly, focusing on the clean technology startups' contribution to green economy, this paper presents a snapshot of both Turkey's and Germany's green startup ecosystem and the potential for integration for the possible future endeavors.

Turkey's green economy constitutes a growing part of its trade volume. Compared with total trade volume, the Compounded Annual Growth Rate - CAGR in the past decade of overall green economy exports is 5.5%, while Turkey's CAGR of total exports is 3.5%. Likewise, the CAGR for green economy imports is 4.1%, and CAGR of total imports is 1.2%. Based on the data from last ten years, the growth rate of the green economy is accelerating faster than that of total trade and is open to be improved for future opportunities.

The analysis reveals that the three different sectors of the green economy (renewables and green infrastructure, transport technologies, green-friendly construction) have a visible impact on Turkey's economy and trade relations. Especially, Germany has a large share in comparison to other trade partners of Turkey. As a result of our analysis, Germany ranked 1st for both exports and imports of renewables and green infrastructure. In the green transport technologies sector, Germany ranked 1st in exports and 2nd in imports which China surpassed. Finally, in green construction, Germany ranked 3rd in exports after Iraq and Israel respectively and ranked 1st in imports.

Germany is the market for 15.5% of Turkey's green economy exports, while accounts for 20.4% of total green economy imports. Currently, Germany ranks 1st the export market for \$567 million of Turkish green economy goods. On the import side, Germany ranks 2nd with overall value of \$1.2 billion in the same category. Germany ranks 1st among the EU members in terms of Turkey's green economy trade values for both exports and imports.

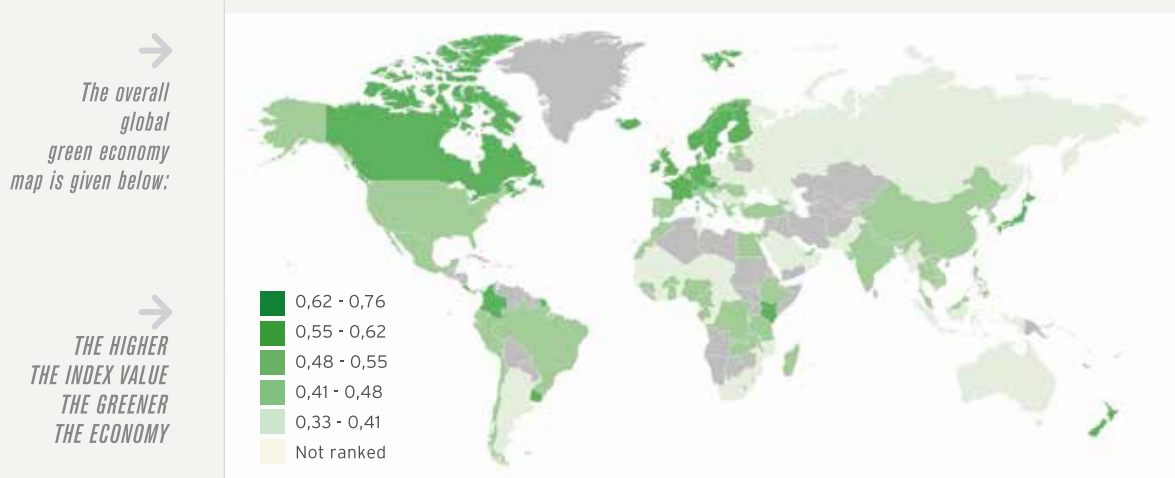
The potential for additional trade and investments is also reflected in the cleantech startups of both Turkey and Germany. Both countries' green economy stand to benefit greatly by the dynamism that is provided by cleantech startups. As is the case for general startup ecosystem, cultural ties and a long history of doing business together provides a very fertile ground for bringing together the cleantech startup ecosystem of each country.



2. INTRODUCTION

The green economy, defined as "low carbon, resource-efficient and socially inclusive" economy by United Nations¹ became central to discussions about development and economic growth. Accordingly, several organizations such as OECD and EuroStat have developed measurement frameworks to track this phenomenon statistically². These measurements are used to foster green economy-based economic growth by tracking and promoting appropriate policies to support the green transition. Turning toward greener outlooks of economic performance, the Global Green Economy Index (GGEI) is a significant initiative that provides necessary data to inform decisions on green investments and policies.³ The latest data of GGEI 2018 measured the economic performance of 130 countries based on four dimensions: leadership & climate change, efficiency sectors, markets & investment, and the environment⁴. Based on the results about markets and investments, it is found that within the five of the world's largest economies, Germany has the most promising performance ranked 6th, followed by Japan 19th, China 28th, United States 31st, India 36th ⁵. The overall global green economy map is given below:

>>> Figure 1: Global Green Economy Index, 2018 (Percentile 0-1)



In 1994, OECD, in collaboration with the Eurostat, established an Informal Working Group on the Environment Industry to collect and analyze data which is based on the scope of "environmental industry."⁶ The broad conceptual framework of the environmental industry-led further studies of organizations to modify their distinct methodologies. The recommended and applicable approaches to measuring the green economy were constructed individually by OECD countries. By making use of multiple and possibly heterogeneous perspectives, these countries agreed on the comprehensive and flexible definition of green economy as following:⁷

1 UN Environment Programme. (2021). <https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-economy>

2 OECD., & Eurostat. (1999). The Environmental Goods and Services Industry Manual for Data Collection and Analysis. Paris: OECD Publishing.

3 Global Green Economy Index: Dual Citizen Inc. (2021). <https://dualcitizeninc.com/global-green-economy-index/>

4 Global Green Economy Index, 2018 - knoema.com. <https://knoema.com/enedcw/global-green-economy-index-2018>

5 Global Green Economy Index: Dual Citizen Inc. (2021). <https://dualcitizeninc.com/global-green-economy-index/>

6 OECD., & Eurostat. (1999). The Environmental Goods and Services Industry Manual for Data Collection and Analysis. Paris: OECD Publishing.

7 Ibid.

The environmental goods and services industry consists of activities that produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air, and soil and problems related to waste, noise, and ecosystems. This includes cleaner technologies, products, and services that reduce environmental risk and minimize pollution and resource use.

The product list of environmental goods was developed by the Informal Working Group on the Environment Industry to support the definition with the quantitative measures. The list was formed by using 6-digit Harmonized System (HS) product numbers and categories according to subgroups⁸. These subgroups divided the environmental goods and services into three main categories: Pollution management group, Cleaner technologies and products group, and Resource management group⁹. Definition and classifications are contextualized based on the product's contribution to "environmental purpose" by its own nature¹⁰. Conforming to a similar ultimate purpose, countries differ in terms of their methods and approaches to identify the sectors which are chosen to be included to their green economy measurement.

As one of the developing countries with a promising potential for the green transition, cleaner energy, and transport construction, Turkey needs its own strategy to position itself for the upcoming discussions around the green economy policies. The European Green Deal Call has positively reinforced Turkey's green transition needed for the Green Deal. In line with the "Net Zero Carbon Emission Target," European Call aims to decarbonize the EU economy by 2050, make radical changes in the energy production systems and transform the member states' economic model into environmentally friendly production models that inspire efforts to combat climate change¹¹. Within the framework of these targets, in the short term, it is expected that the European Commission will work on policies to reduce greenhouse gas emissions by the second half of 2021 and clarify its plans. Subsequently, "Carbon Border Adjustment Mechanism" is planned to be implemented in the customs of European Union member states in 2023. The long-term goals of the agreement include the decarbonization of the energy sector with significant momentum and the completion of a 100% transition to renewable energy sources after 2030¹². Under the Carbon Border Adjustment Mechanism, the EU aims to ensure that the green steps will take in its own production model which do not harm its competitiveness and prevent carbon leakage that may occur when production moves abroad. Since the Carbon Border Adjustment Mechanism stipulates carbon emissions in accordance with EU standards in the products which are exported by the parties trading with the EU member states, it is anticipated that the countries trading with the EU will be greatly affected by this mechanism. Since Turkey realizes almost 40% of its exports are to EU member countries, Turkey's green transition is not only a positive but also a necessary step for the country's future endeavors¹³.

8 Robin Steenblik. (2005). Environmental Goods: A Comparison of the APEC and OECD Lists. OECD Trade and Environment, (2005-04).

9 OECD., & Eurostat. (1999). The Environmental Goods and Services Industry Manual for Data Collection and Analysis. Paris: OECD Publishing.

10 Environmental goods and services sector (env_egs). (2021). https://ec.europa.eu/eurostat/cache/metadata/en/env_egs_esms.htm

11 A European Green Deal. (2021). https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

12 Press Corner. (2021). https://ec.europa.eu/commission/presscorner/detail/en/mex_20_2389

13 T.C. Ticaret Bakanlığı. (2021). <https://ticaret.gov.tr/dis-iliskiler/avrupa-birligi/yani-basimizdaki-dev-pazar-avrupa-birligi>

Green transition objective could also be incorporated in the new round of negotiations for the modernization of the Turkey-EU Customs Union. EU and Turkey have agreed in principle that the renewed Customs Union should also have a green economy component. Therefore, it would be essential to understand the existing gap between green policies of EU and Turkey. This should be followed by the measurement of the impact for Turkey, to converge with the EU Green Deal. Considering these, the need for Turkey to measure its green economy with a view to assess its competitive advantages and pitfalls is indispensable to chart a more robust strategy for the country's economic growth. In line with the EU guidelines explained above, this paper brings a sectoral approach in terms of assessing Turkey's potential for the green transition. The sectoral approach will follow a similar guideline to EU's measurement principles which benefit from HS codes.

This paper presents an outlook for green economy components in Turkey, based on four primary sectors: renewable energy, green infrastructure, transport technologies, and green-friendly construction, as proposed by the recent package "Fit for 55%" of the European Commission¹⁴. Therefore, this paper analyzes these sectors to evaluate the standing of Turkey and its developing relations with Germany, one of the most significant trade partners of Turkey both in overall trade and in the green economy-related trade.

3. METHODOLOGY

To assess the economic potential of green transition in Turkey, it is important to define a methodology for the appropriate sectoral coverage. The defined methodology can then be used to compare Turkey's performance to other countries. First, we provide a summary of the available literature on the green economy measurements. Then the paper presents the identified sectors and list of goods, aligned with the "European Union's plan for a green transition" and its "Fit for 55" plan¹⁵. In this plan, European Council signaled the importance of Renewable Energy and Green Infrastructure, Transport Technologies, and Green Friendly Construction sectors. To define these sectors and quantify their economic value, this paper identifies 41 selected products from the reports of internationally accredited institutions^{16 17 18}. Final product list was created considering these products' relative importance to their sectors based on their trade values¹⁹. Trade values are quantified by HS codes which are standardized codes to identify specific products' export and import values.

14 Fit for 55. (2021). <https://www.consilium.europa.eu/en/policies/fit-for-55/>

15 Ibid

16 Izaak, W. (2021). HS Codes and the Renewable Energy Sector. <https://css.ethz.ch/en/services/digital-library/publications/publication.html/111414>

17 Climate Change, trade and production of energy-supply goods: The need for levelling the playing field. (2021). https://www.wto.org/english/tratop_e/envir_e/wksp_goods_sept09_e/jha_e.pdf

18 UNCTAD. (2021). Towards a harmonized international trade classification for the development of sustainable ocean-based economies. https://unctad.org/system/files/official-document/ditcted2020d4_en.pdf

19 Rothwell, J. (2011). Methodological Appendix for Sizing the Clean Economy: A National and Regional Green Jobs Assessment.

First we take a look at the Turkey's trade performance in the past 10 years for the selected product Harmonized System - HS codes. Then we quantify Turkey's green economy trade performance in Renewable Energy and Green Infrastructure, Transport Technologies, and Green Construction sectors. This methodology also provides a framework to demonstrate Germany's relative importance in the development of these sectors.

Lastly, this paper presents two additional analyses to deepen the discussion around the Green Economy theme. First, it provides a recent methodology developed by Neave O'Clery, Muhammed Ali Yıldırım, and Ricardo Hausmann. These scientists created a productive ecosystem map based on the Ricardian Comparative Advantage theory. With the help of the ecosystem map, this paper provides a group of products and their related HS codes that Turkey can have a comparative advantage to produce and export. Secondly, focusing on the clean technology startups' contribution to green economy, this paper presents a snapshot of both Turkey's and Germany's green startup ecosystem and the potential for integration for the possible future endeavors.



4. GREEN ECONOMY OUTLOOK ANALYSIS

A. RENEWABLE ENERGY AND GREEN INFRASTRUCTURE A.1 Renewable Energy

Renewable energy constitutes a significant part of Turkey's energy generation. According to International Energy Agency 2021 Turkey Report, renewable energy sources accounted for 44% of total electricity generation in 2019.²⁰ Also, renewable energy investments reached \$7 billion in 2020.²¹ Today, in terms of installed capacity in renewable energy, Turkey ranks 5th in Europe and 12th in the world²².

Turkey attracts foreign investment with its developing renewable energy sector. According to the Top European Locations for Renewable Energy FDI ranking by fDi Markets, Turkey ranked 7th, with growth potential in the clean energy sector.²³ Germany has invested approximately €25 billion in Turkey's energy sector, employing more than 15,000 people.²⁴ In particular, German firms so far have contributed 51,000 megawatts to the renewable energy sector in Turkey.²⁵ Among the renewable energy sector, hydro energy, wind, and solar have the largest share.²⁶

Hydropower is the greatest source of renewable electricity in Turkey among the renewable energy sectors, which amounted to 29.2% of total electricity generation in 2019.²⁷ Turkey is one of the significant countries for hydropower generation. With 710 hydroelectric power plants of Turkey, by 2019, the country led Europe with 219MW capacity added. According to the International Hydropower Agency 2019 Report, Turkey's hydropower capacity increased by 145 MW equal to 31% of total national capacity.²⁸ Germany, as the major trade partner of Turkey, contributes significantly to hydropower generation in Turkey. The energy market leader Enerjisa who built 12 hydroelectricity power plants in Turkey, has a 50% partnership as of 2013 with E.ON German company.²⁹ The same year, Akfen Company who has five hydropower plants, sold 60% of its shares to Aquila HydroPowerInvest.³⁰

In addition to hydropower, Turkey's wind energy capacity has risen over the years, contributing over 10% of total electric production for the first time.³¹ From 2008, installed wind energy capacity has steadily increased and reached 9.007 megawatts in 2021.³² Wind power experienced significant growth with a little less than 1.5 terawatt-hours in 2009 to 21.8 terawatt-hours in 2019.³³

20 International Energy Agency. (2021). Turkey 2021-Energy Policy Review. https://iea.blob.core.windows.net/assets/cc499a7b-b72a-466c-88de-d792a9daff44/Turkey_2021_Energy_Policy_Review.pdf

21 Turkey's renewable energy investments reach \$7B in 2020. (2021). <https://www.aa.com.tr/en/energy/renewable/turkeys-renewable-energy-investments-reach-7b-in-2020/31659>

22 From Rep. of Turkey Ministry of Foreign Affairs. (2021). from <https://www.mfa.gov.tr/turkeys-energy-strategy.en.mfa>

23 Turkey is 7th in Europe's foreign renewable investments. (2021). from <https://www.aa.com.tr/en/energy/investments/turkey-is-7th-in-europes-foreign-renewable-investments/29255#>

24 Germany invests €25 bln in Turkish energy sector, employing 15,000 - Latest News. (2021). from <https://www.hurriyetdailynews.com/germany-invests-25-bln-in-turkish-energy-sector-employing-15-000-165233>

25 Ibid.

26 International Energy Agency. (2021). Turkey 2021-Energy Policy Review. https://iea.blob.core.windows.net/assets/cc499a7b-b72a-466c-88de-d792a9daff44/Turkey_2021_Energy_Policy_Review.pdf

27 Key electricity trends 2020 - Analysis - IEA. (2021). <https://www.iea.org/articles/key-electricity-trends-2020>

28 International Hydropower Association. (2020). 2020 Hydropower Status Report. https://hydropower-assets.s3.eu-west-2.amazonaws.com/publications-docs/2020_hydropower_status_report.pdf

29 Hissedarlarımız | Enerjisa Üretim. (2021). <https://www.enerjisauretim.com.tr/hakkimizda/enerjisa-uretim-santralleri/hissedarlarimiz>

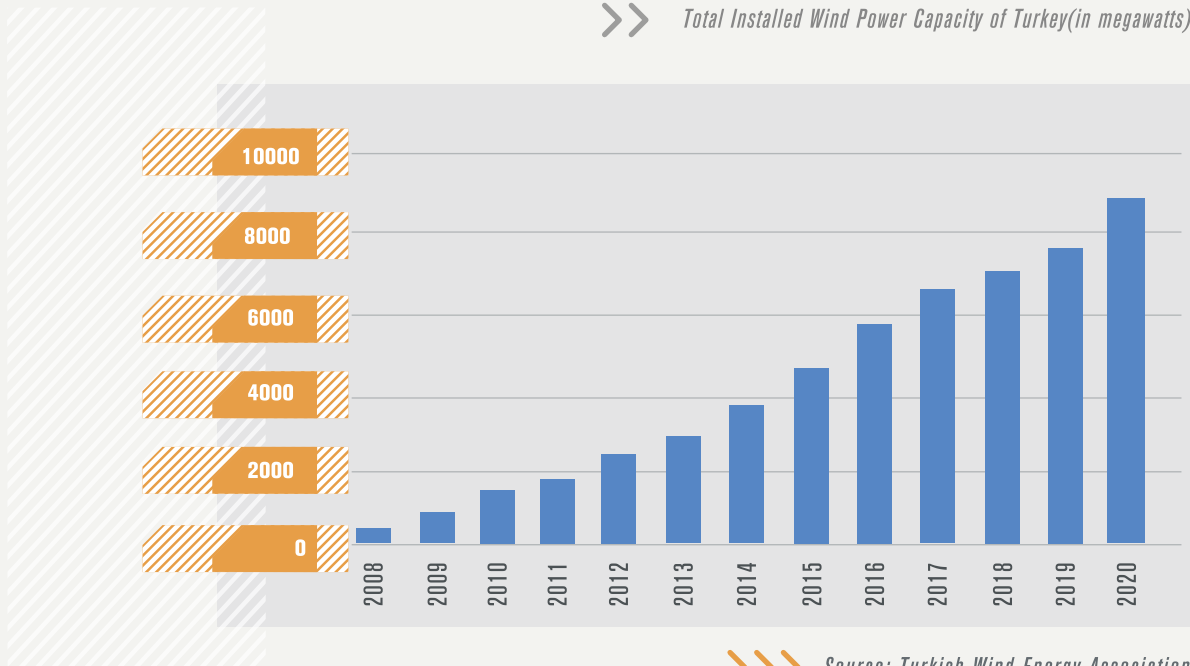
30 Anadolu Agency (2021). <https://www.aa.com.tr/tr/arsiv/akfen-hissesi-satacak/265525#>

31 Daily Sabah. (2021). <https://www.dailysabah.com/business/energy/wind-contributed-to-over-10-of-turkeys-electricity-minister>

32 Turkish Wind Energy Association 2021 Report. (2021). <https://tureb.com.tr/eng/lib/uploads/66fc52919051a660.pdf>

33 International Energy Agency. (2021). Turkey 2021-Energy Policy Review. https://iea.blob.core.windows.net/assets/cc499a7b-b72a-466c-88de-d792a9daff44/Turkey_2021_Energy_Policy_Review.pdf

>> Total Installed Wind Power Capacity of Turkey (in megawatts)



>>> Source: Turkish Wind Energy Association

In Turkey, like hydro and wind energy capacity, solar energy capacity has also risen, especially since 2015. Total capacity has reached to 6.668 megawatts in 2020.³⁴ According to the Stantec data, total Solar PV firms employed more than 3.000 people, and 20% of their products are exported to Europe, which is the second biggest export partner in Solar PV.³⁵ Solar energy also attracts considerable foreign investments; for instance, German firm AE Solar committed to constructing a solar panel factory in Turkey in 2021. The PV module plant in Kayseri is being developed by joint venture of Energate Corp and AE Solar.³⁶

A.2 Green Infrastructure

Various definitions are used to describe green infrastructure. Though, it can be simply considered as the structures that emerge as a result of the high level of harmony with nature, and not only terrestrial transformations by human activities. On the other hand, the traditional infrastructure such as roads, pipes, seawalls, and dams are called gray infrastructures mainly due to their concrete structure. In this respect, the EU Green Infrastructure Policy Report highlights that green infrastructure is founded on the idea that nature and natural processes, as well as the numerous benefits that nature provides to human society, should be actively integrated into spatial planning and territorial development.³⁷ Green infrastructure assists us in appreciating the value of the benefits that nature gives to human society and mobilizing resources to maintain and improve those benefits.³⁸

34 Statista. (2021). <https://www.statista.com/statistics/878791/solar-energy-capacity-in-turkey/>

35 Stantec. (2021). https://www.stantec.com/content/dam/stantec/files/PDFAssets/2020/stantec-market-report-pv-panel-manufacturing-turkey.pdf?utm_source=press-release&utm_medium=cta-click&utm_campaign=pv-panel-manufacturing-turkey

36 Todorović, I., & Todorović, I. (2021). German AE Solar to open solar panel factory in Turkey in April. <https://balkangreenenergynews.com/german-ae-solar-to-open-solar-panel-factory-in-turkey-in-april/>

37 EUR-Lex - 52013DC0249 - EN. (2021). <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52013DC0249&from=EN>

38 Ibid.

It also helps to avoid relying on expensive infrastructure when nature may frequently provide cheaper, more long-lasting alternatives.³⁹ Therefore, green infrastructure emerges as an important term for sustainable economic development. The proliferation of green infrastructure projects is essential for the successful green transition of an economy because it both benefits nature by preserving biodiversity and improve public health quality while at the same time creating demand for more jobs in contrary to gray alternatives.

Green infrastructure covers such product groups as rainwater harvesting systems, green roofs, and bioswales at the micro-levels and urban forests, solar-powered roads, and wildlife bridges at the macro levels. While the citizens' voluntary efforts can produce micro solutions, they still need encouraging policies and regulations implemented by the governments.⁴⁰ Building bigger green infrastructures need government funding and committed policies because green infrastructure projects seem as costly alternatives when compared to traditional methods. Especially, emerging countries need to improve their infrastructure considering their continuously increasing populations. The increasing number of natural disasters caused by global warming put these populations at risk. Meanwhile, traditional gray infrastructure generally perform worse than green infrastructure, especially in natural disasters.⁴¹

In this regard, Germany is a pioneer and model country in the world with its successful green infrastructure projects. While actively participating in multinational projects such as European Green Belt, Germany also succeeded in many green infrastructure practices. Floodplain restoration in Lenzener Elbtalau, MoorFutures in Mecklenburg-Vorpommern, and Storm water management in the Emscher region are examples of some of the larger projects.⁴² In addition, Germany supports international projects in other countries through funds; an example is Indonesian-German Green Infrastructure Development Project financed by German Federal Ministry for Economic Cooperation and Development (BMZ).⁴³ The realization of such projects in developing countries is especially important in changing climatic conditions.

Yet, there has not been any Turkish-German partnership on similar projects to date. However, considering the developing green economy link between Turkey and Germany, green infrastructure may be a productive economic area for mutual cooperation considering Germany's know-how on environmental solutions and Turkey's vast construction industry. The partnership of the two countries may yield cost-effective solutions. Nevertheless, in the current situation, Turkey is still in the early stages in terms of achieving a comprehensive green infrastructure network. Interest towards green infrastructure projects in Turkey is gradually increasing, driven by local municipalities.

39 Ibid.

40 Overcoming barriers to green infrastructure. <https://www.epa.gov/green-infrastructure/overcoming-barriers-green-infrastructure>

41 The multiple benefits of natural infrastructure. (2018). <https://www.iisd.org/articles/multiple-benefits-natural-infrastructure>

42 Green Infrastructure in Germany. https://ec.europa.eu/environment/nature/ecosystems/pdf/Green%20Infrastructure/GL_DE.pdf

43 Making infrastructure in Indonesia more modern and climate-friendly. (2021). <https://www.giz.de/en/worldwide/94255.html>

The cooperation between the Municipality of Istanbul and the European Bank for Reconstruction and Development is to be highlighted in this respect. The municipality of Istanbul and the European Bank for Reconstruction and Development (EBRD) will begin constructing a Green Cities Action Plan to examine, prioritize, and address the city's major environmental concerns through legislative reforms and investments. This will enable a more environmentally friendly and long-term vision for Istanbul and its 16 million residents. ⁴⁴

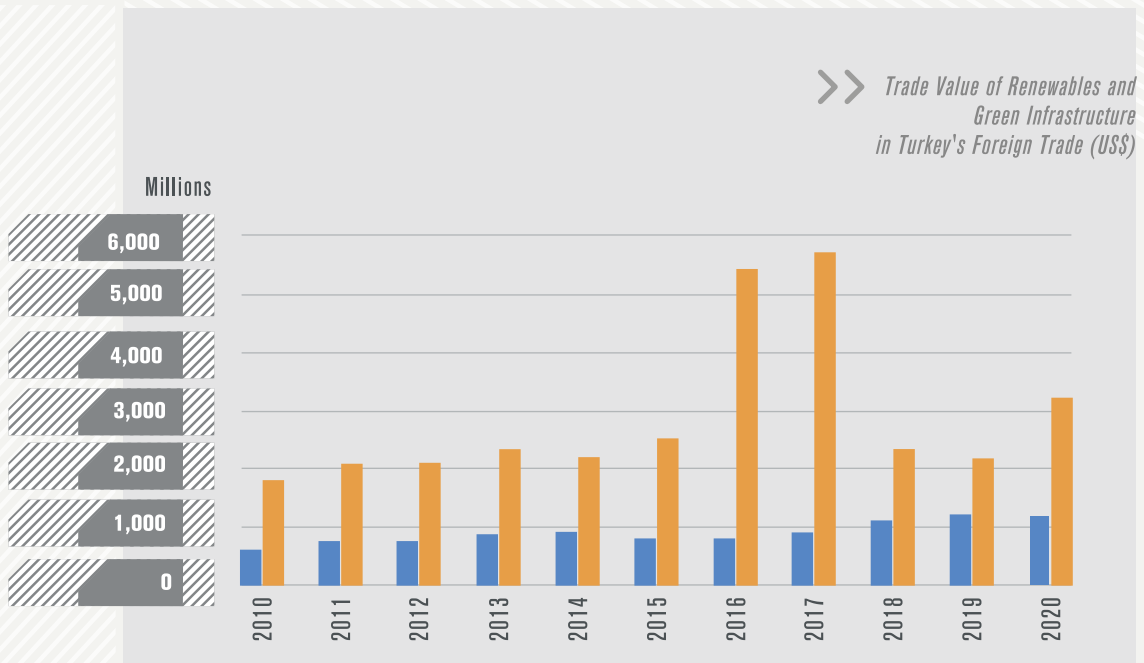
This chapter provides a trade analysis to measure renewable energy and green infrastructure sectors' contribution to Turkey's economy and Germany's role in this contribution. This analysis is based on the trade of products that play a significant role in developing Turkey's renewable energy and green infrastructure sectors. To define these sectors, seventeen different products have been selected. Table 1 below provides a list of these products and their HS codes.

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*Table 1:
Selected HS Codes for
Renewable
Energy and Green
Infrastructure*

HS Code	Name of the Product
840310	Central heating boilers, non-electric
841011	Hydraulic turbines and water wheels, of a power ≤ 1.000 kW
841012	Hydraulic turbines and water wheels, of a power > 1.000 kW but ≤ 10.000 kW
841013	Hydraulic turbines and water wheels, of a power > 10.000 kW
841090	Parts of hydraulic turbines and water wheels, n.e.s.; hydraulic turbine regulators
841280	Engines and motors
841330	Fuel, lubricating or cooling medium pumps for internal combustion piston engine
841861	Heat pumps
841919	Instantaneous or storage water heaters, non-electric
841950	Heat-exchange units
841989	Machinery, plant or laboratory equipment, for the treatment of material involving temperature change
841990	Parts of machinery, plant and laboratory equipment, whether or not electrically heated, for the treatment of materials by a process involving a change of temp.
842121	Machinery and apparatus for filtering or purifying water
850231	Generating sets, wind-powered
850300	Parts suitable for use solely or principally with electric motors and generators
850440	Static converters
854140	Photosensitive semiconductor devices

44 Istanbul joins EBRD Green Cities urban sustainability programme. (2021). <https://www.ebrd.com/news/2021/istanbul-joins-ebrd-green-cities-urban-sustainability-programme.html>

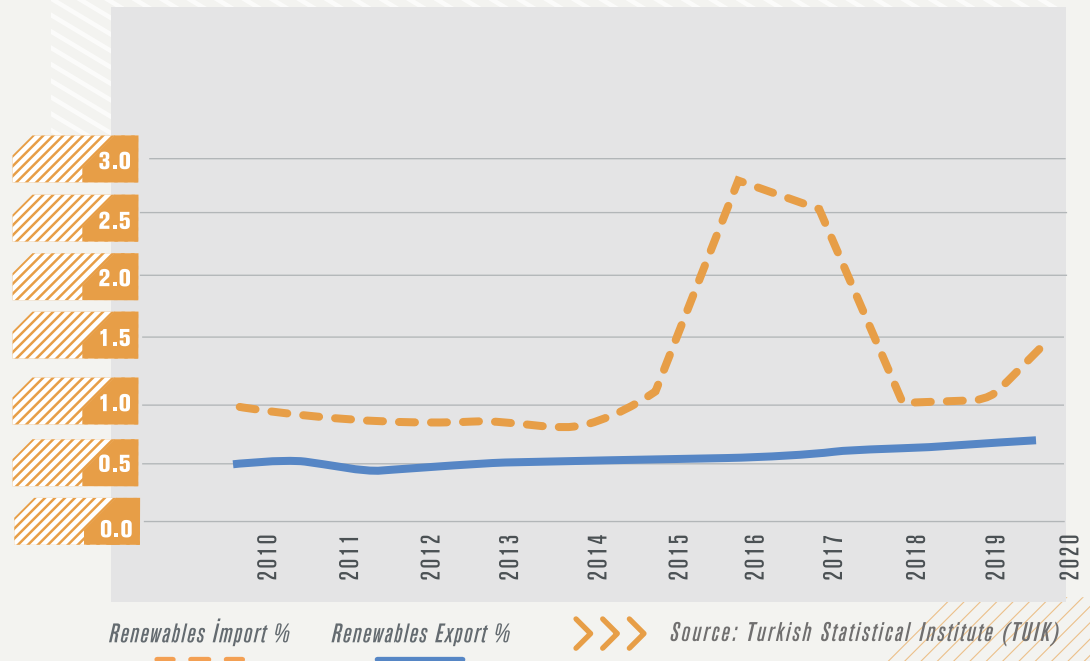
For the last ten years, Turkey tripled its exports in these renewable energy sector-related products from \$547 million to \$1.7 billion. Turkey's imports of these products also increased from \$1.3 billion to \$2.4 billion. The compounded annual growth rate (CAGR) of Turkey's renewable energy sector products imports is 6.2%, and the CAGR for exports is 7.9% for the last ten years. While Turkey's overall exports CAGR is 3.5% and CAGR for imports is 1.2%, renewable energy sector-related products have larger CAGR for the last ten years. Today, renewable energy sector-related products constitute 0.5% of Turkey's total exports, whereas imports constitute 1.2% of the total import. According to this trade data, even though renewable energy exports and imports share in Turkey's total trade fluctuated over time, with the recent investments, the extent of share is likely to increase in the future.



>>> Source: Turkish Statistical Institute (TUIK)

EXPORT IMPORT

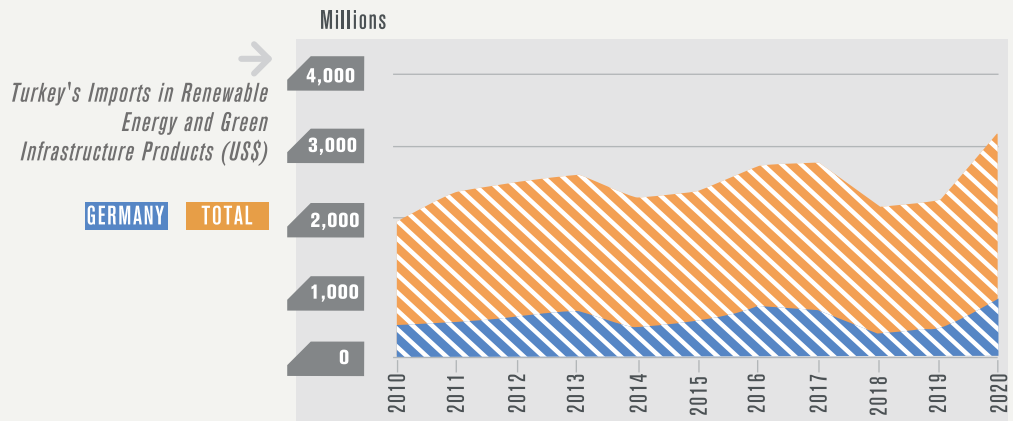
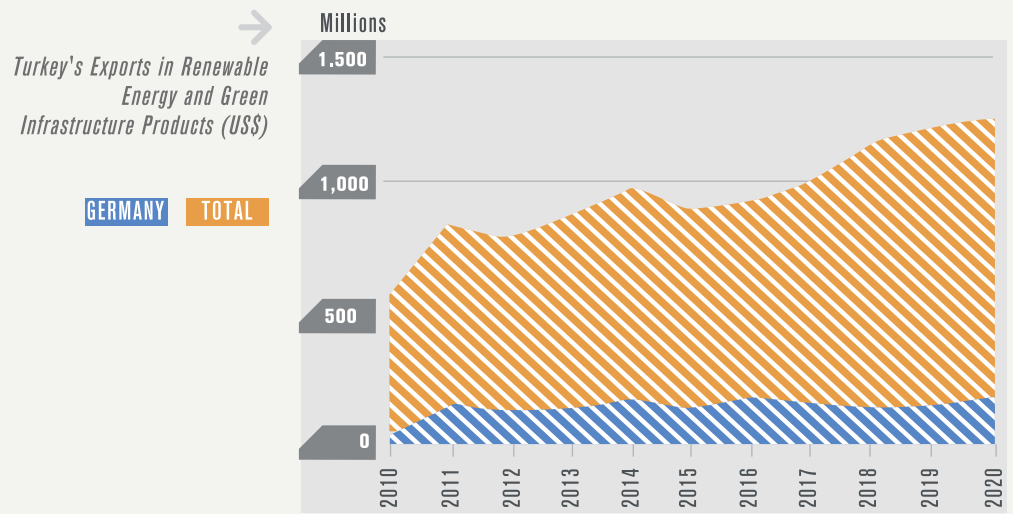
>> Trade Value of Renewables and Green Infrastructure as % of Total Exports and Imports of Turkey



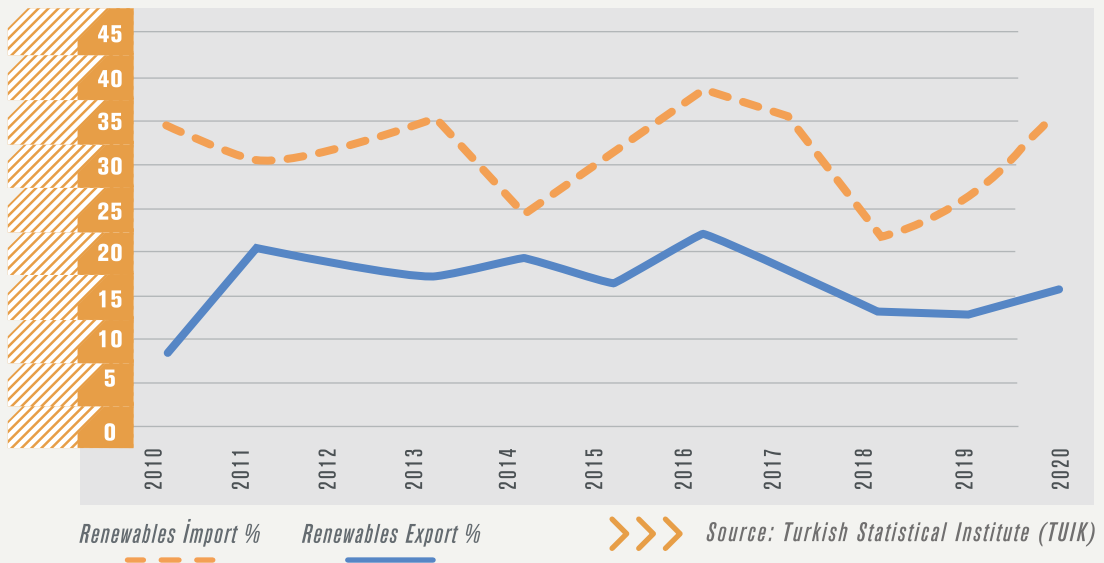
As a strategic trade partner of Turkey, Germany plays a crucial role in Turkey's exports and imports in the renewable energy sector.⁴⁵ Turkey-Germany trade volume was \$42.1 billion in 2018 out of which \$22.7 billion was imports from Germany, and \$19.4 billion was exports to Germany. Furthermore, Turkey ranked as Germany's 17th export and 19th import destination in 216 countries in 2018.⁴⁶ In the case of Turkey, Germany ranks the 1st export destination for Turkey and the 2nd import country among 205 countries. For Germany, Turkey's share in its imports is 1.4% and in its exports is 1.5%. However, gradually developing trade relations between two countries draws positive picture for the renewable energy sector as well.

Turkey's renewable energy products' exports to Germany rose from \$34 million 2010 to \$156 million in 2020. Meanwhile, Germany's exports to Turkey increased from \$374 million to \$652 million in the last ten years. It should be noted that while Turkey's exports to Germany stay within the range of \$110-156 million, German exports to Turkey fluctuates within wide range from \$250 million to \$650 million per annum.

45 Turkey and Germany to boost renewable cooperation. (2021). <https://www.aa.com.tr/en/economy/turkey-and-germany-to-boost-renewable-cooperation/1456703>
 46 Turkish Statistical Institute. <http://www.tuik.gov.tr/>



》》》 Turkey's Renewables and Green Infrastructure Trade with Germany % of Total Renewables & Green Infrastructure Trade of Turkey



In the following analysis products were included for which Germany ranks high as trading partner to Turkey. Table 2 below shows Germany's rank in terms of export and import partner for Turkey for the 17 identified products. Two significant products (HS Codes: 840310 and 850300) substantially impact the renewable energy sector which are used in different green energy technologies.⁴⁷ In the context of Turkey, while the product 840310, Central Heating Boilers, has \$467 million current exports, the product 850300, Parts Suitable For Use With Electric Motors And Generators, has \$255 million value which contributed to Turkey's green economy on a large scale. Furthermore, these products make up a vital portion of Germany-Turkey trade volume.

Table 2:
Germany's Ranking in Turkey's
Exports and Imports (2020)

HS Code	Name of the Product	Export Ranking	Import Ranking
840310	Central heating boilers, non-electric	1	1
841011	Hydraulic turbines and water wheels, of a power <= 1.000 kW	N/A	N/A
841012	Hydraulic turbines and water wheels, of a power > 1.000 kW but <= 10.000 kW	N/A	N/A
841013	Hydraulic turbines and water wheels, of a power > 10.000 kW	N/A	1
841090	Parts of hydraulic turbines and water wheels, n.e.s.; hydraulic turbine regulators	8	4
841280	Engines and motors	9	6
841330	Fuel, lubricating or cooling medium pumps for internal combustion piston engine	2	2
841861	Heat pumps	8	2
841919	Instantaneous or storage water heaters, non-electric	13	1
841950	Heat-exchange units	1	3
841989	Machinery, plant or laboratory equipment, for the treatment of material involving temperat change	15	3
841990	Parts of machinery, plant and laboratory equipment, whether or not electrically heated, for the treatment of materials by a process involving a change of temp.	1	1
842121	Machinery and apparatus for filtering or purifying water	8	3
850231	Generating sets, wind-powered	2	1
850300	Parts suitable for use solely or principally with electric motors and generators	2	1
850440	Static converters	3	3
854140	Photosensitive semiconductor devices	10	10

Moreover, in 2020, Germany was the top trading partner of Turkey for those products both among EU countries and the rest of the world. Turkey's exports to Germany was at \$178 million which is more than double of the exports to the UK which ranks 2nd. Turkey also imports the most from Germany but China is a close 2nd.

→
*Table 3:
Turkey's Top Exports
in 2020*

Ranking	Country	Exports \$
1	Germany	178.501.168
2	United Kingdom	82.571.482
3	Poland	68.143.943
4	France	51.091.427
5	Russia	50.977.810
6	Italy	47.513.273
7	Spain	47.369.688
8	Netherlands	43.076.281
9	United States	23.691.251
10	Belgium	21.916.842

→
*Table 4:
Turkey's Top Imports
in 2020*

Ranking	Country	Imports \$
1	Germany	767.688.180
2	China	713.207.178
3	Italy	125.166.209
4	France	78.663.996
5	Czech Republic	70.576.995
6	United States	61.215.593
7	Spain	56.982.692
8	South Korea	47.136.907
9	United Kingdom	30.735.174
10	Denmark	67.048.704

B. TRANSPORT TECHNOLOGIES

International Energy Agency data shows that transportation is the second-largest energy-related carbon emission source worldwide, while electricity and heat production is the number one. Transportation accounted for 25% of all energy-related carbon emissions worldwide in 2018.⁴⁸ Accordingly, one-quarter of all energy sourced carbon emissions worldwide occurs from transportation activities, a fact demonstrating the importance of improving the efficiencies of transportation technologies to reduce carbon emissions for a green transition. Thanks to recent developments in transportation technologies such as the proliferation of electric cars, global transport emissions increased only 0.5% in 2019 against the 1.9% annual growth rate trend since 2000.⁴⁹ In 2020, global energy-related carbon emissions reduced by 5.8%, and half of this decline came from diminished mobility worldwide.⁵⁰ However, a surprising development has happened during the conditions of the pandemic. While global car sales fell almost 15% in 2020, global electric car sales increased 40% globally in 2020. This is an important indication that shows how robust the global transition to electric cars is. Thus, analyzing the commercial ecosystem for electric vehicles in Turkey and locating Germany's position is essential for the green economy framework.

In 2018, transportation accounted for 22% of all CO₂ Emissions from Fuel Combustion in Turkey. Therefore, the transport sector became the second biggest contributor of carbon emission after electricity and heat-producing, where industrial production was the third. In line with the global trend in electric car proliferation Turkey increased its efforts in this sector. Although only 0.03% of all car sales were electrical in the first half of 2021 in Turkey, it indicated a yearly increase of 200% compared to the 0.01% from the previous year.⁵¹ Nevertheless, the recent low figures in Turkey should not cause pessimism, as the electrical charge station network in Turkey has freshly entered into the expansion stage.⁵² Once the electric car charging station network is complete, the share of the electric car on the roads is expected to increase as a natural result. Nevertheless, real expansion is also expected after the release of indigenous electrical car TOGG. Turkey's indigenous electrical car brand TOGG is expected to put its first cars on the market in early 2023. After Turkey, it is almost certain that the second market for TOGG shall be Germany. In his remarks to Automobilwoche, company CEO Gurcan Karakas stated that TOGG is planning to put its cars on sale in Germany at the beginning of 2025.⁵³

48 Data & Statistics - IEA. (2021). <https://www.iea.org/data-and-statistics/data-browser?country=WORLD&fuel=CO2%20emissions&indicator=CO2BySector>
49 Tracking Transport 2020 - Analysis - IEA. (2021). <https://www.iea.org/reports/tracking-transport-2020>
50 Global Energy Review: CO₂ Emissions in 2020 - Analysis - IEA. (2021). <https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020>
51 Pazar - Otomobil & Hafif Ticari. (2021). http://www.odd.org.tr/web_2837_1/neuralnetwork.aspx?type=35
52 TEHAD. (2019). <https://www.tehad.org/2019/03/25/turkiyedeki-sarj-istasyonu-sayisi-elektrikli-otomobili-yakaladi/>
53 Daily Sabah. (2021). <https://www.dailysabah.com/business/automotive/turkeys-first-electric-car-to-enter-european-markets-via-germany>

The company plans to target German citizens of Turkish origin. Another significant component of green transition in transportation and electric car technology is battery technology. As a substantial component of electric cars, Turkey plans to produce lithium-ion batteries that will be used in the TOGG, also locally. For this reason, investments in battery technology are increasing in Turkey. The recent electric battery assembly factory investment by Koc Holding's Ford Otosan in Izmit attracted close media attention. As a new investment, it was also announced that Koc Holding made an agreement with the German automotive giant Volkswagen AG to produce commercial electric vehicles.⁵⁴

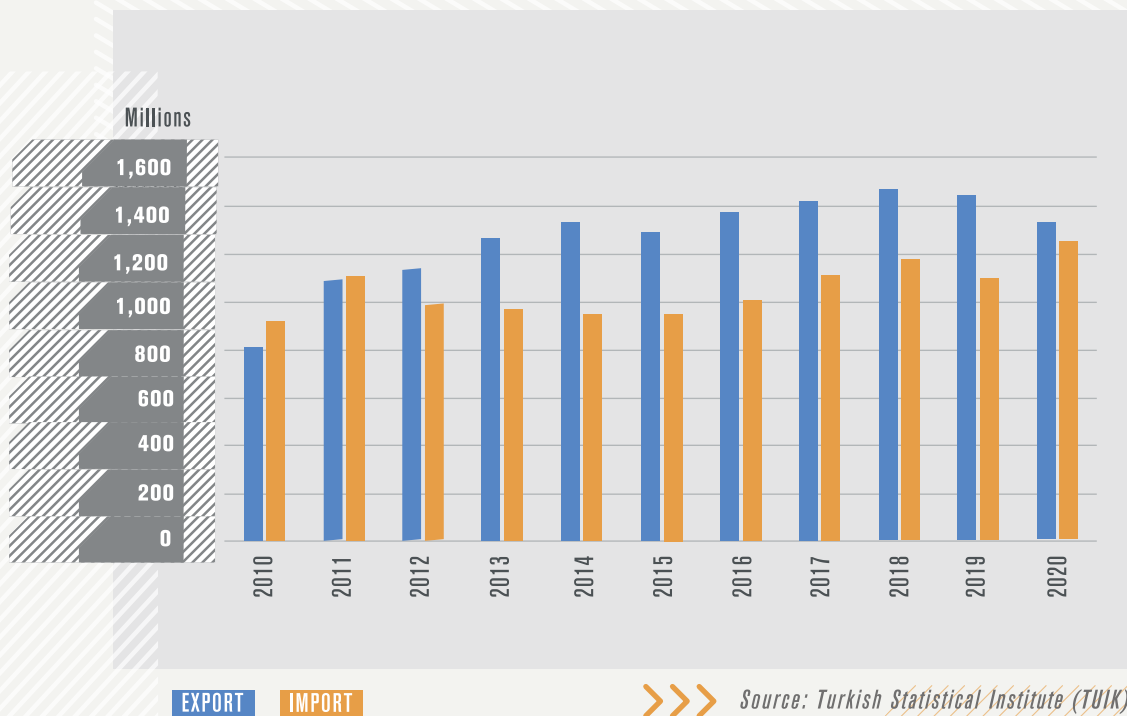
The information provided above demonstrates that Germany is a notable partner and target market for Turkey in its efforts to produce green transportation technologies. This is also backed by market data. Figures below show Turkey's current statistics in most critical components of electric cars and battery technology. Figures also outline Germany's position in the corresponding industry. The following table shows the selected HS codes that define transport technologies.

*Table 5:
Selected HS Codes
for Transport Technologies*

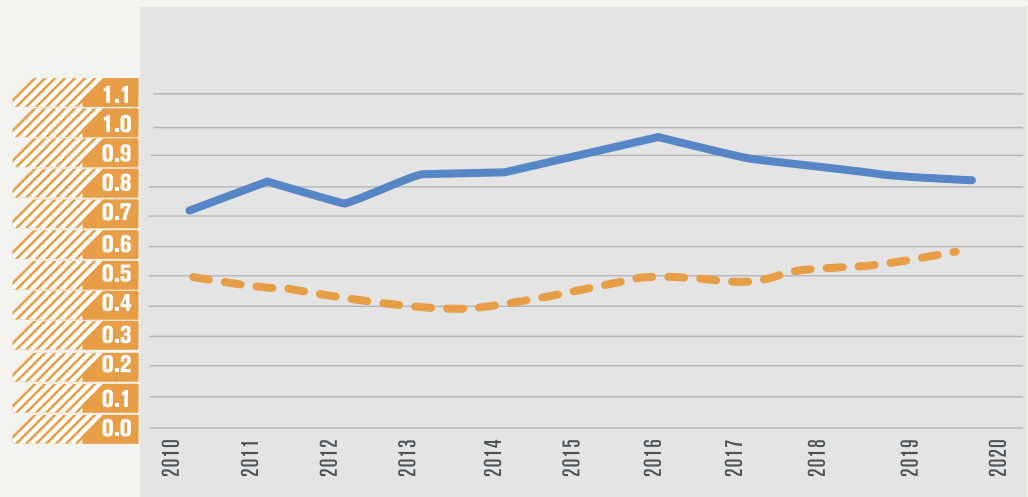
HS Code	Name of the Product
850110	Electric motors of an output not exceeding 37.5 W
850690	Parts of primary cells and primary batteries, n.e.s.
850720	Lead acid accumulators (excl. spent and starter batteries)
850760	Lithium ion batteries
851680	Electric heating resistors (excl. those of agglomerated coal and graphite)
870390	Motor cars and other vehicles principally designed for the transport of <10 persons, incl. station wagons and racing car
870899	Parts and accessories, for tractors, motor vehicles for the transport of ten or more persons, motor cars and other motor

Green transport technologies products constitute 0.8% of total export and 0.6% of total imports of Turkey. In 2010, transport technologies exports amounted to \$820 million reaching \$1.3 billion today. For imports of transport technologies, a similar pattern was observed, which is an increase from \$918 million to \$1.2 billion. Over the past ten years, while Turkey's total exports CAGR was 3.5% and imports CAGR was 1.2%, green transport technologies CAGR for exports was 4.9% and imports CAGR was 3%.

>>> Trade Value of Transport Technology
in Turkey's Foreign
Trade (US\$)



>>> *Trade Value of Transport Technology
as % of Total Exports and Imports
of Turkey*



Transport Tech Import %

Transport Tech Export %

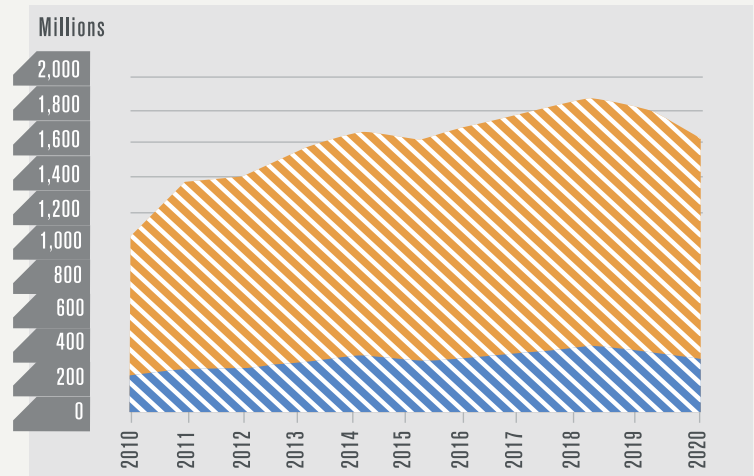


Source: Turkish Statistical Institute (TUIK)

As a significant trade partner of Turkey, Germany was the market for 25% of Turkey's green transport technologies exports in 2020. In 2010, Turkey exported \$236 million worth of green transport technologies to Germany. Today, Turkey's exports to Germany of green transport technologies increased to \$332 million. In contrast, Turkey's imports from Germany decreased in relative terms over the ten years, which is now 8% of the total green transport technologies of the imports of Turkey. While in 2011, imports from Germany had a share of 30% corresponding to \$284 million of Turkey's total green transport technologies import, in 2020 exports to Germany in this industry amounted to \$107 million.

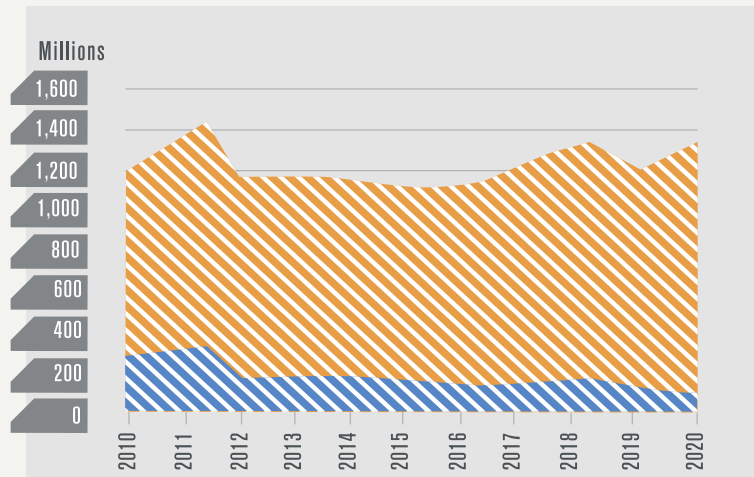
→
*Turkey's Exports in
Transport Technologies
Products (US\$)*

GERMANY TOTAL

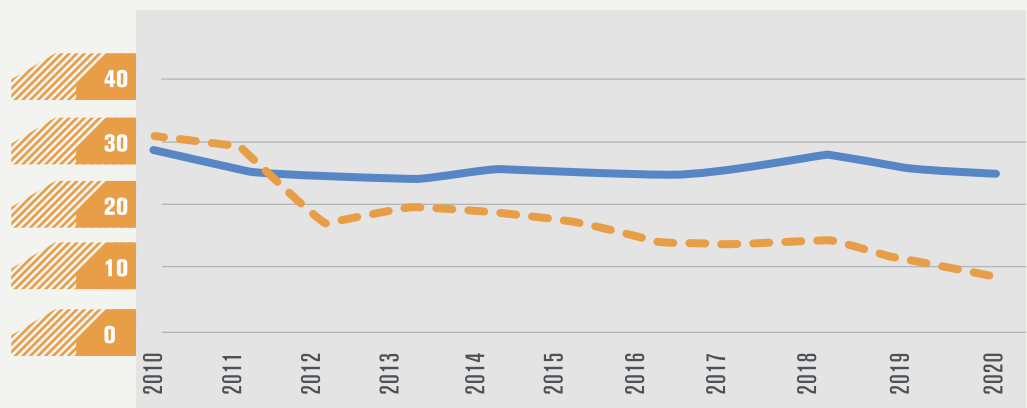


→
*Turkey's Imports in
Transport Technologies
Products (US\$)*

GERMANY TOTAL



>>> *Turkey's Transport Technologies Trade with
Germany as % of Turkey's Total Transport Technologies Trade*



Transport Tech Import % Transport Tech Export %

>>> Source: Turkish Statistical Institute (TUIK)

For the HS Code 853650, named Other Switches under the heading HS Code 8536 Electrical Apparatus for Switching or Protecting Electrical Circuits; in 2019, Turkey exported \$76 million and imported \$251 million worth of Other Switches. In the last ten years, Turkey always had a trade deficit in this product. Germany's ranking in Turkey's exports among other countries was number 1 in 2010, number 4 in 2015, and number 6 in 2019. In contrast, Germany's ranking in Turkey's imports was number 1 in 2010, number 1 in 2015, and number 2 in 2019.

In addition, for HS code 853921, Tungsten Halogen, in 2019, Turkey exported \$1.4 million and imported \$16.2 million. Germany's ranking in Turkey's exports among other countries was number 22 in 2010, number 1 in 2015, and number 1 in 2019. In comparison, Germany is in the 1st rank for the last ten years.

*Table 6:
Germany's Ranking in Turkey's
Exports and Imports (2020)*



HS Code	Name of the Product	Export Ranking	Import Ranking
850110	Electric motors of an output not exceeding 37.5 W	5	2
850690	Parts of primary cells and primary batteries, n.e.s.	6	6
850720	Lead acid accumulators (excl. spent and starter batteries)	1	5
850760	Lithium ion batteries	10	6
851680	Electric heating resistors (excl. those of agglomerated coal and graphite)	1	5
870390	Motor cars and other vehicles principally designed for the transport of <10 persons,incl. station wagons and racing car	N/A	N/A
870899	Parts and accessories, for tractors, motor vehicles for the transport of ten or more persons, motor cars and other motor	1	1

Compared to other trade partners of Turkey, for exports of green transport technologies, Germany ranked 1st today with a trade volume of \$332 million. However, in terms of Turkey's imports, China surpassed Germany with \$277 million and ranked 1st. Even though Germany ranked 2nd with \$107 million imports, it still ranked 1st within the EU countries regarding import relations with Turkey.

→
*Table 7:
Turkey's Top Exports
in 2020*

Ranking	Country	Exports \$
1	Germany	332.064.296
2	Italy	99.985.490
3	United Kingdom	78.922.125
4	Poland	74.867.425
5	United States	73.633.838
6	France	65.060.411
7	Belgium	57.983.955
8	Spain	55.736.548
9	Russia	52.617.272
10	Czech Republic	18.512.348

→
*Table 8:
Turkey's Top Imports
in 2020*

Ranking	Country	Imports \$
1	China	277.041.128
2	Germany	107.351.466
3	France	71.957.294
4	Italy	60.383.527
5	Spain	56.684.545
6	United States	49.003.267
7	South Korea	48.481.462
8	Czech Republic	31.208.917
9	Vietnam	16.526.366
10	Slovakia	16.514.728

C. GREEN FRIENDLY CONSTRUCTION

According to the most comprehensive annually published report on green construction, the 2020 Global Status Report for Buildings and Construction⁵⁵ published by UN Environment Programme, CO₂ emissions from the building and construction industry recorded the highest levels ever in 2019. This outlook in 2019 indicated the construction industry moved away from the Paris Agreement objective of keeping world average temperature rise well below 2 degrees Celsius, and there is more effort needed to reach climate goals.⁵⁶ From the green economy perspective, adaptation and proliferation of more environmentally friendly construction technologies and design and also capacity increasing of green-friendly building stocks in countries is especially critical. According to IEA, buildings construction industry accounts for 10% of all carbon emissions and 5% of all final energy consumption worldwide directly.⁵⁷ When the energy consumption and carbon emissions from the operation of the buildings are included in the equation, the corresponding numbers reach 35% for global final energy consumption and 38% for global carbon emission.⁵⁸ The broad scope of the numbers illustrates the high potential in emission reduction through the adaptation of more environmentally friendly technologies in the building industry and the essential green transformation of the current building stock.

The GlobalABC Roadmap for Buildings and Construction 2020-2050 co-published by the UNEP and IEA sets out a comprehensive strategy to this aim.⁵⁹ The report prioritizes eight action areas for a green transformation of the construction and building industry. These eight priority areas capture the essential aspects of green-friendly construction and provide a framework. Energy-efficient urban planning policies, increasing the number of net-zero buildings in newly constructed buildings, reduction of energy leakage through building retrofits, improving energy management tools at building operations, adaptation of higher energy labeled home systems, using more recyclable construction materials, designing buildings more resilient to natural disasters, and enabling buildings to increase their own electricity production capacity are considered as critical components of environmentally friendly construction.⁶⁰ However, the definitions and criteria are not limited to these eight factors. There are many rating systems and certificate systems worldwide used to determine the sustainability performance of buildings. American 'Leadership in Energy and Environmental Design (LEED)', British 'Building Research Establishment Environmental Assessment Method (BREEAM)',¹ and German DGNB System (Deutsche Gesellschaft für Nachhaltiges Bauen e.V.) are the world's leading classification systems. In Turkey, there are 425 LEED and 70 BREEAM certificated projects.⁶¹ On the other hand, it is observed that German DGNB classification is not widespread in Turkey and only one project in Turkey is DGNB certificated.⁶² Additionally,

55 2020 Global Status Report for Building and Reconstruction. (2020). https://globalabc.org/sites/default/files/inline-files/Buildings%20GSR_Executive_Summary%20FINAL_0.pdf
56 Ibid.
57 Ibid.
58 Ibid.
59 GlobalABC Roadmap for Buildings and Construction. (2020). https://iea.blob.core.windows.net/sets/6cca78af-2327-4e97-868c-294d48cb66b3/GlobalABC_Roadmap_for_Buildings_and_Construction_2020-2050.pdf
60 Ibid.
61 Çedbik. <https://cedbik.org/>
62 Certified projects | DGNB System. (2021). https://www.dgnb-system.de/en/projects/index.php?filter_Freitextsuche=&filter_Land=T%C3%BCrkei&filter_Bundesland=&filter_Standort=&filter_Jahr=&filter_Zertifizierungsart=&filter_Nutzungsprofil=&filter_Zertifiziert_von_1=&filter_Verliehenes_Guetesiegel=&filter_Architekt=

Turkey also developed its indigenous classification system in 2020 and put the system into effect in 2021.⁶³ With the adaptation of the indigenous green building classification system, Turkey aims to increase the number of green buildings.

Upgrading building energy efficiency decreases energy consumption and CO2 emissions significantly while simultaneously promoting job development and making energy more economical for households. Reducing energy costs is especially important for energy-dependent countries such as Turkey and Germany. Some materials are critical for building green constructions. An assessment is given below.

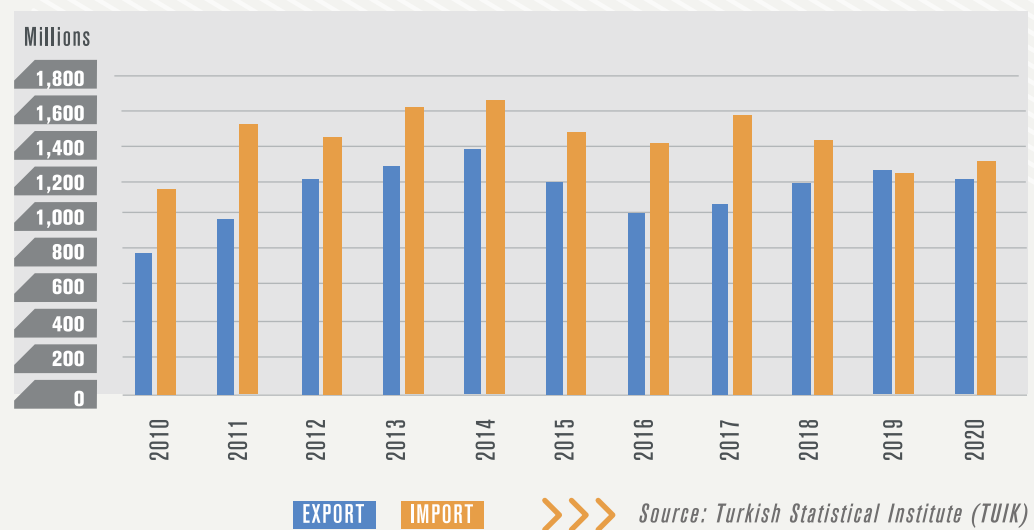
As with other green economy components, green-friendly construction is a substantial part of Turkey-Germany trade relations. The following analysis emphasizes significant products for green-friendly construction and their trade volume within Turkey-Germany affiliation. To carry out an empirical analysis, twenty green-friendly construction products were chosen. The products' names and HS codes are following:

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Table 9:
*Selected HS Codes
for Green Construction*

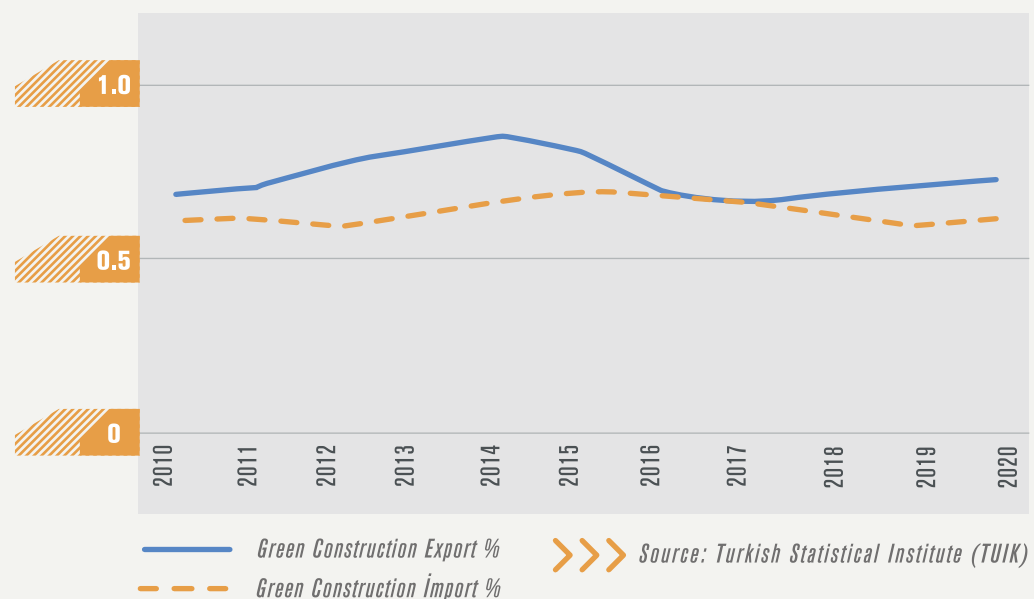
HS Code	Name of the Product
390720	Polyethers, in primary forms (excl. polyacetals)
392111	Plates, sheets, film, foil and strip, of cellular polymers of styrene, unworked or merely surface-worked or merely cut
392113	Plates, sheets, film, foil and strip, of cellular polyurethanes, unworked or merely surface-worked or merely cut into sq
392119	Plates, sheets, film, foil and strip, of cellular plastic, unworked or merely surface-worked or merely cut into squares
700800	Multiple-walled insulating units of glass
730890	Structures and parts of structures, of iron or steel, n.e.s. (excl. bridges and bridge sections, towers and lattice mast)
760720	Aluminum foil, backed, of a thickness "excl. any backing" of ≤ 0,2 mm (excl. stamping foils of heading 3212, and foil)
851690	Parts of electric water heaters, immersion heaters, space-heating apparatus and soil-heating apparatus, hairdressing app
853922	Filament lamps of a power ≤ 200 W and for a voltage > 100 V (excl. tungsten halogen filament lamps and ultraviolet)
853931	Discharge lamps, fluorescent, hot cathode
853650	Switches for a voltage ≤ 1.000 V (excl. relays and automatic circuit breakers)
853921	Tungsten halogen filament lamps (excl. sealed beam lamp units)
854110	Diodes (excl. photosensitive or light-emitting diodes "LED")
854121	Transistors with a dissipation rate < 1 W (excl. photosensitive transistors)
854129	Transistors with a dissipation rate ≥ 1 W (excl. photosensitive transistors)
854130	Thyristors, diacs and triacs (excl. photosensitive semiconductor devices)
854150	Semiconductor devices, n.e.s.
854160	Mounted piezoelectric crystals
854190	Parts of diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices, light-emitting dio
902890	Parts and accessories for gas, liquid, or electricity supply or production meters, n.e.s.

Turkey demonstrates an increasing trend in the export of green-friendly construction products from \$777 million in 2010 to more than \$1 billion in 2020. An increasing pattern can also be observed for imports throughout the years, with total imports reaching \$1.3 billion in 2020. To compare green-friendly construction growth rate with total trade of Turkey, while CAGR for exports of green construction products is 4.2% and CAGR for imports is 1.2%; Turkey's total export CAGR is 3.5%, and import CAGR is 1.2% based on the last ten years.

Trade Value of Green Construction in Turkey's Foreign Trade (US\$)



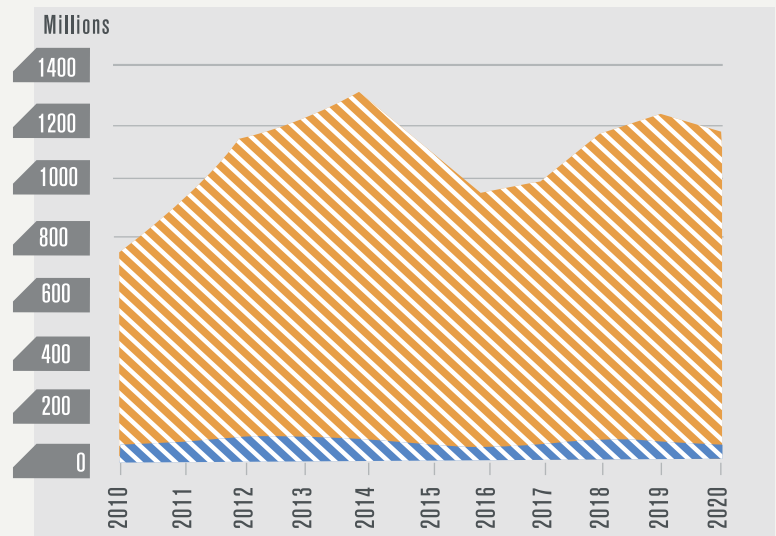
Trade Value of Green Construction as % of Total Exports and Imports of Turkey



Germany's share in total exports of Turkey remained steady at 7% to 8% for ten years. For Turkey's imports, Germany's share is relatively high at over 20% in 2020. Germany's high average percentage is encouraging future trade affiliation between the two countries.

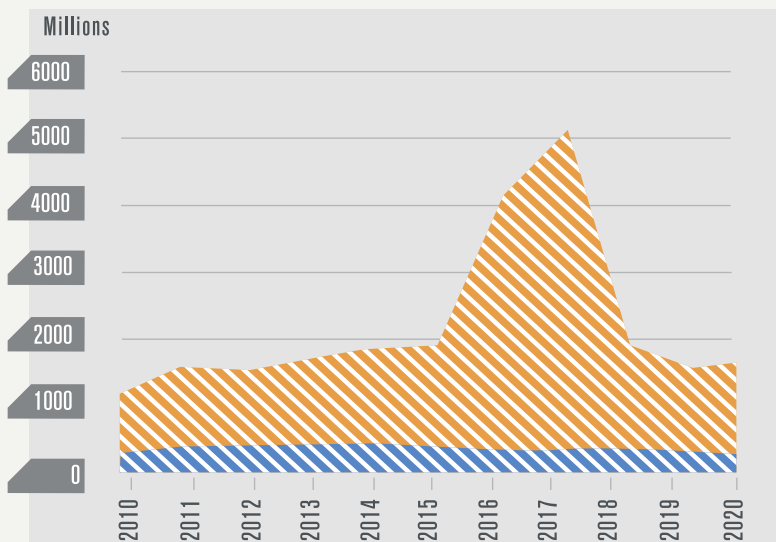
→
*Turkey's Exports in
Green Construction
Products (US\$)*

GERMANY TOTAL

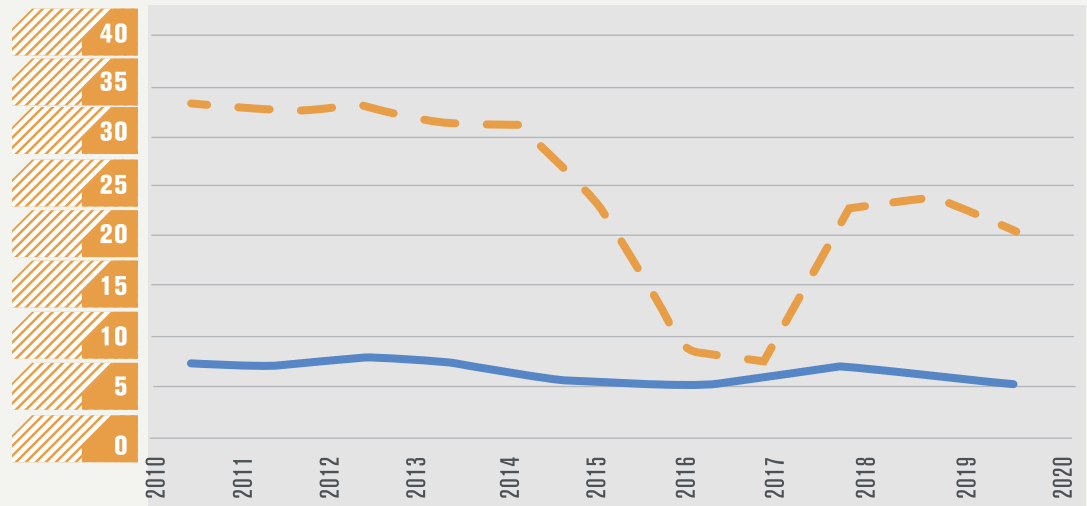


→
*Turkey's Imports in
Green Construction
Products (US\$)*

GERMANY TOTAL



>>> *Turkey's Green Construction Trade with Germany as % of Turkey's Total Green Construction Trade*



— Green Construction Export %
- - - Green Construction Import %

>>> Source: Turkish Statistical Institute (TUIK)

Germany's position in bilateral trade with Turkey is consequential for a wide range of green construction products. Two significant products (HS Codes: 700800 and 730890) have a substantial impact on green construction in which Germany is one of the significant exporters in the world.⁶⁴ Turkey, has \$81 million current export volume of Multiple-walled insulating units of glass, and it has \$731 million current export volume of *Structures and parts of structures, iron or steel*.

64 Structures and parts of structures, iron or steel, ne (HS: 730890) Product Trade, Exporters and Importers | OEC. (2021). <https://oec.world/en/profile/hs92/structures-and-parts-of-structures-iron-or-steel-ne>

→
*Table 10:
Germany's Ranking
in Turkey's
Exports and Imports
(2020)*

HS Code	Name of the Product	Export Ranking	Import Ranking
390720	Polyethers, in primary forms (excl. polyacetals)	54	2
392111	Plates, sheets, film, foil, and strip, of cellular polymers of styrene, unworked or merely surface-worked or merely cut	30	4
392113	Plates, sheets, film, foil and strip, of cellular polyurethanes, unworked or merely surface-worked or merely cut into sq	29	1
392119	Plates, sheets, film, foil and strip, of cellular plastic, unworked or merely surface-worked or merely cut into squares	11	1
700800	Multiple-walled insulating units of glass	4	1
730890	Structures and parts of structures, of iron or steel, n.e.s. (excl. bridges and bridge sections, towers and lattice mast	5	6
760720	Aluminum foil, backed, of a thickness "excl. any backing" of <= 0,2 mm (excl. stamping foils of heading 3212, and foil	5	1
851690	Parts of electric water heaters, immersion heaters, space-heating apparatus and soil-heating apparatus, hairdressing app	2	2
853922	Filament lamps of a power <= 200 W and for a voltage > 100 V (excl. tungsten halogen filament lamps and ultraviolet)	19	3
853931	Discharge lamps, fluorescent, hot cathode	9	4
853650	Switches for a voltage <= 1.000 V (excl. relays and automatic circuit breakers)	7	2
853921	Tungsten halogen filament lamps (excl. sealed beam lamp units)	1	1
854110	Diodes (excl. photosensitive or light-emitting diodes "LED")	8	6
854121	Transistors with a dissipation rate < 1 W (excl. photosensitive transistors)	-	8
854129	Transistors with a dissipation rate >= 1 W (excl. photosensitive transistors)	11	11
854130	Thyristors, diacs and triacs (excl. photosensitive semiconductor devices)	24	2
854150	Semiconductor devices, n.e.s.	15	1
854160	Mounted piezoelectric crystals	1	1
854190	Parts of diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices, light-emitting dio	8	6
902890	Parts and accessories for gas, liquid, or electricity supply or production meters, n.e.s.	1	3

While Iraq and Israel led green-friendly construction product exports, Germany ranked 3rd in 2020 with a value of \$57 million which makes Germany the 1st export partner of Turkey within the EU countries. In terms of Turkey's imports from other countries, Germany ranks first after China.

→
*Table 11:
Turkey's Top Exports
in 2020*

Ranking	Country	Exports \$
1	Iraq	90.547.305
2	Israel	61.727.161
3	Germany	57.157.982
4	Russia	46.372.510
5	France	44.568.357
6	Romania	28.851.734
7	United States	28.696.227
8	United Kingdom	23.807.689
9	Iran	23.468.815
10	Saudi Arabia	23.198.970

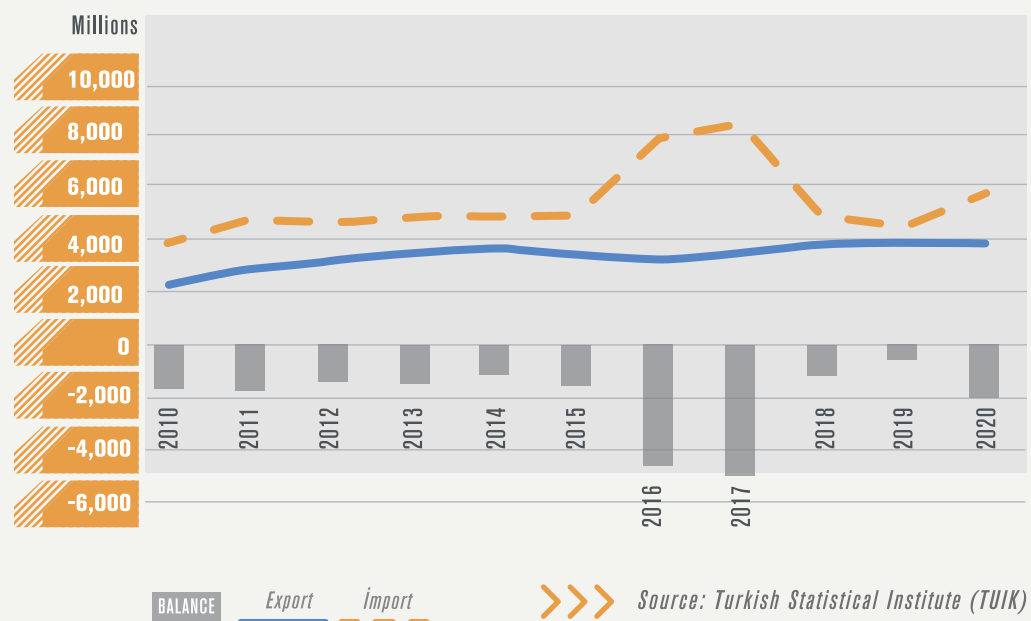
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*Table 12:
Turkey's Top Imports
in 2020*

Ranking	Country	Imports \$
1	Germany	284.922.691
2	China	254.152.200
3	Netherlands	124.408.035
4	Italy	67.355.173
5	South Korea	55.380.516
6	Russia	46.312.293
7	Spain	45.504.714
8	France	36.831.140
9	Saudi Arabia	36.690.267
10	United States	31.936.240

C. OVERALL ANALYSIS

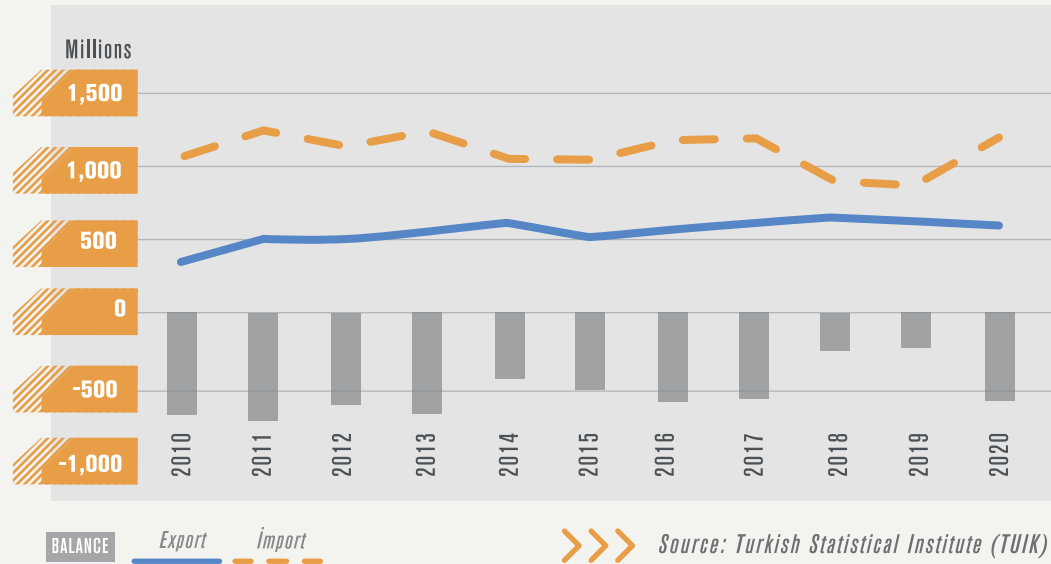
Turkey's green economy constitutes a sizable part of its trade volume. As analyzed for three different green economy components, Turkey has a great potential for strong green transformation and trade relations with Germany based on the mutual interest and international competitiveness of both countries. In 2010, Turkey's green economy exports were \$2.1 billion rising to \$3.6 billion recently. Similarly, while the overall green economy imports were \$3.8 billion in 2010, they stood at \$5.7 billion as of this year. The trade balance remains negative, which is approximately \$1.5 billion per year on average. Compared with total trade volume, the CAGR of overall green economy exports is 5.5%, while Turkey's CAGR of total exports is 3.5%. Likewise, the CAGR for green economy imports is 4.1%, and CAGR of total imports is 1.2%. Based on the data from last ten years, the growth rate of the green economy is accelerating faster than that of total trade and is open to be improved for future opportunities.

>> Turkey's Green Economy Trade (US\$)



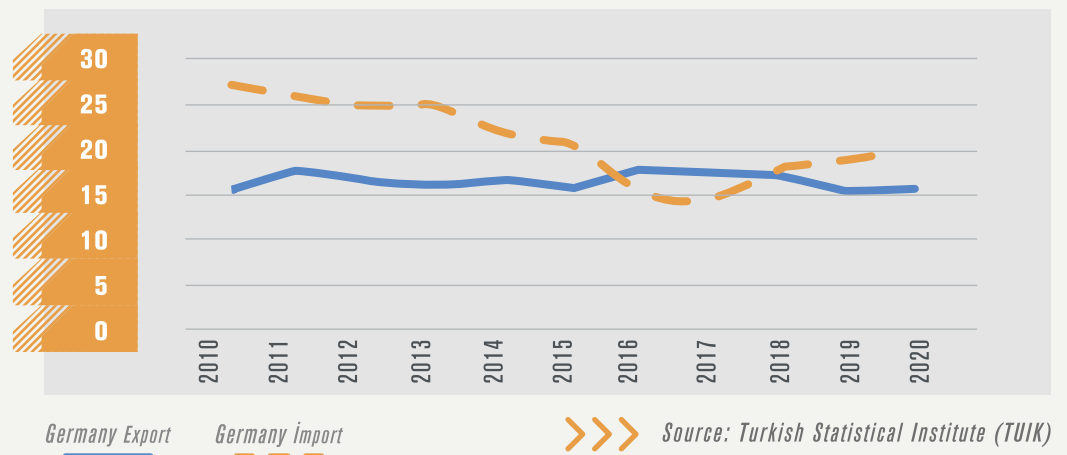
Turkey's overall green economy exports to Germany increased substantially from \$332 million in 2010 to \$568 million in 2020. Despite fluctuations, Turkey's green economy imports from Germany remained around \$3 billion dollar. In terms of total green economy trade with Germany, trade deficit of Turkey remains high; however, an incremental rise of exports in the last ten years implies a positive outlook for the future.

>> Green Economy Trade Between Turkey and Germany (US\$)



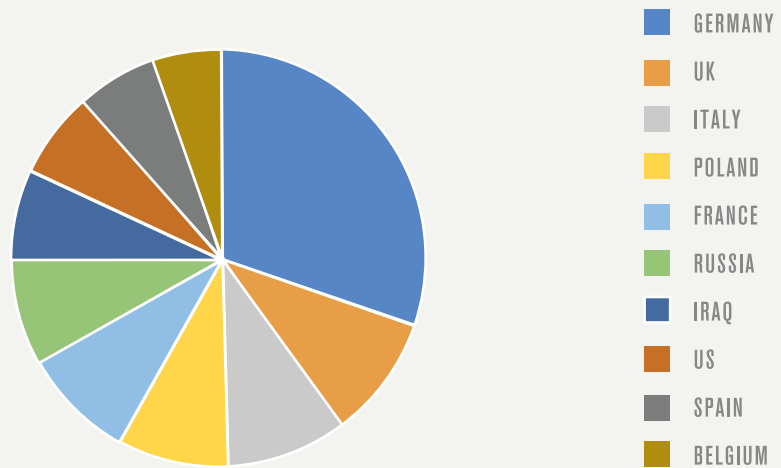
Trade data reveals that Turkish-German trade relations account for an important share of Turkey's green economy trade. Based on the provided data, total green economy exports to Germany constitutes 15.5% of Turkey's total green economy exports in 2020. Percentage of exports to Germany remained around the same in the last ten years and continues to maintain its importance for Turkey's green economy. Furthermore, Germany constitutes 20% of Turkey's total green economy imports. While, Germany's share was almost 30% in 2010, it decreased drastically and reached 13% in 2017. Nevertheless, in the last three years, Germany's portion has started to rise again which is an important signal for the future of trade relations in the green economy between Germany and Turkey.

>> Turkey's Green Economy Trade with Germany as % of Total Green Economy Trade of Turkey

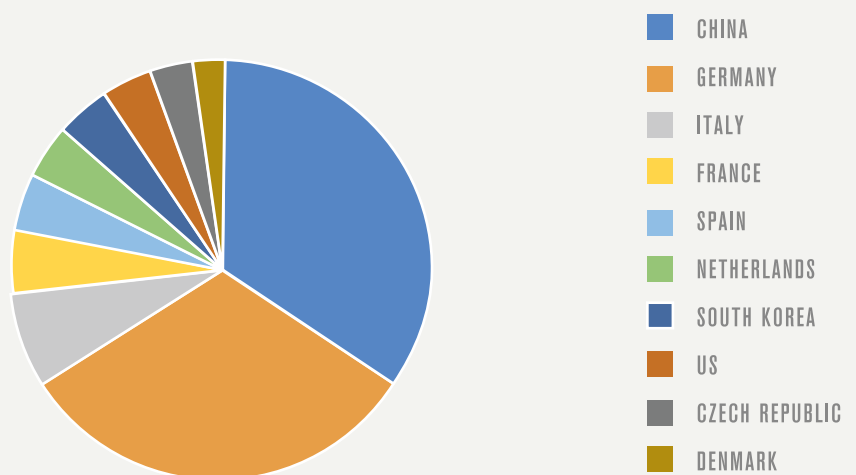


In comparison to other trade partners of Turkey in the green economy, Germany has prominent significance. In terms of Turkey's green economy exports to other countries, Germany currently ranks 1st with \$567 million. The United Kingdom and Italy respectively follow Germany in total green economy exports of Turkey. In terms of Turkey's green economy imports, China surpasses Germany with an overall value of \$1.2 billion. Nevertheless, Germany ranks 2nd overall with \$1.1 billion, and 1st within the EU countries in terms of both exports and imports and therefore in trade volume. Within the top ten countries of Turkey's trade partners in green economy, Turkey's green economy exports to Germany constitutes 30% while Turkey's green economy imports from Germany forms 32%.

>> Turkey's Green Economy Export Shares for Top 10 Trade Partners in 2020



>> Turkey's Green Economy Import Shares for Top 10 Trade Partners in 2020



>>> Source: Turkish Statistical Institute (TUIK)

5. PRODUCTIVE ECOSYSTEMS

In this part of the paper, a recently developed method and ecosystem map by Neave O'Clery, Muhammed Ali Yildirim, and Ricardo Hausmann, in the article *Productive Ecosystems and the Arrow of Development* is used (2021).⁶⁵ This article is based on the diversification of economies and the Ricardian Comparative Advantage (RCA) theory. Authors argue that it is easier for countries to produce new products that require set of capacities and abilities as inputs similar to their existing production capacity. Authors constructed a product space that includes an ecosystem of networks between products based on countries' capabilities. For instance, if one country has a comparative advantage to produce one product, the article expects that this country is already prosperous in the required qualifications during the mode of that production. Therefore, the study guides low-middle income countries by creating a product network where they can produce many products according to their competencies. The map they prepared is a network system based on a theoretical concept that suggests the distance between two products is related to the distance between the capabilities to create them. Therefore, in this paper, it is beneficial to use this product space map to signal Turkey's potential competency on green economy products with reported HS codes to suggest further investigation.

To guide further analysis, this part focused on twenty out of forty products of the green economy. These twenty products were selected by a ranking system which is based on how much they contributed to Turkey's green economy trade. According to the Atlas of Economic Complexity, fifteen different products were obtained by product space mapping. These fifteen products have the largest know-how similarities with the most contributed twenty products of Turkey's green economy. Therefore, based on the product network and comparative advantage theorem, Turkey has significant potential by producing the following fifteen products:

→
Table 13:
Turkey Product
Network Mapping

HS Codes	Description
732219	Radiators for central heating
901410	Navigational instruments
731511	Chain of iron or steel
903290	Automatic regulating instruments
820810	Knives and blades for machines
853229	Electrical boards
790700	Other articles of zinc
732490	Sanitary ware and parts of iron or steel
870421	Motor vehicles for transporting goods
390390	Polymers of styrene
391739	Plastic tubes and fittings
842810	Other lifting machinery
392510	Plastic builders ware
854690	Electrical insulators or any material
420500	Other articles of leather

65 O'Clery, N., Yildirim, M., & Hausmann, R. (2021). Productive Ecosystems and the arrow of development. *Nature Communications*, 12(1). doi: 10.1038/s41467-021-21689-0

6. STARTUPS: TRANSFORMING AND REBUILDING GREEN ECONOMY

6.1 Green Startups and Why It Matters

Technological developments inspire new ideas for solutions to global problems and these solutions turn into startups if they are successfully executed. Startups bring creative, measurable and scalable solutions to the world's toughest social, economic and environmental challenges by taking advantage of emerging technologies such as artificial intelligence. Even some startups are declaring their goal as to contribute to one of the United Nations Sustainable Development Goals (SDGs) from day one, and there is a niche ecosystem that reinforces these startups with the mission.⁶⁶ Impact investing, an investment strategy to create a portfolio of startups that generate social and environmental goods, as well as financial return, is receiving a rising interest. In 2020, \$2.3 trillion has been invested in companies with this strategy and the number is expected to increase in the upcoming years.⁶⁷ It is safe to say that there is growing interest in startups that tackle the world's most prominent problems. Moreover, these startups pressure existing big corporations to transform and innovate by leaving the stubborn companies out of the game.

Considering the promising effect of startups on deploying technology to businesses and making incremental and innovative improvements on various solutions, it is foreseeable that they will be a vital component of the green transition towards Net Zero Target. There is an umbrella term for technologies that prioritize environmental goods referred as clean technologies, or shortly "cleantech". Primary areas of cleantech are energy generation and storage, water, transportation, waste and sustainable materials, built environment, and lastly agriculture and food services.⁶⁸ Innovative and newly established digital companies that have been built around these topics are called cleantech startups. The number of cleantech startups is rising every year, and Turkey and Germany are one of the most promising countries for these startups to appear in Europe. Furthermore, both countries can benefit from the integration among these countries' startup ecosystems. This crucial integration can be fueled by human capital and potential end-users.⁶⁹ Potential for shared human capital with Turkish-rooted Germans and newly immigrated Turkish tech talents is high and Turkey's demographic and economic characteristics underlines Turkey's end-user potential for German startups. Moreover, the modernization of the Customs Union has the potential to start policy convergence on digital policies. Adding digitalization and green transition components into these discussions around Customs Union, will ease the process of integration of two countries' startup ecosystems.

66 SDG Impact Accelerator. <https://www.sdgia.org>

67 Investing For Impact: The Global Impact Investing Market 2020. (2020). https://www.ifc.org/wps/wcm/connect/365d09e3-e8d6-4da4-badb-741933e76f3b/2021-Investing+for+Impact_FINAL2_web.pdf?MOD=AJPERES&CVID=nHFe68P

68 The 6 Key Areas of Cleantech. (2021). <https://medium.com/cleantech-rising/the-6-key-areas-of-cleantech-245a07393b7e>

69 Center for Economics and Foreign Policy Studies (EDAM). (2021). The State and Future of Turkey and Germany Relations: Assessment of Existing and Emerging Economic Relationship. <https://edam.org.tr/en/the-state-and-future-of-turkey-and-germany-relations/>

6.2 Current Green Startup Ecosystems of Turkey and Germany

With 15.5%, Turkey has a higher percentage of the youth population, between the ages of 15-24, than any other country in the European Union.⁷⁰ Turkey's digitally connected young population and global-minded tech talents is turning Turkey into a star of European tech.⁷¹ Turkey now hosts 5 different billion-dollar companies: Getir, Trendyol, Hepsiburada, Peak Games and Dream Games. These companies expanded their business to Europe and America and helped the country to raise more venture capital in 2021, than the sum of all previous years.⁷² The growth of these startups paved the way for newcomers and made Turkey an attractive country for startup investment. Cleantech startups took their share from this growing pie. Below, is a list of venture and angel investment-backed Turkish startups on cleantech industries: renewable energy and green infrastructure, transport technologies, and green construction.⁷³

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Table 14:
*List of Turkish
Green Startups
That Received Funding*

Name of the Startup	Sector	Description
Biotrend Energy	Energy, Cleantech	Solid waste management service, energy production
Ferge	Cleantech	Rubber based polymer spare parts production
Evreka	Smart city, Cleantech	Smart garbage collection with sensors detecting fullness
BioGuy	Cleantech	Purification Unit Provider
BioPipe (GreenAgeTech)	Cleantech	Biopipe treats wastewater effectively for irrigation and secondary use proposes
Eatron Technologies	Autotech	Electric and autonomous vehicle technologies
Chargery	Autotech	Service provider for the future of mobility in urban areas
DUCKT	Smart city, Energy	Electrical scooter charging station
Verisun	Smart city	Manufacturer of Endirek (Solar powered charging and public wi-fi spot)
Nicat Batarya	Energy	Nickel-based cathode production and artificial intelligence



70 TUIK. Youth in Statistics. (2020). <https://data.tuik.gov.tr/Bulten/Index?p=Istatistiklerle-Genclik-2020-37242>

71 How Turkey became a star of European tech. (2021). <https://www.ft.com/content/1010e729-a33f-4fd8-acd6-e5391bca45e0>

72 Ibid.

73 Startups watch. <https://startups.watch/>



Laska Energy	Energy	Obtains electrical energy from the rubber based waste by thermo-chemical method
Sensgreen	Energy	Energy and time saving solutions for commercial real estates
Biotrend Energy	Energy, Cleantech	Solid waste management service, energy production
Batron Arge	Energy	Battery design and development
QuantCo	Energy	Analytic solutions using optimization and machine learning techniques for renewable energy
RePG Energy	Energy	Range extender power generator
Bren	Energy	Embedded system design and renewable energy production systems and applications
Enwair	Energy	Silicon based anode materials for lithium ion batteries.
BEAD	Energy Smart home	IoT solutions to fully digitalize building operations
PEAK	Energy, Smart home	Energy efficiency for buildings
Integreen	Energy	Renewable power plant planning&setup
Hidroturbin	Energy	R&D of power generating systems
Reengen	Energy	Manage your energy consumption of your building
CivicSolar	Energy	Innovative solar distributor with operations and customer service infrastructure
Aplus Enerji	Energy	Energy solutions

Germany hosts more than 2000 startups, from which more than 30% are Greentech.⁷⁴ In Germany, Greentech startups are considered as one of the most attractive businesses in addition to *Zebra startups*, that focus on both profit and social good.⁷⁵ 76% of German startups value social impact as more crucial than their financial success and strategies. These prove that in Germany, greener and more impact-oriented companies are on the rise. According to Green Startup Monitor 2021 report, these startups serve as an “engine of the sustainable transformation to climate neutrality by 2050”.⁷⁶

74 Green Startup Monitor. (2021). <https://deustestartups.org/wp-content/uploads/2021/03/GreenStartupMonitor2021.pdf>

75 Center for Economics and Foreign Policy Studies (EDAM). (2021). The State and Future of Turkey and Germany Relations: Assessment of Existing and Emerging Economic Relationship. <https://edam.org.tr/en/the-state-and-future-of-turkey-and-germany-relations/>

76 Green Startup Monitor. (2021). <https://deustestartups.org/wp-content/uploads/2021/03/GreenStartupMonitor2021.pdf>

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*Table 15:
Top 10 Green
Startups of Germany*

Name of the Startup	Sector	Description
Ecoligo	Energy	Solar service that renders low-cost solar energy to local businesses in developing markets
Next Kraftwerke	Energy	Administrator of a large-scale virtual power plant and a certified energy trader
Smart Hydro Power	Cleantech	Manufactures, sells and trades kinetic micro-hydropower plants
Solytic	Energy	Data-driven startup focused on solar energy
Ecoworks	Smarthome	Practices mechanical prefabrication, digital processes, and energy systems for multi-family homes
Greencom	Energy	Integrates issued assets like Solar PV, electric vehicles, battery storage and heat pumps
Zolar	Energy, Smart home	Online provider of solar systems that facilitates entry into the private energy supply for private households.
Wind Mobility	Autotech	Micro-mobility startup that gives convenient, secure and pleasant last-mile transportation services
Tado	Smarthome	The Heating App for private homes and small enterprises
Sonnen	Energy, Smart home	Offers effective energy management, smart metering and virtual power plant integration.

As the share of green industries in the bilateral trade between Turkey and Germany increases, the countries signaled their intention to increase green economic activity by founding The Turkish-German Energy Forum.⁷⁷ Like established German firms' investments in Turkish energy companies, it is expected from German Venture Capitals will invest in Turkish cleantech startups in the future. Some of the green startups in Turkey are already attracting attention. Some examples are; energy consumption management company Reengen's project involvements in Germany, and garbage collection company Evreka's cooperation with ALBA Singapore. Moreover, Chargery, a Berlin based autotech startup has received investment from a Turkish venture capital named Vinci.⁷⁸ All of these investments and cooperation signal the future integration of these two countries' green startup ecosystems, which then will be an integral part of the economic relationship of Turkey and Germany.

77 Anadolu Agency. (2019). Turkey and Germany to boost renewable cooperation. <https://www.aa.com.tr/en/economy/turkey-and-germany-to-boost-renewable-cooperation/1456703>
78 Webrazzi (2020). <https://webrazzi.com/2020/02/05/vinci-chargery-yatirim/>

7. CONCLUSION

Green economy transition is a substantial path that leads to a sustainable future. Several organizations and countries have been preparing for effective transition with appropriate policies. The EU as Turkey's lead trade partner has an ambitious target to reach a climate-neutral economy by 2050.⁷⁹ Therefore, green economy components such as renewables, environmentally friendly transport technologies, and green construction are crucial sectors that will guide green-era trade relations.

Based on our analysis, three different sectors of the green economy (renewables and green infrastructure, transport technologies, green-friendly construction) were found to have a significant impact on Turkey's economy and trade relations with Germany playing a foremost role. Germany was ranked first for both Turkey's exports and imports of renewables and green infrastructure. In the green transport technologies sector, Germany ranked 1st in exports and 2nd in imports after China. Finally, in green construction, Germany ranked 3rd in exports after Iraq and Israel respectively and 1st in imports.

It was calculated that Germany accounts for 15.5% of Turkey's green economy exports 20.4% of its total green economy imports. Currently, Germany ranks 1st with \$567 million of exports that contributes to Turkey's green economy. On the import side, Germany ranks 2nd with overall value of \$1.2 billion for Turkey's green economy. As a crucial strategic trade partner, Germany ranked 1st among the EU members in terms of Turkey's green economy trade values for both exports and imports.

Besides the existing trade relationship of these countries, there is room for development and potential for improved trade performance at some products, which are specified by the productive ecosystem map. By focusing more on these products, Turkey can increase its share in the green economy trade. Furthermore, with the inclusion of Green Deal and Digitalization components to the discussions around modernization of the Customs Union, Turkey can position itself as an important player of the green startups ecosystem within Europe.

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ECONOMICS & ENERGY PAPER NO 11/2021

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EDAM Publications

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EDAM thanks the Friedrich Naumann Foundation for its contributions to the preparation of this publication.

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