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Energy Efficiency as an Inexhaustible Energy Resource in Turkey

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Abstract
We are familiar with fossil fuels as the primary energy resource, but the time has come to firmly establish energy efficiency as an important resource to be considered in future energy investment decisions. Energy efficiency is already being touted as the '6th Fuel' after coal, oil, natural gas, nuclear energy, and renewable energy. Because the cost of electricity from energy efficiency is often between 1-3 cents/kWh, it is also the least expensive source. Energy efficiency is also labor-intensive and locally produced, and substituting pollutants, it has a large positive environmental impact. Energy efficiency's effects and significance are widely recognized in industrialized nations, but this is not yet the case in developing nations. As an example; Turkey would require around 5 GW of additional installed capacity to meet this surplus demand if refrigerators throughout the country used power at the rate they did in the 1980s. This translates to 10 coal-fired power stations with a 500 MW nominal capacity on average. That means 10 coal-fired power plants with an average nominal capacity of 500 MW and construction costs of around 10 billion dollars. Furthermore, the protective measures introduced in Turkey in the 1970s and 1980s were sufficient to meet most of the electricity needs of the growing economy. As outlined in the energy policy report Vision 2023, the country plans to cover at least 30% of the expected future load increase through energy efficiency. Developing countries should take these developments into account and make energy efficiency a top priority in their energy investment decisions to meet increasing demand.

Keywords: Energy efficiency, inexhaustible energy source, conservation.

1. Introduction

The global community today relies significantly on fossil fuels, which are nonrenewable and unfriendly to the environment, to supply its energy needs. Fossil fuels produced 68% of the world's power in 2012 and accounted for 80% of all energy use (26% coal, 33% oil, and 21% natural gas) [1,2]. Renewable sources were responsible for 13% of world energy consumption and 18% of electricity production [3,4].

The remaining 6% of total energy consumption and 14% of electricity were generated by nuclear power. The overall annual CO2 production climbed from 16 billion to 30 billion tons during the same time period, while the total global power generation increased from 9.1 trillion kWh in 1985 to 20.2 trillion kWh in 2012 [1,2]. The anticipated life of known reserves, however, is approximately 250 years for coal, 60 years for oil, and 80 years for natural gas, therefore this fossil fuel-based economy cannot be sustained [1-5].

Since the 1700s, fossil fuels have powered the growth of industry and the comforts of contemporary life, but this has not been without unfavorable side effects [6]. An examination of energy systems is incomplete if it does not take into account how the combustion of fossil fuels to produce thermal energy has an influence on the environment and the air we breathe [7].

Smog, acid rain, and climate change are all caused by pollutants released by the burning of fossil fuels. Environmental pollution has grown to such extreme proportions that it now poses a major risk to human health, wildlife, and plant life [8]. Numerous health issues, including as asthma and cancer, have been linked to air pollution. As a result, switching to non-fossil energy sources is a must, and recovering energy that is now being lost is the most valuable resource

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that can be used to fulfill the world's rising energy needs [3].

The first items that come to mind when discussing energy sources are coal, oil, and natural gas, as well as uranium mines that power nuclear power plants and renewable energy sources like the sun, wind, geothermal, and biomass [1]. However, the largest energy source we can easily access was just identified in 1973, following the end of the oil embargo. It is a virtual energy source. This resource is available everywhere, including in our homes, and many economic powerhouses, notably the United States, rely on it to supply half of their new energy needs [2].

This resource produces an equivalent quantity of energy to that produced by coal, oil, natural gas, nuclear power, and renewable energy sources [3,4]. Additionally, this resource doesn't take up any space, it doesn't run out, and it helps the environment rather than destroying it. Energy efficiency is the name of this resource [3-5].

This paper's main goal is to increase awareness of the fact that investing in energy efficiency offers the highest and fastest returns on investment and that doing so doesn't require a lot of money. Additionally, it cannot be left in the hands of private citizens or businesses. As the experience from the modern world indicates, a strong commitment by the governments and providing leadership is essential in raising public awareness and in initiating change toward energy-efficient technologies and practices.

Despite having abundant energy resources, Turkey imports 74% of the energy it uses, as illustrated in Tables 1 and 2 [11], despite being a developed nation. Due to its rapid economic expansion and the corresponding rise in energy demand, it is extremely dependent on imported energy, and this dependence is only growing [12]. Despite having abundant renewable energy resources, including hydroelectricity, only 9% of the energy it used in 2007 came from renewable sources. 97% of the natural gas, 93% of the oil, and 20% of the coal it used in 2007 were imported [10]. Turkey produced 198 billion kWh of electricity in total in 2008, with natural gas power plants accounting for 48% of that amount.

When compared to wind power, which made up only 0.4% of power generation in 2008, hydroelectricity's proportion has decreased from 40% in 1990 to 17% in 2008. The demand for energy in Turkey is anticipated to rise by nearly 6% annually on average during the following ten years, reaching 460 billion kWh in 2020. A rise in installed power capacity is also anticipated, from 41 700 MW in 2008 to around 88 000 MW in 2020.

The high level of reliance on imported energy poses a threat to energy security and has a negative impact on the trade deficit. Turkey has recently focused on energy efficiency and renewable energy, but the degree of activity is far from sufficient [9–12].

Table 1.Turkey’s energy balance (Mtoe)

Indicators	1995	2000	2005	2010	2013
Total primary energy production (TPEP)	26.48	25.86	24.76	32.23	31.95
Net imports	38.25	52.23	66.34	81.02	96.23
Exports	1.68	1.33	5.84	7.11	5.50
Total primary energy supply (TPES)	61.55	76.35	84.42	105.13	120.30
Total final consumption (TFC)	47.62	57.85	66.74	77.61	88.69

Mtoe: Million tons of oil equivalent

Table 2.Total final energy consumption (ktoe)

Products	1995	2000	2005	2010	2013
Coal and lignite	6 431	10 845	11 764	14 118	30 874
Petroleum	25 414	26 125	26 913	28 390	33 896
Natural gas	2 787	4 910	10 246	13 136	37 628
Hydropower	5 601	8 245	11.342	14 610	5 110
Geothermal	437	620	782	1 391	2 636
Solar and wind	144	262	282	304	1 445
Wood and waste	6 788	6 456	5 346	4 440	4 323
Total final consumption	47 602	57 463	66 675	76 389	115 912

ktoe: Kilo tons of oil equivalent

2. Energy intensity and efficiency

Earning money is important for a comfortable lifestyle, but it's also necessary to spend it carefully and reduce waste. In the same way, getting the most energy possible out of a resource is important but so is using it effectively and minimizing waste [6].

Energy efficiency is the practice of minimizing energy consumption while maintaining profitability, production quality, and living standards. Energy conservation is the outcome of energy efficiency, which is a term for the most efficient use of energy resources [6]. Efficiency and conservation are closely related, and the two phrases are frequently used in the same sentence. When it comes to energy conservation, actions are typically performed to limit energy use at the point of consumption, such as when lighting a home with electricity [7].

Energy efficiency, on the other hand, refers to the most effective and, thus, least wasteful use of energy at all phases, from production to end usage. Consequently, the word "energy efficiency" is more general and encompasses energy conservation. Energy efficiency is intimately related to the second law of thermodynamics since a second-law efficiency of 100% equates to no waste and serves as the maximum possible level of energy efficiency.

Although they appear to be different ideas, energy conservation and renewable energy are closely associated. It will go to waste and only contribute to global warming if wind energy is not captured by a wind turbine or solar energy incident at an area is not immediately collected by solar collectors or PV cells and converted into a usable form. Simply said, burning natural gas to produce energy that may be acquired from the sun or the wind constitutes the wasteful use of natural gas. As a result, one of the best ways to conserve energy is to use renewable energy more frequently [6].

The amount of energy required to produce a dollar's worth of gross domestic product (GDP) is known as energy intensity and is a frequent indicator of how energy-efficient a country's economy is. For instance, Turkey's energy intensity is twice as high as the OECD average [9]. In other words, Turkey consumes twice as much energy as the OECD nations do to generate a dollar's worth of goods and services [10]. Furthermore, in equivalent climatic conditions, Turkey uses more than twice as much energy for space heating per square foot than do the nations of the European Union. Although this high percentage of energy waste is concerning, it also highlights the tremendous prospects for energy efficiency: Turkey can reduce its energy consumption by half without reducing its standard of living by simply incorporating measures of energy efficiency in all aspects of life.

Turkey can meet its growing energy needs demanded by its growing economy until its GDP is doubled by implementing energy efficiency measures alone without tapping on any additional energy resources [9]. That is, the only kind of power plant Turkey needs to power its economic growth is the ‘conservation plant’ that has no chimneys and emits no pollutants instead of the usual coal, oil, or natural gas power plants that pollute the air, cause global climate change, and jeopardize energy security [10]. The most effective way to combat rising energy costs, greenhouse gas emissions, and foreign dependence on energy is to increase energy efficiency and thus to reduce energy intensity [9-14].

Energy-saving measures range widely, from insulation to lighting and appliances to electric motors with excellent energy efficiencies [6]. When compared to incandescent lamps, energy-efficient compact fluorescent lamps (CFL) use between one-third and one-fifth of the electricity. Furthermore, by simply swapping out the magnetic ballasts with their electronic counterparts, fluorescent tube fixtures that are often used in commercial, industrial, and public buildings can lower their energy consumption by up to 30% [7]. By increasing the power factor from 0.60 to 0.99, this replacement has the extra benefit of getting rid of the annoying buzzing sound, the flickering light, and the reactive power loss.

Due to their improved efficiency and thus lower rate of heat production, electronic ballasts work at lower and thus safer temperatures with a longer lifespan [8]. They are affordable, simple to install, and they fit into existing fixtures. By switching out older fluorescent bulbs for newer, more energy-efficient ones that produce the same amount of light, additional savings can be made [6–8].

The transportation industry was significantly impacted by energy efficiency initiatives as well. Due in part to modern technology including better engine design and controls, improved transmission, weight reduction, and greater aerodynamics, cars in the U.S. in 2001 used around 60% less gasoline per mile driven than they did in 1972 [6].

Utilizing cutting-edge lightweight materials and hybrid technology, automobile energy efficiency is rising. Since cars and light trucks make up more than 75% of the transportation sector's energy consumption in the United States, even a slight improvement in vehicle energy efficiency can have a significant effect on both human health and the environment [8]. In order to prevent the development of fuel-inefficient automobiles, governments continue to employ regulations and generous incentives to encourage the purchase of fuel-efficient vehicles [6–8].

3. The power of energy efficiency

Two examples from the United States clearly demonstrate the importance of energy efficiency. The first deals with domestic refrigerators, while the second deals with nuclear power plants [6].

3.1. Energy-efficient refrigerators

In the last 30 years, the energy efficiency of refrigerators and freezers has increased greatly, and all appliances follow the trend. In 1984, a typical refrigerator in the United States consumed 1700 kilowatt hours of energy per year. But thanks to improved control systems, more effective insulation, and upgraded engine and compressor systems, average annual electricity consumption has fallen by 75% to 450 kWh. That means that compared to 1984, an average refrigerator in the United States now uses only a quarter of the electricity, which means that it saves 1350 kWh of electricity annually [6]. There are 140 million refrigerators in the United States and the national average price for electricity is 10.4 cents [8]. Because of this, the energy efficiency of refrigerators alone saves 189 billion kilowatt-hours of electricity in the US per year, saving nearly $20 billion for US consumers instead of paying utility bills. The 192 billion kilowatt-hours of electricity saved offset the emission of 140 million tons of CO2, considering that in the US an average of 0.713 kg of CO2 is produced per kilowatt-hour of electricity. For this reason, saving energy is an important way to stop global warming [6-8].

To meet the additional power needs of US refrigerators at 1984 levels, about 30,000 MW of additional installed capacity would be needed. There are 30 nuclear power plants with an average rated output of 1000 MW or 60 coal-fired power plants with an average rated output of 500 MW [8]. If coal-fired power plants cost an average $2 million per megawatt-hour to build, the cost to build to meet the additional demand due to refrigerator inefficiency would be $60 billion. These power plants would cost $12 billion to run annually if fuel and other operating costs were $0.065 per kilowatt hour [6-8].

Therefore, the costs of implementing energy efficiency measures should be compared with the costs that are compensated. It is noticeable that the 30,000 MW also corresponds to Turkey's peak output. For this reason, we can claim that US refrigerators would now consume more electrical energy if their efficiency remained at 1984 levels [6].

3.2. Cancelled nuclear power projects in USA

The closure of nuclear power plant projects in the United States is another area where conservation efforts have had a significant impact. At the end of 2012, 438 nuclear power plants with a total nominal capacity of 376,000 MW consumed 14% of the total electricity worldwide, with 104 of them with a nominal capacity of 100,000 MW operating in the United States, supplying 18% of the electricity consumed there [2].

Before the US discovered conservation, they planned

to fuel economic growth primarily with nuclear power, and began building numerous nuclear power plants in the 1970s. But something unexpected happened: the conservation measures were sufficient to meet the energy needs of the growing economy [6]. As a result, 98 nuclear power plants with a total capacity of 109,000 MW were shut down in various construction phases [8]. About 90% of these shutdowns took place between 1974 and 2000, and no new nuclear power plants have been built in the country since 1979. This demonstrates the effectiveness of conservation measures and teaches that energy efficiency should be a top priority when planning energy projects [6, 8].

3.3. Impact of energy efficiency in the U.S.

The best way to minimize the use of a natural resource is to conserve it rather than use it. However, this should be done without impairing the quality of life. In the US, this approach was followed in the 1970s after the oil embargo, and conservation became a high priority [6,8]. The results were impressive: total energy consumption remained unchanged from 1975 to 1985 with sustained economic growth. That is, conservation provides the energy needed for economic growth. While the US economy grew 126% between 1973 and 2000, total energy consumption increased 30% - about a fifth of economic growth. Furthermore, industrial production increased by 41% from 1990 to 2000, while the consumption of industrial equipment increased by only 11% [6].

The US would have used 70% more energy in 2000 had it not turned to energy conservation and continued its energy use at 1970 energy intensity levels. As a result, the US would spend about $2 billion more per day on energy. The US now pays about $600 billion less a year for energy than it did before, and this is a result of conservation efforts eagerly begun in the 1980s. As such, previous investments in energy efficiency have delivered significant benefits while delivering both economic stimulus and environmental and hence health benefits. Energy efficiency, a domestic, environmentally friendly and inexhaustible resource, is the largest energy resource following the example of the United States [6].

4. Impact of basic energy efficiency measures

4.1. Insulation: the first step in energy efficiency

As a rule, energy saving begins with insulation. For decades, insulation has been an essential part of energy saving projects and a significant role in the sustainable economy.

The cumulative insulation products used in US buildings save consumers about 42% of the energy that would have been consumed without insulation. In addition, insulation contributes to the environment and human health. Installing insulation in buildings in the United States prevents more than 780 million tons of carbon dioxide emissions each year. Simply improving insulation, along with an improved quality of life, could save $5.9 billion annually in health and economic costs from air pollution in the United States [6-9]. A 2001 report found that current levels of insulation in residential, commercial and industrial buildings would save 96 billion barrels of oil, saving $177 billion and eliminating 366 million tons of carbon emissions [8] . Also, between 1985 and 2000, the energy consumption of US government buildings per unit of floor space was reduced by 20%.

The costs of the energy saved are often amortized within a few months. For example, during an energy audit of a manufacturing facility, an outside surface temperature of a furnace was found to be 90°C and calculations showed that heat losses cost $6400 per year. Insulating the exterior surfaces with 5 cm thick insulation was recommended, reducing heat loss costs to $1600 per year [9]. That means a one-time investment of $1300 has resulted in energy savings of $4700 per year and the insulation has paid for itself in three months. Looking at energy efficiency as a resource, it seems like one manufacturer leverages it by paying a one-time fee of $1300 and ripping off annual benefits of $4700, while another manufacturer uses the natural gas pipeline and pays $6400 each year. This gives the first producer a competitive edge while improving profitability. This type of energy efficiency measures also has positive effects on the environment [6-10].

In contrast, more than 80% of buildings in Turkey have little or no insulation; If these buildings are properly insulated to minimize heat loss, savings are estimated at $7 billion per year [9]. That means $7 billion stays in consumers' pockets when buildings are properly insulated, instead of emitting smoke and pollution through chimneys [10]. Everyone involved needs to be educated to make this a reality. Trade associations, engineering societies and even universities must take an active part in this issue, although government guidance and the incorporation of financial incentives are crucial [11].

The new building code, which came into force in 2009, ensures that the new buildings are properly insulated. However, there is still a need to develop the necessary mechanisms to bring the existing building stock into compliance. These actions will also support

the country to meet its greenhouse gas emissions and energy security targets [9-12].

4.2. Energy-efficient lighting

In 2014, 40 billion kilowatt hours were used for lighting in Turkey. Although there are large differences between manufacturers and wattage, incandescent bulbs produce less than 18 lm/W and use less than 6% of the energy. They consume energy and produce light. In addition, they have a short service life of approximately 1000 hours. These limits can be doubled for halogen lamps. As lightbulbs made in Turkey in 2012 need to be 25% more efficient compared to those made in 2006, these figures are likely to increase. Incandescent lamps are also being gradually phased out or banned in many other countries [12].

Fluorescent lamps generate up to 105 lm per watt with a service life of around 10,000 hours and have an electrical-to-light conversion efficiency of up to 35%. High-intensity discharge lamps are just as powerful as fluorescent lamps. Low-pressure sodium vapor lamps generate up to 200 lm per watt, but are only of limited use due to their unmistakable yellow tone and the associated poor color rendering index. LED bulbs are seen as the future of lighting as solid state technology has improved in recent years.

LEDs can produce 400 lm per watt of white light. The goal of the Turkish government for 2030 is to achieve an efficiency of 220 lm per watt, which corresponds to a conversion efficiency of 50% electrical energy into light, and to reduce the energy consumption for lighting by half. This saving is equivalent to shutting down 52 of the 104 nuclear power plants in the US, or avoiding the construction of as many new nuclear power plants. In addition, this will reduce greenhouse gas emissions associated with electricity generation by 11% and save consumers $30 billion annually [6-8].

4.3. Energy efficiency in electric motors

Electric motors consume about half of the electricity produced in Turkey and two-thirds of the electricity consumed in industry. This shows how important it is to use high-efficiency motors in industry to reduce energy costs. The total cost of acquiring a typical new engine is less than 2% of the total cost [7]. Motor life can account for 98% of its total cost. This means that the energy consumed by a typical motor over its average 20-year lifespan costs more than 50 times its original price. In other words, the energy costs consumed by a normal electric motor in a few months can be equal to the purchase price of the motor. On average, a motor consumes its purchase price within two months. The total energy cost of a $5000 engine over its lifetime can exceed $1 million [6-10].

Many production managers are unaware of the seriousness of the problem. Because of the price difference, they often prefer standard efficiency motors over high efficiency motors, but later pay much more for energy [6]. They also lower the cost of new engines by redoing the burned out engines. Even so, rewinding reduces the motor's efficiency even further, and with rising energy costs, the money saved from repairing an old motor is quickly gone. On the other hand, a new, high-efficiency motor purchased to replace an old motor will reduce costs in a short period of time and continue to save energy and money throughout its lifetime [6].

A 20 HP motor has an efficiency of about 90%. High-efficiency motors achieve 92% efficiency with the same nominal power, premium efficiency motors even 94%. Purchasing a premium efficiency 20hp motor with 94% efficiency and an average load factor of 76% running 6000 hours per year results in an annual energy saving of 4102 kilowatt hours. Premium efficiency is believed to prevent almost 3 tons of greenhouse gases into the atmosphere when CO2 emissions are 0.76 kg per kWh. Due to their higher reliability and maintenance costs, high-efficiency motors also reduce operating costs [6-8].

Switching to high-efficiency motors can reduce energy consumption by around 4% [7]. But when the load is variable, like fans, pumps, compressors and conveyors, using motors with variable speed drives (VSD) can reduce energy consumption by 50% and sometimes even 70%. Significantly reducing energy costs can improve the competitiveness and profitability of industrial plants [6]. Annual energy and cost savings of 9 billion kilowatt-hours or about 1 billion US dollars can be achieved in Turkey by saving 25 percent on pump and fan systems. VSD savings can benefit municipal pumping stations, farm well water pumping systems and even homes that meet their water needs from their own wells. The cost of the VSD varies by engine. But in the first year, VSDs often pay for themselves from the cost of the energy saved [9-14].

4.4. Replacing old appliances by new energy-efficient ones

Household refrigerators consume about 7% of electricity in Turkey. In 2012, homeowners paid approximately $1.8 billion for the 13 billion kilowatt hours of electricity consumed by refrigerators [12]. Due to their energy efficiency, refrigerators are

classified in classes A11, A1, A, B, C, D and E. These refrigerators consume 274, 383, 507, 639, 832, 916, and 1149 kWh per year. In other words, a class E refrigerator consumes almost three times as much electricity as a class A1 refrigerator and twice as much as a class A refrigerator. Therefore, an important part of the country's energy efficiency initiatives is providing incentives for consumers and manufacturers to purchase refrigerators and other high energy efficiency home appliances [9, 12].

Consumers in Turkey can save between 100 and 300 US dollars when buying a refrigerator depending on the energy efficiency. Manufacturers of high energy efficiency models are also offered incentives to partially offset the costs associated with designing and manufacturing energy-efficient appliances. In the EU, energy-efficient refrigerators are supported for up to 200 euros [9-12].

Turkey does not currently have a program for high-efficiency appliances, but plans to do so to encourage customers to replace their old fridges with new ones with a minimum efficiency rating of A. A $200 incentive seems to be enough to get people to replace their old refrigerators with new ones, especially considering the experience and price difference between the different models. In Turkey, there are about 4 million refrigerators older than 10 years, based on the number of households and refrigerator sales in the last ten years, and the market penetration of refrigerators is 100% [10]. Their energy efficiency is equivalent to Class D refrigerators. Replacing these old refrigerators with Class A refrigerators will cost $800 million. However, the new energy-efficient refrigerators will save about 1.6 billion kilowatt-hours of electricity annually, at a cost of about $200 million.

In addition, the need to build a new power plant with a nominal capacity of 430 MW will be eliminated, the construction cost of which will be approximately $550 million in the case of a natural gas power plant. This means that the estimated $800 million in incentive costs are mostly spent on building new power plants when not used as incentives. In addition, the energy-saving expenses are reimbursed within four years [9]. When the environmental benefits are quantified, incentives for consumers to buy more efficient appliances become even more attractive [10, 11].

Table 3.Turkey energy efficiency in 2012

Primary intensity (EU=1000)	95
CO_2 intensity (EU=100)	110
CO_2 emissions per capita (in CO_2/cap)	3.4
Efficiency of thermal power plants (%)	44
Rate of electricity T&D losses (%)	17
CO_2 emissions per kWh generated (in gCO_2/kWh)	446
Energy intensity (EU=100)	84
Share of industrial CHP in industrial consumption (%)	7
Unitconsumption of steel (in toe/t)	0.17

5. A sample action plan for energy efficiency: Turkey vision 2023

Since 1990, the intensity of energy in Turkey has hardly changed. Energy consumption per unit of GDP was 0.195 in 1995 and fell to 0.184 in 2012, although there were some lower values. This is the result of the country's rapid GDP growth, while energy consumption, although to a lesser extent, also increased. In the period from 1995 to 2012, energy consumption per capita gradually increased from

1,030 koe to 1,563 koe. Turkey's energy intensity is 0.18 koe per unit of GDP, which is below the world average of 0.24 but above the OECD average of 0.14 and the EU Member State average of 0.11 [9-12].

Energy savings in the power sector can be achieved by constructing and commissioning large and small capacity power plants, decommissioning obsolete equipment and replacing it with new high-efficiency equipment, constructing and commissioning new substations and power transmission lines. Turkey has taken various measures to achieve this [9]:

- *Cogeneration/Trigeneration technology:*
  - As part of the regulation on unlicensed electricity generation in the electricity market, there are approval exemption rights for Cogeneration systems with an overall cycle efficiency of over 80%.
  - In line with the renewable energy feed-in tariff scheme, the regulation also obliges electricity distribution companies to purchase the electricity produced by micro-cogeneration units at a certain price.
  - As a result, combined heat and power technologies in three shopping malls, six hospitals, three airports, seven hotels and one university have reduced CO2 emissions by 54,375 tons per year.
- *Rehabilitation of Public Plants:*
  - In order to make energy production more efficient, the efficiency values of the public thermal and hydroelectric power plants were evaluated.
  - EUAS began upgrades and retrofits in 2005 to increase efficiency and production capacity through new technologies and these are expected to be completed in 2016.
  - As of 2012, 787 projects incorporating these improvements have been completed, with 156 operating at four hydroelectric power plants and 16 thermal power plants.
  - The performance, reliability and lifespan of the assets will be improved by these remediation projects while ensuring compliance with environmental legislation.
  - The expected results include an increase in production of 13.9 TWh per year as well as improved generation processes, replacement of obsolete or inefficient equipment with new and efficient ones (e.g. expansion joints, boilers, motor drivers), etc.
- *Increased utilization of natural gas as auxiliary fuel in thermal power plants:*
  - In 2008, the Ambarli fuel oil plant, which had an installed capacity of 630 MW, started a fuel conversion project.
  - Two parts of the power plant with an installed capacity of 150 MW will be converted to natural gas.
  - In addition, two new machines of 270 MW each, which also include waste heat boilers, will be introduced.
  - Fuel oil continues to be used in three blocks of 110 MW. It is planned to increase the installed capacity of the machine to 1,170 MW
- *Privatization of the Electricity Distribution Activities:*
  - In Turkey, there are 21 different regions that comprise the distribution network.
  - The privatization of power distribution activities aims to increase operational efficiencies while reducing the high rates of theft and loss in the distribution network.
  - To this end, target loss ratios have been set for each of the 21 distribution companies, along with a penalty and reward system based on company performance.
- *Other activities:*
  - Thermal imaging cameras for instant fault detection, workforce optimization tools, smart meters, power quality monitoring systems, and communication and control systems (e.g. SCADA and GIS) are other activities already implemented or planned in the transmission and distribution areas. Some smart grid applications are used in Turkey.

Under Turkey's 10th Development Plan, the Energy Efficiency Improvement Program intends to generalize energy recovery, cogeneration and micro-cogeneration systems in power generation. This plan has two main objectives [9]:

- Develop projects to use the waste heat from coal-fired thermal power plants for heating and agricultural activities in the region.
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- Generalize waste heat power generation in industry, create a market for the sale of waste heat energy, and encourage the establishment of cogeneration and micro-cogeneration plants. Pilot projects to recover waste heat from TPPs are currently underway. These projects provide hot water and heating for homes or greenhouses.

According to the RE Strategy Paper (2012-2023), the average cycle efficiency of coal-fired thermal power plants, including waste heat recovery, is to be increased to more than 45% by 2023. In addition, by 2023, the electrical energy intensity is to fall by at least 20% below the current level. In order to increase energy efficiency, especially in relation to electricity generation, research and development and implementation projects are carried out [9-14].

6. Conclusions

Past experience and the above arguments make countries like Turkey, which have not played an active role in energy efficiency due to a lack of resources, reconsider their position. Their energy policies should focus on energy efficiency and take serious measures to achieve it. Instead of building new power plants and developing new energy sources, Turkey plans to meet at least half of its growing energy demand through efficiency measures. Energy efficiency measures are a way for Turkey to alleviate the burdens caused by the economic crisis. In countries like Turkey that waste a lot of energy, such measures should work better because energy efficiency measures can save a lot of energy. Therefore, energy efficiency should be a high priority in government policies and serious measures should be taken. This will also help stop the economic slowdown and get the economy moving again [13, 14].

The recognition of energy efficiency as an important energy resource is the first step in this project. In this way, it is appropriate to take additional measures to increase energy efficiency. Well-planned campaigns must raise public awareness, and the public should be made aware of the possibilities.

Low-interest loans with a long payback period and cost-sharing are required for significant energy efficiency projects. Also, most energy efficiency activities should be managed locally, with sufficient incentives built into programs, and local utilities and communities should play a leading role.

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