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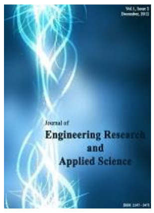

Renewable energy is capable of meeting our energy needs

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Abstract
Despite having public support and advantages over other energy sources, renewable technologies have been repeatedly characterized as unable to meet our energy needs. People have been presented only a choice between fossil fuels and nuclear power. This, however, is a false choice. Renewable energy can reliably generate as much energy as conventional fuels, and can do so without producing carbon emissions or radioactive waste. Demand for energy and natural resources has been increasing due to economic and population growth in Turkey. Over recent years, the country has experienced the fastest surge in energy demand and the projections of the Ministry of Energy and Natural Resources (MENR) confirm that this trend will continue for the medium and long term. Turkey has a substantial amount of renewable energy potential, and utilization of this potential has been on the rise over the last decade. As of the end of 2020, hydro, wind, solar and geothermal resources constitute the vast majority of the country's renewable energy resources, accounting respectively for 30,491 MW, 8,315 MW, 368 MW and 1,564 MW of the total installed capacity of more than 94,746 MW. However; biomass and municipal waste energy resources are also expected to comprise a considerable portion with the rapid growth in utilization of these resources in the market. This study shows that renewable energy is capable of meeting our energy needs both globally and for Turkey.

Keywords: Renewable energy, energy demand, sustainable development, Turkey.

1. Introduction

Demand for energy and natural resources has been increasing due to the economic and population growth in Turkey. It has posted the fastest growth in the OECD, with an annual growth rate of 5.5 percent since 2002. Since then, Turkey's primary energy supply has increased from 78.4 Mtoe to 155 Mtoe, a two-fold increase within 17 years. Turkey's growing economic performance has also been reflected on the country's electricity generation infrastructure given the dramatic rise in the total installed capacity from 31.8 GW to 88.5 GW, and in the electricity consumption from 132.6 TWh to 305.5 TWh as of end-2018. To satisfy the increasing needs of the country, the current capacity is expected to reach 110 GW by 2023 through further investments to be commissioned by the private sector as underlined in the 11th Development Plan for 2019-2023 [1-10, 11-36].

The success of a privatization and liberalization program going on since 2002 has handed over all of the power distribution assets and 86% of the power generation assets to the private sector, creating revenues of USD 34 billion for the Treasury. In the same period, about USD 100 billion of new public and private investments were completed in power generation, transmission, and distribution assets. The privatization of electricity generation assets and the strategy to clear the way for more private investments has resulted in an increased share of private entities in electricity generation, from 40% in 2002 to 95% in 2020. Turkey's prominent economic performance, backed by the liberalization efforts, also allowed for attraction of around USD 222 billion of FDI between 2002 and 2020, of which about USD 24 billion flowed into the energy sector. In 2020, investors carried out M&A activities across various sectors with a total deal volume of about USD 16 billion through 266 deals, with the energy industry standing among the leading sectors in terms of M&A transaction volume with USD 400 million.

It is no doubt that Turkey is a net energy importer country, depending on such imports for 73 percent of

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its energy requirements. The energy import bill was USD 43 billion in 2020, decreasing by nearly 14% compared to 2017 due to Covid 19 pandemic. However, with the exception of fluctuations in certain years, the bills depict a significant downward trend given the considerable decline from USD 60.1 billion in 2012 to USD 43 billion in 2020. The import dependence has been the main driving force behind the formulation and implementation of new policies and investment models to commission local and renewable energy resources [11-20].

Turkey has a substantial amount of renewable energy potential, and utilization of this potential has been on the rise over the last decade. As of end-2018, hydro, wind, and solar resources constitute the vast majority of the country's renewable energy resources, accounting respectively for 28.29 GW, 7.01 GW, and 5.07 GW of the total installed capacity. As part of the ongoing efforts to promote localization, the Turkish government has made it a priority to increase the share of renewables to 30 percent, with geothermal installed capacity to be 3 GW by 2023, as well as to have 16 GW of installed capacity in solar and wind each by 2027. In order to create a favorable investment environment to strengthen renewables' position in the market beyond the 2020s, the government has designed various investment models such as unlicensed (small-scale), licensed (medium-scale), and YEKA (large-scale) models, which address different sorts of investors and are encouraged by lucrative incentive instruments [21].

Utilization of local coal reserves in line with the environmental standards for electricity generation has also been prioritized as an instrument to increase localization. The government has adopted a new tender mechanism based on transfer of coal reserves to the private sector with the obligation of building and operating coal-fired power plants in the vicinity. Turkey has a substantial amount of coal reserves, totaling 17.3 billion tons and composed of mostly lignite. The main coal reserves are located in Kangal, Orhaneli, Tufanbeyli, Soma, Tunçbilek, Seyitömer, Çan, Muğla, Çayırhan, Afşin-Elbistan, Karapınar, Tekirdağ, Alpu, and Afyonkarahisar. Among these reserves, the Afşin-Elbistan field alone has 4.8 billion tons of lignite resources, which constitutes 28 percent of Turkey's total lignite reserves. The fields to be tendered in reverse-auctions bear 6.4 GW of installed generation capacity potential [22].

It is also worth mentioning that Turkey's natural gas sector has been steadily improving. In order to increase security of supply and seasonal gas send-out capacity, Turkey has commissioned two Floating Storage Regasification Unit (FSRU) terminals in 2018 and opened up the first phase of the Tuz Golu (Salt Lake) Natural Gas Storage Facility. Another goal of these investments is to expand Turkey's gas storage capacity to 11 billion m^3 by 2023, up from its current capacity of 4 billion m^3 [23-36]

As a crossroads between major energy consumers and suppliers, Turkey occupies a strategic location that serves as a regional energy hub. The existing and planned oil/gas pipelines, the critical Turkish straits, and promising finds of hydrocarbon reserves around Turkey allow for increased leverage over regional projects and reinforce the country's gateway status. Last but not least, Turkey has taken important steps in energy efficiency. In the National Energy Efficiency Action Plan, which was adopted in 2018, Turkey aims to achieve savings of USD 30 billion in total by 2040. In this regard, approximately USD 16 billion of investments will be made by 2030, resulting in energy savings equivalent to 27 Mtoe. This saving is equal to decreasing the primary energy consumption of Turkey by 24% in 2030 compared to the base usage scenario. As part of Turkey's efficiency efforts, Turkey will eliminate the need for USD 4.2 billion worth of power plant investments while also providing additional employment for 20,000 people by 2023. In the present study, we analyzed situation of the renewable energy is capable of meeting our energy needs in both globally and country bases. The obtained results are show that the renewable energy potential of Turkey is enough to meet our energy demand.

2. Renewable energy for meeting our energy needs

2.1. Introduction

Renewable energy includes solar, wind, hydro, biomass and geothermal has the potential to replace conventional fossil fuels (see Tables 1-4 and Figure 1-5). While non-hydro renewables presently provide just 23% of electricity in Turkey, it is technically and economically feasible for a diverse mix of existing renewable technologies to completely meet our energy needs. In fact, as much as 55% of Turkish electricity could immediately come from renewable energy sources without any negative effects to the stability or reliability of the electrical grid. Over the longer term, improvements to the grid can be made, and renewable technologies could supply increasingly higher percentages. Importantly, renewable energy technologies produce virtually no greenhouse gas emissions and can effectively address climate change. If unchecked, the disruption of the earth's atmosphere poses the greatest threat to humankind in our lifetimes. Continuing to fill the atmosphere with greenhouse gases will melt the ice sheets, raise sea levels, bring extreme weather patterns, disrupt food production, and destroy whole ecosystems. Hundreds of millions of people may be left without food, shelter or clean water, causing political and social upheaval. According to a study by Turkey's Ministry of Energy and Natural Resources (MENR), renewable energy combined with efficiency measures could reduce greenhouse gas emissions to a level consistent with goals of global climate stabilization – a 80% reduction by 2050. With minimal initial capital costs and short deployment times, renewable technologies could address global climate change more quickly than nuclear power, and without the production of radioactive waste or other significant types of pollution [11, 12].

Table 1. Turkey's total energy production in 2019 (Mtoe)

Energy Sources	Production	Consumption
Coal and Lignite	16.36	40.57
Oil	3.14	35.45
Gas	0.40	37.13
Hydropower	7.64	7.64
Geothermal	9.66	9.66
Wood and Biomass	3.16	3.16
Solar/Wind/Other	4.46	4.46
Total production	44.82	144.21

Table 2. Installed electricity capacity in Turkey (MW)

Energy source	2010	2020
Lignite	8 280	10 120
H.coal+Asph.	560	1 210
Imported coal	1 840	8 987
Natural gas	14 840	25 585
Geothermal	90	1 556
Other	2 460	860
Biomass	62	980
Hydropower	16 393	30 510
Wind energy	810	8 318
Total (MW)	45 255	94 750

Table 3. Renewable source potential, utilization by 2019 and target for 2030

Energy sources	Potential (TWh/yr)	Potential (GW)	Utilized (GW)	2030 Target (GW)
Hydropower	180	100	75	180
Wind energy	150	50	20	40
Geothermal	4.2	6.0	3.2	4.2
Solar energy	380	8.1	6.1	10
Biomass	3.6	5.0	1.2	2.2

Table 4.Investment potential for renewable energies in Turkey

Sectors	Million $	Remarks
Hydroelectric	128	Economical development potential of 28,400 MW, Corresponding 100,000 GWh/a
Wind power	72	Economical development potential of 48,000 MW With wind speed > 7 m/s
Solar thermal	178	Economical development potential of 131,000 GWh/a, Corresponding to approx. 300 million m^2 collector area
Biogas	6	Agricultural residual material and dung, when used for electricity generation, 1,000 MWe and 7,000 GWh/a
Total	384	

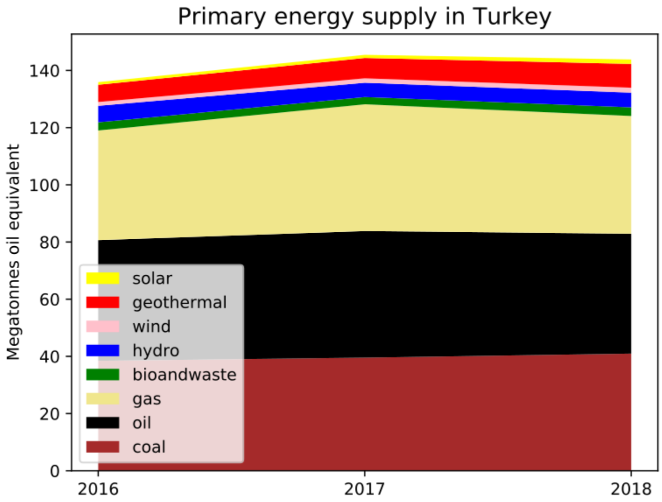

Figure 1. Primary energy supply in Turkey.

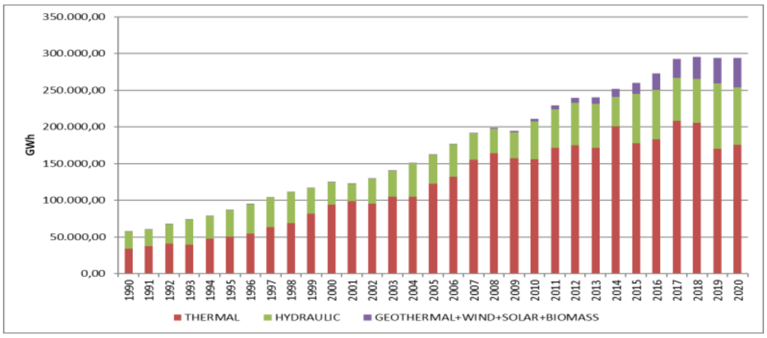

Figure 2. Source-based development of licensed electricity generation in Turkey (GWh)

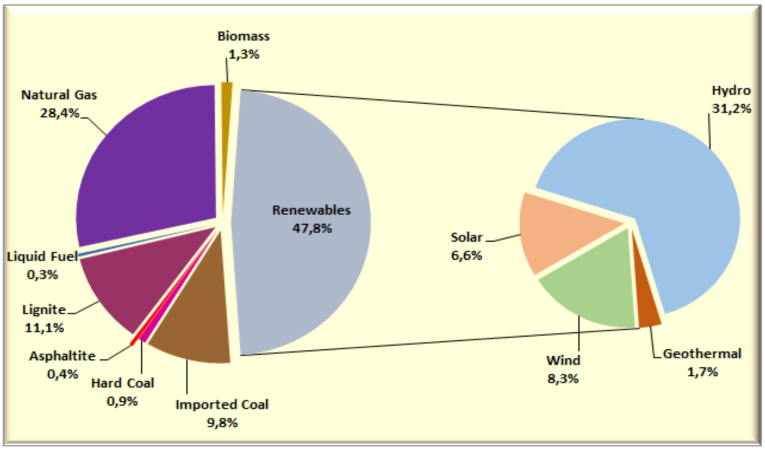

Figure 3. Turkey's installed capacity by primary resources in 2019 (MW, %)

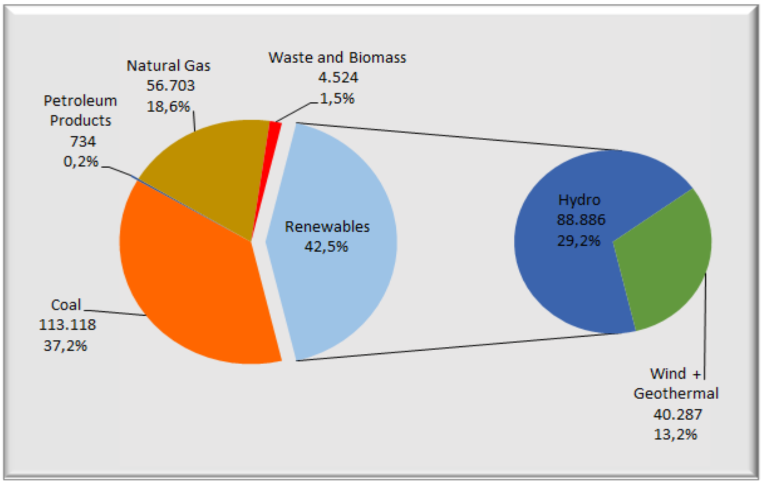

Figure 4. Turkey's electricity generation by primary resources in 2019 (Million kWh, %)

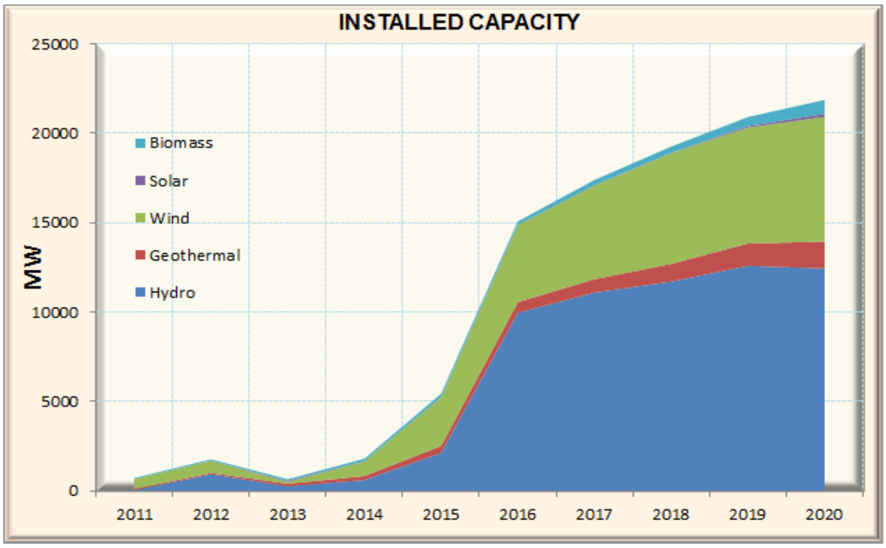

Figure 5. Installed capacity of renewable power plants in Turkey.

2.2. How much renewable energy is there?

In the near to medium term, the combination of wind, solar, hydropower, biomass and geothermal energy could completely meet Turkish electricity needs. According to a recent MENR analysis, the entire Turkish electricity demand could technically be met by renewable energy resources by 2040. In the longer term, the potential of domestic renewable resources is more than 15 times current country energy use [11-20].

2.2.1. Wind Energy

Evaluating the wind potential of the Turkey, the Ministry of Energy and Natural Resources (MENR) has estimated that land-based wind across the contiguous Turkey is capable of producing almost one and a half times current Turkish annual electricity use. According to a recent analysis by MENR, there is also an additional 40 GW of power from offshore wind within 2.0 km of the Turkish coastline. This is equivalent to at least 0.45 trillion kWh/yr – almost 30% of current country electricity use [11, 12, 23].

To produce this much energy, no significant developments in wind technology would be needed. Modern turbines are rugged horizontal-axis three-bladed designs that are turned into the wind by computer-controlled motors. The power capacity of these turbines has increased dramatically in the last twenty years, from 24 kW in 1981 to 3.0 MW in 2020. The turbines have been developed to function at high speeds, high efficiency, and with low stress, which all contribute to good reliability. Research on new lightweight composite materials, advanced control systems, and methods for addressing the additional variables involved in offshore sites will only improve the effectiveness of these designs. Counter-rotating horizontal axis turbine designs, which capture a wider range of wind speeds, and vertical axis turbines, which have the potential to generate 4-10 megawatts (MW) per turbine, are also expected to become common in the next five to ten years. The most significant issue facing wind turbines will be the need for appropriate siting and community approval [11, 12, 23].

2.2.2. Solar Energy

The amount of solar energy by any measure is also enormous. Every hour more energy strikes the surface of the Earth than is consumed globally in a year. According to the MENR's solar energy technologies program, there is on average between 2.8 and 6.2 kilowatt-hours (kWh) of sunlight available per square meter (m^2) each day. The exact amount of sunlight depends on the region and the season. In Turkey, the annual average is 3.6 kWh/m^2 per day [11, 12, 23].

One way of using this solar energy is to transform it directly into electricity.17 Two types of photovoltaic technology that have been developed for this purpose are photovoltaic panels (PV) and photovoltaic concentrators. For PV panels, the efficiency – or ability of the photovoltaic cells to capture solar energy and convert it into electricity – ranges from 12 to 25%. The panels themselves have efficiencies slightly lower than the actual cells because of structure and wiring. Traditionally, the highest efficiencies have come from expensive, thick silicon panels. Recent work by several scientists, however, has led to the development of cheap, flexible thin film panels capable of at least 15% efficiency. These panels have begun to be produced on a significant scale [8-12, 23, 26, 28].

As a result, with existing technology, PV could make a significant contribution to Turkish energy production. According to a recent MENR study, assuming 15% panel efficiency and a conservative estimate of at least 354 million m^2 available residential and commercial rooftop space, the country could accommodate about 10,000 MW of PV by 2030, which would generate approximately 0.4 trillion kWh per year – almost half of current country electricity use. This does not include other distributed forms of PV electric generation, such as ground mounted PV, PV shingles, covered parking lots, windows, awnings, and sides of buildings. It also does not take into account additional improvements in panel efficiency [11, 12, 23].

Photovoltaic concentrators could also make a significant contribution to meeting country energy needs. Solar concentrators move to track the sun, produce a more constant level of "peak energy" throughout the day, and operate at higher efficiencies than PV panels. Concentrators can also reduce costs by using less PV material per unit of energy generated (although they do require an inexpensive optical element and a support structure and tracker). Concentrators could be well-suited for stabilizing the generation of wind farms and for installation along highways and transmission corridors [23].

2.2.3. Hydropower

Hydropower currently provides 25% of the electricity generation in Turkey and could be a significant source of renewable energy. Large conventional dams, however, have caused serious environmental damage. Conventional dams have had serious impacts on rivers. Turbines have killed large numbers of fish swimming downstream and blocked others from migrating upstream to feed and reproduce. Water quality is also deteriorated, as the concentration of metals and sediment organic matter in the water increases after construction, and the dams themselves push oxygen into water below the turbines. Rivers above dams also tend to become slow and stratified, resulting in the build up of sediment that makes layers of the river unlivable for aquatic life. Dam construction has also flooded large swaths of land, often unbalancing local ecosystems, covering important farmland, and endangering various species [17-21].

They will have to be retrofitted or taken down, while smaller systems with advanced turbine designs are set up (up to 25 MW). According to MENR, advanced systems can be applied at more than 80% of existing hydropower projects, and can also be built at small existing dams that have not been previously used to produce power. Advanced hydro designs reduce the impact of turbines on fish, facilitate upstream fish migration, and mitigate sediment and water quality problems. River-run systems – which harness the power of moving water without dams or reservoirs - are also a small, low-impact alternative that could be developed where dams are removed or at new sites. Estimates of potential sustainable hydro resources from existing dams in Turkey range from 7 to 8 gigawatts (GW). This includes 12 GW from retrofitted existing hydropower projects and 6-15

GW from fitting advanced systems onto other existing small dams. These hydropower sources could provide between 37 and 59 billion kWh per year [11].

2.2.4. Biomass

Biomass is the burning of organic matter such as agricultural crops and grasses to produce heat or electricity. Biomass, unlike solar and wind, does produce significant carbon dioxide emissions. These emissions, however, can be balanced out by planting new crops, which take up carbon dioxide as they grow. The carbon emission to carbon uptake ratio, the location of the two processes, and the effects on local soil and water quality, are important issues that must be considered in determining what forms of biomass are sustainable. For biomass to be a significant source of non-carbon emitting renewable energy, crops must be grown with little cultivation and fertilizer, transported only over short distances, and grown and harvested in a way that does not degrade the land. Grasses such as switch grass and big blue stem are low impact possibilities for biomass. If produced and used correctly, biomass could contribute significantly to meeting Turkish energy needs. According to a recent MENR study, biomass could produce 10-20% of Turkish electricity by 2030 [9-16].

2.2.5. Geothermal

About 450 geothermal fields have been discovered in Turkey. Rapid development at geothermal electricity installed capacity reached up 1385 MWe as of February 2021. The capacity has increased twice since 2016. Geothermal direct-use applications have reached 3787 MWt geothermal heating including district heating (1233 MWt), 4,3 million m^2 greenhouse heating (920 MWt), thermal facilities, hotels etc heating 420 MWt, balneological use (1205 MWt), agricultural drying (1.5 MWt), geothermal cooling (0,1 MWe) and total heat pump applications (109 MWt). Geothermal electricity installed capacity reached up 1283 MW_e as at the end of 2018 (TEİAŞ 2019). Deep reservoir explorations are going on for electricity production purposes. For this reason deep drilling targets have reached up to 4500 m. The successful results have been obtained exploration of deep reservoirs. The increase of directional drillings and coil tubing operation applications are other important environmental and economic developments for the geothermal fields in Turkey [11, 12, 23, 25].

2.3. Variability and intermittency

Despite the abilities of renewable technologies and the vastness of the resource, renewable energy is still often depicted as far too variable and inconsistent to meet our energy needs. This, however, is an incorrect picture. Advanced hydro and sustainable biomass are already capable of producing baseload power, and offshore wind has similar potential. For PV and land-based wind - although it is true that “the sun doesn’t always shine and the wind doesn’t always blow” - it is possible to harness these sources of energy in a way that substantially reduces the problems of intermittency and variability [5-7].

Significant advances along these lines have already been made. The first three measures alone can allow non-hydro renewable technologies to well exceed 20% of generating capacity by 2020 without impacting grid reliability or stability. In the longer term, storage remains the most significant issue. Presently, the best options for storage are hydroelectric pumped water and compressed air. Hydroelectric pumped storage moves water from lower to higher reservoirs when extra electricity is being produced, and releases it when that energy is needed. These systems are well-established, low in cost, up to 80% efficient, and have an enormous capacity for storage. Also, because energy is stored in times of excess generation, pumped storage systems do not compete with hydro generation. Using advanced hydro technology, these systems can also have minimal environmental impact. Air compression systems work on a similar principle, compressing air and storing it in airtight underground caverns during times of less demand, and releasing it to run turbines when needed. These technologies have undergone significant developments recently, being designed to store energy from wind farms. In the longer term, the development of extensive regional grids will increasingly stabilize geographically distributed generation, and the production of hydrogen will likely become an important energy storage mechanism [5-7, 11, 12, 23].

2.4. Cost of renewable technologies is decreasing

Despite all their advantages, renewable technologies are still often rejected as too costly. But this fails to take two very important factors into account. In the last fifty years, federal support for nuclear power and fossil fuels has far surpassed support for renewable technologies. This imbalance has resulted in unequal technology development and commercialization. In addition, while the costs of renewable technologies are decreasing substantially, the costs of nuclear power and conventional fuels continue to be underestimated. The disparity in funding continues, and is well illustrated by recent appropriations and the Energy Policy Act of 2005.

Despite the vast discrepancy in federal support, wind power is competitive with nuclear power and fossil fuels at around $0.02-0.04 per kWh, and the price of solar PV has fallen to roughly $0.20-0.25 per kWh. With recent advancements in thin film PV technology, improved wind turbine performance, and greater economies of scale, it is expected that the costs of these technologies and others will continue to fall. For solar, this fall is expected to be particularly dramatic, as more panels are produced and significantly less photovoltaic material is required per panel. The price of PV, for instance, has been shown to drop by 20% for each doubling of production volume [4-8].

It is also important to include the costs of conventional technologies not presently accounted for in their cents per kWh. These externalized costs from fossil fuels include carbon emissions, air pollution, and land and water degradation from coal mining. For nuclear, they include the pollution from uranium mining, the safety and security risks posed by commercial reactors, risks from nuclear weapons proliferation, and the dangerous legacy of radioactive waste. Coal and uranium are also finite, while most renewable energy sources are unlimited in supply and free. If these effects are quantified and included in the price of conventional fuels, renewables are already far cheaper for society [4-8].

2.5. Potential for efficiency

In addition to renewable technologies, using energy more efficiently is also an important part of moving to a clean energy future. Efficiency is the cheapest and easiest way to reduce electricity use and facilitate the transition to renewable technologies. In 2019, the Turkish government's Office of Technology Assessment (OTA) estimated that the country could reduce its electricity use 20-45% by adopting currently available efficiency technologies. OTA similarly concluded in 2019 that the government could reduce the energy use at its facilities by at least 25% using commercially available, cost-effective efficiency measures. These changes range from improvements in heating, ventilation, and air conditioning systems, to more efficient refrigerators and other appliances, advanced lighting systems, and increased building insulation. Since the early 1990's when these analyses were performed, other efficiency measures such as LED lights have become commercially available, and thus the energy reductions possible through efficiency today are likely to be even greater. For example, earth source heat pumps which use the relatively constant temperature of the earth to provide heating and cooling are also an effective efficiency measure. It is estimated that widespread use of these pumps could reduce energy used for heating and cooling by 30-60% [2-8].

Presently, there are many artificial regulatory barriers limiting the immediate growth of renewable energy technologies. If we are truly to move towards these technologies, adjustments to the way renewable energy is produced and sold, and the establishment of long-term purchase agreements between renewable energy producers, utilities, and large end-users are necessary. Change like this can be affected from the local and state level. In addition, cities and states can develop renewable portfolio standards (RPS) which mandate a certain percentage of energy generation come from renewable technologies, and states can also put in place financial incentives that encourage the development of renewable technologies [2-8].

3. Investments in Turkish renewable energy sector

3.1. Overview of renewable energy

Demand for energy and natural resources has been increasing due to economic and population growth in Turkey. Over recent years, the country has experienced the fastest surge in energy demand among OECD countries, and according to the International Energy Agency (IEA) forecasts, is set to double its energy use over the next decade. The projections of the Ministry of Energy and Natural Resources confirm that this trend will continue for the medium and long term. Recent energy data indicate that Turkey is a net energy importer country, depending on such imports for 73% of its energy needs. This high rate of energy dependence has been the main driving force behind the formulation and implementation of new policies to commission local and renewable energy resources. In this respect, Turkey announced the National Energy and Mining Strategy in 2017 which identified security of supply, localization, and predictable market conditions as the main pillars to follow in energy sector. Under the Strategy, ensuring localization and reducing import dependence through utilization of domestic resources stands as a top priority for Turkey which is ambitious to generate 2/3 of its electricity from local and renewable resources by 2023 [11, 12, 23].

Turkey has a substantial amount of renewable energy potential, and utilization of this potential has been on the rise over the last decade. As of the end of 2020, hydro, wind, solar and geothermal resources constitute the vast majority of the country's renewable energy resources, accounting respectively for 30,491 MW, 8,315 MW, 368 MW and 1,564 MW of the total installed capacity of more than 94,746 MW. However; biomass and municipal waste energy resources are also expected to comprise a considerable portion with the rapid growth in utilization of these resources in the market [11, 12, 23].

As part of the ongoing efforts to promote localization, the Government has identified following targets to strengthen renewables' position in the market beyond 2020s:

- Increasing the share of renewables to 60% by 2030,
- Increasing geothermal installed capacity to 3,000 MW (from the current 1556 MW) by 2030,
- Maximizing the use of hydropower,
- Increasing wind installed capacity to 16,000 MW (from the current 8,355 MW) by 2030,
- Increasing solar installed capacity to 16,000 MW (from the current 5,435 MW) by 2030.

Three different investment models are in place in Turkish renewable energy market in this new period: unlicensed, licensed, and the REZone (YEKA) model [11, 12, 23].

3.2. Unlicensed model

In line with the recent changes in the unlicensed electricity market, real persons or legal entities may install renewable energy systems generating up to 5 MW of energy without any requirement to obtain a license. The installation must be in the same connection point as the consumption facility and the installed power cannot exceed the contract power identified for the "related consumption facility" which means unlicensed facilities can only be set up as rooftop or façade installations. The Presidential Decree No.1044 dated May 9, 2019 reserves only for the public institutions the right to install ground-mounted generation facilities with different connection point from the consumption facilities with the condition not to exceed contract power of the consumption facilities. Under the relevant Local Content Regulation, local content support is not provided for unlicensed projects unlike for the licensed ones. So, 6,353 and 78 MW of unlicensed capacity are installed in solar and wind respectively as of the end of May 2021 [11, 12, 23].

3.2.1. General procedures of application for unlicensed projects

The procedure for unlicensed projects (up to 5 MW) doesn't require establishment of a company; the applicant does not need to participate in a capacity bidding process, there is no yearly time schedule for applications unlike the licensed applications which are received only during a specific time of the year; and there is no need to have metering data for the project site. Under the new regulation on unlicensed electricity generation, the private real persons or legal entities can only apply for rooftop or façade installations which can be up to 5 MW capacity and cannot exceed the contract power of the related consumption facility. For unlicensed solar and wind projects, following documents are required in application to relevant Network Operator (Distribution Company):

- Connection Application Form for unlicensed electricity generation,
- The original or certified copy of the title deed or the rental contract for the project site,
- Official documents testifying to non-sensitive nature of the location not required for rooftop and façade installations,
- Information about the consumption facilities,
- Environmental Impact Assessment exemption document from Provincial Directorate of Environment and Urbanization - not required for rooftop and façade installations,
- Bank receipt testifying to the payment of the application fee,
- Single-line diagram,

- Technical evaluation report of DG for Energy Affairs of the Ministry of Energy and Natural Resources,
- Coordinated Project Application Drawing Facility efficiency document,
- Declaration of non-affiliation with the relevant network operator or the commissioned supply company.

The documents are evaluated by the relevant network operator and "invitation/call letters" are sent to the applicants considered eligible. Within the first 90 days of the announcement of the letters, the applicant shall submit its generation project and the connection line project to Turkish Electricity Distribution Company (TEDAS), the relevant body of the MENR. Within the first 180 days following the announcement of the invitation letter, the investor shall submit the approved project to the relevant network operator and the operator shall sign a connection agreement with the investor within the first 30 days following the submission [11, 12, 23].

After the connection agreement, the applicant shall construct the project and apply to the operator to obtain an official report confirming the suitability of the facility for provisional acceptance, a document required for application to the MENR. Pursuant to the Regulation, provisional acceptance procedure shall be completed for all the facilities to be connected to the Grid through medium voltage level within one year following the signing of the connection agreement. A system usage agreement shall be signed as the final step between applicant and operator no later than 30 days following the provisional acceptance [11, 12, 23].

Under the unlicensed generation regulation, rooftop, and façade installations up to 10 kW are differentiated from other facilities more than 10 kW in terms of installation procedures. In January 2018, the Energy Market Regulatory Authority (EMRA) released a Board Decision (Decision No. 7590 dated 28/12/2017) on "the Procedures and Principles on Application and Excess Power Purchasing for the Unlicensed Solar Generation Facilities with the Same Connection Point as the Consumption Facility" in order to facilitate installation of the solar facilities up to 10 kW installed power. An additional amendment to the Income Tax Law was passed by the Parliament on "exemption from income tax of those selling the excess electricity generated from the installations up to 10 kW on the rooftops or facades of the houses they own or rent" which was published in the Official Gazette dated 27 March 2018 [11, 12, 23].

3.2.2. Pricing Mechanism

The Presidential Decree No.1044 dated May 9, 2019 brought about critical changes on the unlicensed electricity generation facilities. Under the Decree, unlicensed capacity limit has been increased from 1 MW to 5 MW and the power purchase price has been identified for the first ten years of operation as the relevant standard retail price for all unlicensed generation facilities up to 10 kW and more. Retail electricity prices are updated quarterly by EMRA for different types of consumers such as industry users, commercial users, household, agricultural irrigation and lighting.

Under Article 24 of the new regulation on unlicensed electricity generation announced in the Official Gazette No. 30772 dated 12.05.2019, the generation facilities installed and put in operation before the new regulation, shall continue to benefit from 13.3 USD cent/kWh for the first ten years of operation. For those being granted invitation letters following the new regulation, the power purchase price shall be the same retail price as electricity procurement price of the related consumption facility.

4. Case study in Germany and China

Human development has been depending on energy sources. This energy source has shifted from slavery to fossil fuel and in the last couple decade's renewable energy. Many countries around the world are trying to diversify their source of energy by replacing fossil fuel with renewables. However, there are many obstacles for states successfully shifting their energy dependency from fossil fuel to renewables. For instance, Germany and China are one of the leading countries in the decarbonization process. On the other hand, China, although is the biggest emitter of greenhouse gasses among the U.S China is also the leading power in the renewable sector. However, unlikely Germany, China is the big pusher for renewable is a matter of survival rather than political ideology. To sustain economic growth, China has relied on coal, as it is a cheap source of energy that accounts for 73% of energy sources in the country (Hager and Stefes, 2016). Notwithstanding, coal is a cheap energy source also emits toxic hazards into the atmosphere. For instance, a study shows that in 2013, 96% of Chinese cities air qualities exceed the WHO standards recommendation [37-40]. With that in mind, this essay analyzes and explores the political and economic implications that China and Germany face upon shifting its energy policy to renewables. As such, both China and Germany's renewable energy plan driving forces are policymaking, socio-economical and public opinion [37-50].

Policymaking for green energy is one of the key contributors to China and Germany’s renewable energy projects. This process is divided into two phases. Firstly, both China and Germany defined a CO_2 emission target. Second, policymaking is implemented to allow the development of the renewable sector and the necessary infrastructure to guarantee the sustainability of this industry. As such, China and Germany have both followed the previous steps; defining the target of cut the greenhouses emissions and introducing legislation and governmental programs to support the renewable energy industry [41-45].

For instance, Germany's renewable power has already exceeded 30% of its total energy output in 2015 (IRENA, 2015). Second, Germany's EEG program accelerated and contributed to developing the infrastructure among local level educational institutions, nongovernmental groups, private sector scheme of renewable through with subsidies to fund households and villages to obtain solar panel [46, 47]. However, some experts have also pointed out that these measures are not sufficient to provide a successful transition from fossil fuel source of energy to renewables [48].

One of the successfully essential elements for this challenges especially in Germany's EGG is the creation of young entrepreneurs establishing start-up companies. These start-up companies are responsible for the development of new technologies for energy efficiency and renewable energy. With that in mind, these start-ups companies are crucial in the decarbonization of the energy sources as fulfill the gap which the government or large-scale renewable industry does not satisfy [40]. Although Germany's geographic location is not endowed with an enormous amount of sunlight and wind power sites such as Brazil, Germany's renewable energy policies resulted in 2020 approximately 30% cheaper than the compared renewable energy in the respective countries [37, 38].

Similarly, with Germany, China has also followed the two steps towards renewable energy production. First, China announced that would achieve 20 percent in renewable energies in 2030 [37-40]. Also, to develop its renewable energy sector, China has invested US$386 billion in renewable energy development between 2010-2020 [38]. Second, China has introduced top-down policymaking for renewables, which is regulated by the National Development and Reform Commission. China's renewable plan model is called Authoritarian Environmentalism; which is the ability to produce rapid outcomes through centralized governmental actors [39]. The Authoritarian environmentalism policy structure is a mixture of state-led development policies and market-oriented legislatures.

The socio-economical challenge is one of the obstacles that China and Germany encountered upon shifting from fossil fuel to renewable sources. Although, China and Germany have aggressively invested economically and politically on renewable energy, this type of alternative, remains expensive compared to fossil fuel energy sources. Consequently, these governments have introduced measures to lessen the burden on consumers through subsisted, tax rebates and other means. However, the costs of this transition have also been felt among households, industries and especially among fossil fuel industry workforce. As a result, the oversight effects of this change created socio-economical challenges, which especially true in the case of Germany. Germany's abrupt shift from nuclear and fossil fuel to renewable sources of energy resulted in the increase of prices of the electric bill despite the government's annually subsidies that account for EUR 16 billion in 2013 and 2015 [47]. With that in mind, the higher prices of renewable energy have increased the costs of living of the lower income families.

One example is reflected in a study, which estimated that 40 percent of Germans are afraid that they will not be able to pay their electric bill [44]. Moreover, another study shows that in Germany, more than "0.75% of all households have their electricity cut-off each year because they failed to pay their electricity bill" [48]. This oversight effect is known as Energy Poverty, as many low-income families have to compromise significant part of their income on electricity bills and many cases cannot adequately heat their homes due to the unaffordability of energy [46]. Consequently, this alternative system would allow Germany’s power grid to take advantage of cheaper fossil fuel energy source combined with renewable energy. As such, this hybrid system would result in decreasing costs of energy production altogether by alternating from renewable to fossil fuel [37-50].

In the case of China, on the other hand, although the government has set ambitious goals for CO_2 emissions reduction by the introduction of renewable energy sources. The socio-economical challenges are rooted in the coal industry. Coal continues to account for 73% of energy sources in the country [39, 41]. Moreover, China's coal industry accounts for 47% of global production [42]. With that in mind, the coal industry in China it is a vital sector of the economy. According to some experts, the coal industry in China employs around 10 million people [43]. Consequently, regardless the willingness of the Chinese government to rapidly decarbonize its energy sources to renewable, this transition requires extensive caution measures and planning to mitigate the negative impact of the energy plan.

Another socio-economical challenge that China faces upon decarbonizing its energy resources is that lower-income families depend on coal to warm their houses and for cooking. Coal is one of the cheapest and most efficient sources for heating. For instance, a study conducted by the World Bank shows that 57.6 million depend on coal for cooking and heating their homes [41]. Because of that, unlikely in other developed nations, in China the shift of decarbonization to renewable is not limited to energy generation, but it is also related to the massive scale of human development [43]. The Chinese government decarbonization plan encounters substantial socio-economical obstacles that could lead to massive unemployment, therefore undermining of its authoritarian regime. Considering all points above, China and Germany have been facing prominent obstacles on the shift from fossil fuel to a renewable energy source [45].

Public opinion is one of the leading elements that contributed to China and Germany's decarbonization of their energy source to renewables. While renewable energy is the key strategy to reduce CO_2 emission, China and Germany's renewable energy plans have also received pressure from their constituencies for the decarbonization process. For instance, in Germany the decarbonization process is rooted in the grassroots anti-nuclear movement that started in the 1970's. This movement gained more public support in the 1980's in the awakening of the prominent nuclear disaster of Chernobyl [50]. As such, in 1990's from the to the 2000's Germany sought to gradually move away from nuclear energy and fossil fuel to renewables. However, in 2011, after the Fukushima nuclear accident, the public opinion reminded Germans of the fear of radiation, therefore pressuring the government to shut-down its nuclear plants.

In the case of China, however, although the country does not enjoy exceptional levels of political freedom and democracy, public opinion is one of the factors that exert extreme influence on energy decarbonization through renewable sources. The public in China is concerns over air and water pollution as result of coal plants demanding the government to provide rapid and clean energy. With that in mind, it is estimated that in 2013, 96 percent of the Chinese cities exceed the standards of established by the WTO of air pollution [50]. Under those circumstances, in 2013 the Chinese government has introduced a National Environmental Air Quality Monitoring Platform to monitor the level of hazards such as P.M 2.5 and P.M 10 that emitted into the atmosphere through the burn of fossil fuel [39, 41, 43, 45, 50].

On the other hand, some experts point out that the air pollution issue in China is rooted in the unplanned urbanization of the metropolises, due to the government inability to control migration to the major cities such as Beijing. For instance, according to these experts, the air pollution worsened with the uncontrolled population growth, which in Beijing increased 30 percent from the early 2000's [39]. For these reasons above, the public opinion in China has cornered the government to decarbonize its energy resources aggressively. Considering these points above the Chinese Communist Party Leadership faces prominent obstacles as cheap coal provides employment and energy to vital for the economic growth, whereas, the growing middle class demands improvement on air pollution [41]. As shown above, the Communist leadership is responding to public opinion by moving away from fossil fuel to renewable to alleviate the public pressure. Which neglected could lead to the collapse and undermine its regime. Public opinion is one of the leading factors that profoundly influenced China and Germany's renewable plan [43, 50].

To summarize, many countries around the world are in the process of decarbonization of their energy sources. As such, renewable energy is one of the main alternatives for this solution. China and Germany are leading countries in decarbonization process. However, regardless the numerous obstacles China and Germany remain great advocators of renewable energy. With that in mind, China and

Germany shift of energy policy may serve as a model for other countries. Under those circumstances, both China and Germany are encountering various challenges politically and economically [39].

There are three factors that China and Germany shared upon the decarbonization of its energy plan; policymaking, socio-economic and public opinion. First, policymaking is one of the key contributors to the advancement on decarbonization plan of China and Germany. This process is divided into two steps. As such, both China and Germany set ambitious goals to target CO_2 emission and expand its renewable energy sources. For instance, Germany introduced in 2000 the Renewable Energy Act by targeting CO_2 reduction by 90 percent in 2050. Consequently, the second step in Germany the government provided policymaking to facilitate instruments for education institutions, NGOs, the private sector and programs to subsidize the installation of solar panel for households. In the case of China, the government announced to shift 20% of its energy to renewables. Moreover, China between 2011 and 2015 invested US$286 billion in renewable energy through the through the energy program. As a result, the second policymaking shift to stimulate renewable energy introduced bidding projects and a tax rebate for companies in the renewable energy sector [39, 41, 43, 45].

Therefore, attracting foreign companies resulting in the transfer of renewable technology to China. Second China and Germany encountered the socio-economical obstacle on the decarbonization of its energy plan. Although, Germany has invested heavily in renewable energy the costs of this shift from carbon-based energy remains expensive. Consequently, the abrupt change in energy policy exacerbated the adverse effects. With that in mind, 40 percent of Germany's low-income families reported that they are afraid not to be able to pay their electricity bill. As a result, the unaffordability of the electricity created the phenomenon Energy Poverty as many families deprive themselves to heat their houses adequately. The shift of renewable energy also affected China socio-economically. For instance, the coal industry remains a substantial sector employing around 10 millions of people. Moreover, approximately 57.6 million depend on coal for cooking and heating their homes. As such, the reduction of fossil fuel remains a delicate topic for the Chinese leadership, as the economical growth and socio-economic aspects must be taken into account on the energy shift to renewable. Third, public opinion in China and Germany are one of the prominent implications on policy shift to renewable energy [38-40].

In Germany an anti-nuclear grassroots movement born in the 1970 and 80's has been one of the main forces driving to the rapid decarbonization of its energy policy. These changes become even stronger after the Fukushima nuclear accident, which forced the government to shift its energy source to renewables rapidly. As a result, the political parties in Germany such as Green Party unanimously decided to respond to public opinion by introducing renewables. In China, however, the public opinion has also shaped the government to decarbonize its energy plan. However, unlikely in Germany, China's air pollution issue is the pivot for this shift. For instance, 96 percent of the Chinese cities air pollution exceeds the recommended levels of WHO. Also, massive protests throughout the country and petitions have overflowed the government demanding improvements on air quality, therefore influencing the renewable energy shift. Considering the circumstances, the Chinese Communist Party leaders face a dilemma to provide reliable and cheap energy with coal source of energy while the growing middle class demands improvement on air quality [38-40].

Taking all that into account, although some experts conclude that lower level of democracy is negatively impacting on environmental development and renewable energy this notion is slightly misleading. According to some studies, authoritarian regimes have demonstrated efficiency in tackling environmental threats through policymaking. As such, all points above shows that China and Germany are shifting its energy policy to renewable based on the political will influenced by public opinion and socio-economical factors. However, above all, both China and Germany decarbonization case study shows that while political system and economic development stage may be a factor on the transition of fossil fuel to renewable energy sources, these variables should not be an obstacle for the development of green energy. Considering the circumstances above, China and German turned their energy sources to renewable energy as an act of renovation. As a result, allowing them to learn from their weakness and strength. With that in mind, other countries that aim to make the transition to decarbonization energy source may learn from China and Germany’s development model to avoid and mitigate the unintended consequences. However, perhaps in the future other countries may be forced to follow their footsteps to cope with the extreme weather patterns and climate change as a matter of survival. Therefore, turning the decarbonization of their energy source the ultimate goal for development [37-50].

5. Conclusions

This analysis primarily focuses on wind, solar, and advanced hydro technologies. Geothermal heat pumps are also discussed under efficiency. These technologies are the fundamental and nearest term options for renewable energy. While there is potential for some sustainable biomass and other forms of geothermal energy, we have not focused on them here, because they are more problematic and not necessary to make the case for renewable energy. In the future, wave and tidal energy technologies are very likely to also be developed. At present, however, these technologies are still in the research and development phase, and only beginning commercialization. Impacts on aquatic ecosystems are also not well understood.

Renewable energy sources derive their energy from existing flows of energy from ongoing natural processes, such as sunshine, wind, flowing water, biological processes, and geothermal heat flows. A general definition of renewable energy sources is that renewable energy is captured from an energy resource that is replaced rapidly by a natural process such as power generated from the sun. Currently, the most promising alternative energy sources include wind power, solar power, and hydroelectric power. Other renewable sources include geothermal and ocean energies, as well as biomass and ethanol as renewable fuels.

With a rapidly growing economy Turkey has become one of the fastest growing energy markets in the world. Turkey has been experiencing rapid demand growth in all segments of the energy sector for decades. Recent forecasts indicate that the growth trend of 6-8 % per year will prevail in the energy sector in the following years. The primary energy consumption, which reached around 126 million tons of oil equivalent (toe) in 2010 will rise to 146 million toe in 2017 and 222 million toe in 2020. The limits of Turkey's domestic energy sources in light of its growing energy demand have resulted in dependency on energy imports, primarily of oil and gas. At present, around 30 % of the total energy demand is being met by domestic resources, while the rest is being satisfied from a diversified portfolio of imports.

Turkey has the challenge to decrease its energy dependency, fulfill the huge growth in the energy demand but at the same time reduce the GHG emissions as mentioned in the Paris Agreement. The current plans for generation are mainly based on the addition of coal and gas power plants and would lead as we can see in the baseline scenarios to a huge increase in the GHG emissions as well as the imports of crude oil and coal. A shift toward renewable energy technologies is expected with the GHG mitigation scenario. This scenario is quite ambitious in term of added capacity but the investment costs are actually lower than the nuclear scenario. The addition of capacity stops after 2023 since the government plan is only for the period 2013-2023 explain why this scenario has higher GHG emissions than the nuclear scenario but the government should keep on the same pace for additional renewables for the period 2023–2040 since the plans are currently not enough.

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