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CONCEPTUALIZING ENERGY EFFICIENCY WITHIN THE SCOPE OF ENERGY SECURITY AND ENERGY SUSTAINABILITY

Enerji Verimliliğinin Enerji Güvenliği ve Enerji Sürdürülebilirliği Odağında Kavramsallaştırılması

Gelengül KOÇASLAN

Prof. Dr.

İstanbul Üniversitesi

İktisat Fakültesi, İktisat Bölümü

ORCID ID: 0000-0002-4902-2054

kocaslan@istanbul.edu.tr

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Abstract: As energy is essential to life utilizing energy resources efficiently has been at the top of the agendas of the governments and energy efficiency has been among the major components of energy policies so far. However it is not that easy to achieve energy efficiency as it is inherently related to the other components of sustainability. Sustainability plays a key role in development goals of the countries and refers to sustainable economic, social, environmental, political and security policies. It is critical to promote sustainability showing regard to each of them without any conflict. In addition to being related to each other energy efficiency, energy security and energy sustainability play a significant role within the energy policies of the countries all over the world. It is not possible to mention energy sustainability without referring to energy security and energy efficiency. This research presents a comprehensive understanding of energy efficiency focusing on energy sustainability and energy security. It is aimed to better understand energy efficiency within the scope of energy sustainability and energy security.

Keywords: Energy Efficiency, Energy Security, Energy Sustainability, Energy Policy.

Öz: Enerji hayati öneme sahip olduğu için enerji kaynaklarından verimli şekilde faydalanmak hükümetlerin gündemlerinin ilk sırasındadır ve enerji verimliliği şimdiye kadar enerji politikalarının başlıca bileşenleri arasında yer almıştır. Yine de özü itibariyle sürdürülebilirliğin diğer bileşenleri ile ilişkili olduğu için enerji verimliliğini başarmak o kadar da kolay olmamaktadır. Sürdürülebilirlik ülkelerin gelişme hedeflerinde anahtar rol oynar ve sürdürülebilir iktisadi, sosyal, çevresel, siyasal ve güvenlik politikalarına işaret eder. Sürdürülebilirliği herbirini gözönünde bulundurarak ve aralarında bir çatışma olmaksızın sağlamak son derece önemlidir. Enerji verimliliği, enerji güvenliği ve enerji sürdürülebilirliği birbirleriyle yakın ilişkili olmalarının yanısıra; tüm dünyada ülkelerin enerji politikaları içerisinde önemli role sahiptirler. Enerji güvenliği ve enerji verimliliğine atıfta bulunmadan enerji sürdürülebilirliğinden söz etmek mümkün değildir. Bu araştırma enerji sürdürülebilirliği ve enerji güvenliğine odaklanarak enerji verimliliğinin kapsamlı bir anlatımını sunmaktadır. Enerji sürdürülebilirliği ve enerji güvenliği odağında enerji verimliliğini daha iyi anlamak amaçlanmaktadır.

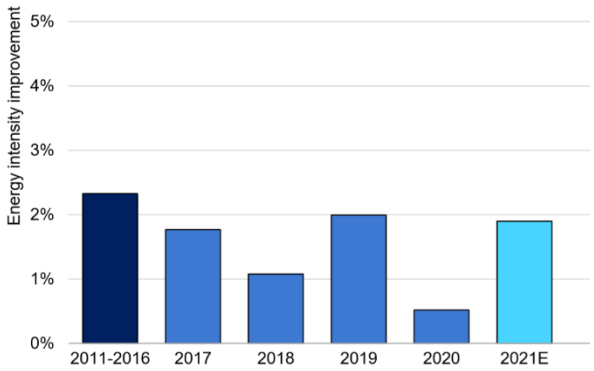
Anahtar Kelimeler : Enerji Verimliliği, Enerji Güvenliği, Enerji Sürdürülebilirliği, Enerji Politikası.

INTRODUCTION

Utilizing energy productively without wasting it; energy efficiency means using less energy for the same production. Energy efficient production of a certain good or service means providing it with reduced amounts of energy. Efficient use of energy improves performance, lowers energy demand and thus reduces economic, social, environmental and political risks. Energy efficiency is stated to reduce peak demand leading to a decrease in the investments of new generation, transmission and distribution systems called as "avoided capacity costs" related to peak demand savings defined as average energy savings during a system's peak period (Stern and Spencer, 2017; Couder, 2015).

Energy efficiency, energy intensity, energy productivity and energy saving are relevant concepts. Defining energy intensity as the energy quantity required for per unit of activity and output it is concluded that less energy use refers to low energy intensity (Koçaslan, 2020a). Global energy intensity is expected to decrease by 1.9% in 2021(IEA, 2021a). Figure 1 shows primary energy intensity improvement between the years 2011 and 2021.

Figure 1 : Primary energy intensity improvement, 2011-2021



Source: IEA, 2021a:20

Being suggested as the inverse of energy intensity and defined as the ratio of annual GDP to annual total primary energy use; energy productivity is associated with energy use, economic output, quality of life, living standards, economic well-being and GDP growth (Keyser et al. , 2015). It is possible to consider saving energy as an energy resource on its own as additional energy quantity is obtained by saving (Koçaslan, 2006). In other words energy efficiency improvements result in energy productivity and energy saving. Energy efficiency, energy saving and energy productivity are the concepts to be noted referring to 'energy trilemma' (World Energy Council, 2013).

Energy efficiency policies are included in the sustainable development goals of the countries all over the world. However energy efficiency should include standards and these standards are required to include multifaceted perspectives. Recently energy policies are aimed to be harmonized with inovation to shape long-term competitiveness globally in order to achieve energy efficiency targets. Investing in energy markets has been attractive. Thus energy markets are highly competitive. This is why investing in energy efficiency technologies is critical. Providing both microeconomic and macroeconomic openings energy efficiency is related to the concepts which are of particular concern to all the countries in the world:

- economic and political perspectives

.monetary stability within energy consumption/production/trade

.growth

.employment

.tax incentives/exemptions and subsidies

.military perspectives

.energy security

.storage

.transmission

•environmental and social perspectives

.climate change

.carbon intensity

.emission targets

.renewable energy resources portfolio

.public service announcements

.TV commercials

.creating awareness

.changing habits

.energy education methods for schools, universities

•technologial perspectives

.construction

.infrastructure

.energy conservation in buildings

.cogeneration

All of these factors are closely related to each other. Thus governments aim to develop policies putting together all of them. Being a common component of economic, social, political and environmental perspectives energy efficiency bolsters sustainability. This study explains energy efficiency within the scope of energy sustainability and energy security. The rest of the paper is organized as follows. Following the detailed introduction of energy efficiency, energy efficiency and energy sustainability are explained in part I. Part II examines energy efficiency and energy security. Final section concludes.

Energy Efficiency and Sustainability

Energy fuels the global economy and thus plays a key role in global political, social, environmental and security policies. To pursue sustainability and stability, energy efficiency has been under the spotlight. The world's energy demand has been increasing depending on economic and demographic growth. The global energy markets seem to be in danger of the limited reserves of oil, natural gas and coal which are known as fossil fuels. Moreover the problem is not only limited reserves but also their geographical locations. Because these locations are politically volatile; countries need to have alternative plans, strategies and programs to be put into action in case of unexpected shocks, crises, wars, terrorist attacks,

outbreaks, epidemics or pandemics to ensure sustainability. Energy efficiency contributes to energy sustainability within two major topics:

- environmental sustainability

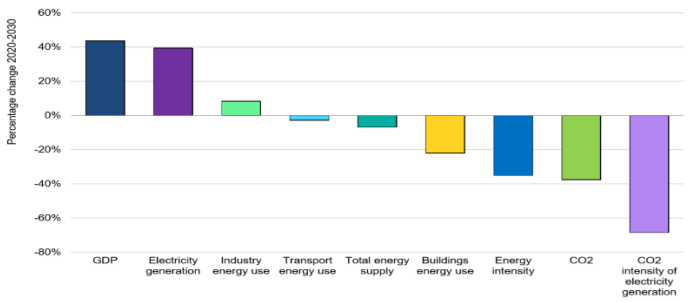
.reducing CO_2 emissions

- economic sustainability

.reducing energy costs

The relationship between energy efficiency and energy sustainability has been harmonized with economic and environmental sustainability. Figure 2 shows macroeconomic and energy indicators referring to the percentage change between the years 2020 and 2030.

Figure 2 : Macroeconomic indicators in addition to energy indicators in the IEA Net Zero Emissions by 2050 scenario, 2020-2030



Source: IEA, 2021a:13.

Climate change remains as a threat to human well-being, health, biodiversity, global security and sustainable development goals. By 2030 the EU aims to achieve an energy efficiency target of 27% by (Climate Policy Info Hub, 2020; Republic of Turkey Ministry of Foreign Affairs Directorate for EU Affairs, 2020; European Commission, 2022a, 2022b, 2022c, 2022d, 2022e, 2022f, 2022g, 2022h, 2022i):

.establishing a set of measures by Energy Efficiency Directive,

.supporting cogeneration of heat and power, presenting the key initiatives for energy efficiency within European Green Deal,

.launching SFSB-the Smart Finance for Smart Buildings, Clean Energy for All Europeans,

.stating EPBD 2010-the Energy Performance of Buildings Directive and EED 2012-the Energy Efficiency Directive to mitigate greenhouse gas emissions within energy efficiency targets,

.proposing EU Heating and Cooling Strategy,

.allocating ESIF-European Structural and Investment Funds and EFSI-European Fund For Strategic Investment) within ELENA and PDA H2020 programmes, and

.monitoring risk by EEFIG-the Energy Efficiency Financial Institutions Group and DEEP-the De-Risking Energy Efficiency Platform.

European Green Deal considers building sector as a key initiative to drive energy efficiency as it is reported to be responsible for approximately 40% of the union's energy consumption and 36% of the CO_2 emissions(European Commission, 2022e). Construction sector has been monitored in order to achieve energy efficiency targets and zero-energy buildings. Thus minimizing heat loss is critical because of the impact of a building's energy demand for heating

(Mokrzecka, 2018). It is emphasized that shape and orientation can influence energy demand by 30-40% (Mokrzecka, 2018; Brophy and Lewis, 2011). A building's heating energy demand is related to architectural implementations referring to the micro-climate shape of the building (Lylykangas, 2009). Because there is a relationship between architectural design and energy consumption it is suggested that optimizing the architectural design of the buildings will serve for energy efficiency targets (Alanzi et al. 2009; Geletka and Sedlakova, 2012; Ourghi et al. 2007; Pessenlehner and Mahdavi, 2003). However further research is needed to assess different architectural concepts. There are several indicators referring to the relationship between shape and heat. Because the shape factor of a building is suggested as the ratio between its envelope area and its volume; higher values of the shape factor result in larger losses of heat(Danielski et al. , 2012). smaller values of building shape coefficient lead to less heat loss and energy consumption (Lin et al. 2014; Tianzhen, 2009). It is suggested that the energy performance of rectangular with plan proportions 2:5 is better than square and L-shaped plans, trapezoid performs the best and square is only slightly worse (Mokrzecka, 2018; Tuhus-Dubrow and Krarti, 2010). It is stated that the most compact orthogonal building would then be a cube and a hyper-compact building is not then preferred because it will increase electricity consumption preventing the use of daylight(Catalina et al. , 2011). The costs must be considered to find an optimal solution. Saving performances have been monitored within the context of device and system levels technologies (IEA, 2021a, p. 80):

- Device level technologies

.smart LED lighting/window and HVAC (heating, ventilation and air conditioning)/electric motors/ water heating/thermostats and HVAC

- System level technologies

.home energy management systems

- smart appliances

- automation monitoring/management

- feedback

.commercial building energy management systems

- smart appliances/zoning thermostats

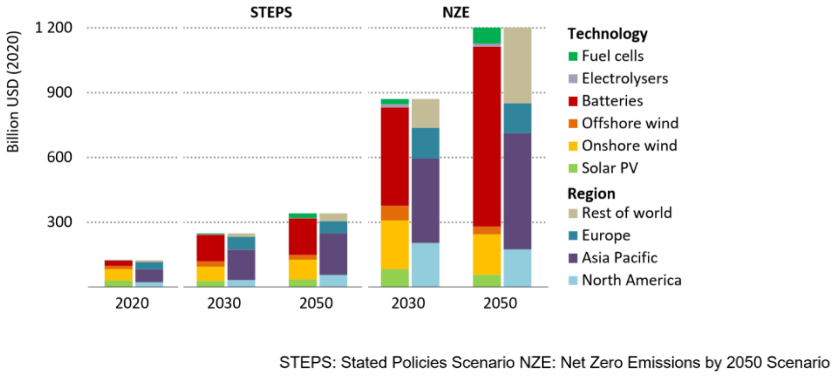
-automation monitoring/management

- feedback

-detecting/diagnosing fault

Energy sustainability initiatives deal with greenhouse gas emissions, ecological limits, climate change, environmental sustainability, enhancement of global living standards, human well being, social sustainability, economic development, business cycles, supply chains, source diversification and technological progress. Figure 3 presents estimated market size for clean energy technologies examining Europe, Asia Pacific, North America and rest of the World within the years 2020-2050.

Figure 3 : Estimated market size for clean energy technologies by technology and region, 2020-2050



STEPS: Stated Policies Scenario NZE: Net Zero Emissions by 2050 Scenario

Source: IEA, 2021b.

Energy security is a key concern at this junction in reference to energy sustainability.

Energy Efficiency and Energy Security

Energy efficiency has been essential for energy security enhancement. Effective use of existing energy resources or effectively utilizing existing energy resources promotes energy security. However energy security has been a complicated issue and needs to be discussed from multidimensional perspectives even to have a globally accepted definition (Koçaslan, 2020b; Azzuni and Breyer, 2018; Martišauskas et al. 2018; Laldjebaev et al. 2016; Kisel et al. 2016; Cox 2016; Krishnan, 2016; Sovacool, 2016; Blumer et al. 2015; Tziogas and Georgidas, 2015; Mansson et al, 2014; Gracceva and Zeniewski, 2014; Kanellakis, 2013; Augustis, 2012; Winzer, 2012; Hughes, 2012; Sovacool, 2011; Faas et al. 2011; Ciuta, 2010; Chester, 2010; Christie, 2009; Kruyt et al. 2009; Simpson, 2007). The components of energy security considering environmental, political, social, economic, national/international security concerns are listed below (Koçaslan, 2020b; Haar and Haar, 2019; Martišauskas et al. 2018; Azzuni and Breyer, 2018; Zhang et al. 2017; Krishnan, 2016; Cox, 2016; Laldjebaev et al. 2016; Kisel et al. 2016; Sovacool, 2016; Blumer et al. 2015; Koçaslan, 2014; Shih, 2014; Sovacool et al, 2014, Cherp and Jewell, 2014; Tippee, 2014; Ren and Sovacool, 2014; Sovacool, 2013; Hughes, 2012; Sovacool et al. 2012; Winzer, 2012; Faas et al. 2011; Bambawale and Sovacool, 2011; IEA, 2011, Winzer, 2011; Jewell, 2011; Sovacool et al. 2011; Chester, 2010; Jansen and Seebregts, 2010; Yueh, 2010; Valentine, 2011; Badea 2010; Le Coq and Paltseva, 2009; Kruyt et al. 2009; Jun et al. 2009; IEA, 2008; Asif and Muneer, 2007; APERC, 2007, Grubb et al. 2006; Dorian et al. , 2006; The European Commission, 2000; Yergin, 2006, 1988):

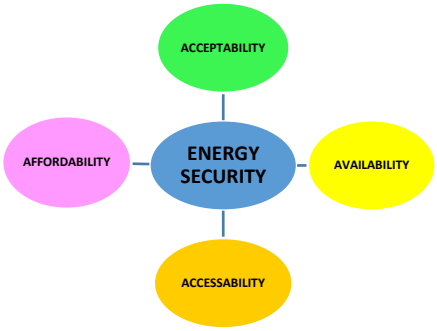
- uninterrupted availability
- affordable price
- timely investments
- supplying energy in accordance with sustainable economic development and environmental policies
- the capability to respond rapidly in case of shortages/disruptions
- resource availability for the long term
- reliable, stable and sustainable supply of energy
- acceptable social cost

•diversification of energy resources

•taking account renewable energy resources

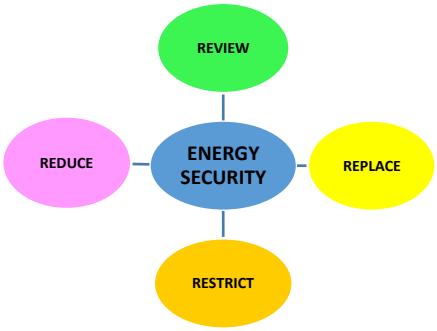
Acceptability, accessibility, affordability and availability are known as the 4As of energy security.

Figure 4. 4As of energy security



In addition to 4As; review, reduce, replace and restrict are presented as 4Rs of energy security (Hughes, 2009):

Figure 5. 4Rs of energy security



Globalization brings about energy markets being more vulnerable to risks, economic crises, shocks, natural disasters, technical problems, political instabilities, wars and outbreaks. Energy efficiency is stated to contribute to energy security by reducing energy demand and fossil fuel import dependency and thus leads to macroeconomic benefits (IEA, 2019). The IEA requires to set stockholding for member countries to ensure oil supply security. Each country holds approximately 90 days of net oil imports as emergency oil stocks to be released to the market in case of an unexpected disruption in accordance with the Agreement on an International Energy Programme (I.E.P.). This release is considered to be a collective action. It is not possible to satisfy this requirement without energy efficiency regulations, technologies and applications. The IEA suggests reducing oil import, diversificating energy supply and developing alternative technologies as emergency measures in case of a shortage and reported three collective actions since the creation of the IEA in 1974 (IEA, 2022a):

-1991: the Gulf War

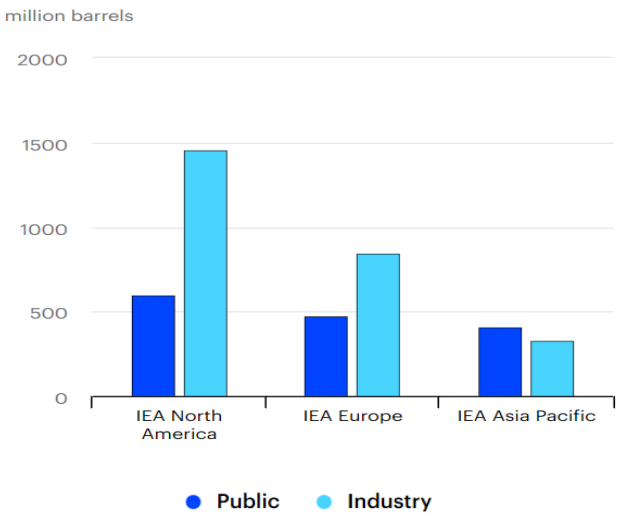
-2005: pipelines, oil refineries and offshore oil rigs in the Gulf of Mexico are damaged by Hurricanes Katrina and Rita

-2011: Libyan Civil War

Recently collective actions have become the main topic of the conversation once again as a consequence of the war in Ukraine. “IEA Member Countries agreed to make 60 million barrels

of their emergency oil stocks available to the market" (IEA, 2022b). Figure 6 shows IEA total oil stocks.

Figure 6 : IEA total oil stocks, end-December 2021



Source: IEA, 2022c.

Efficient energy use reduces energy demand which will reduce import dependence in turn. As a result energy efficiency will contribute to energy security ensuring sustainability as well. Although the significance of the components of energy security differs by being an exporter or an importer; energy efficiency is a permanent issue to be dealt with.

CONCLUSION

Covid-19 lockdowns and the war in Ukraine bring about the reconsideration of energy policies by governments. Although the share of renewable energy resources especially wind and solar PV technology and electric vehicle sales have been improved remarkably; energy markets have been going under a remarkable transition including technology and innovation for a long while. Economic, environmental, social, political and security perspectives are indispensable and critical components of this transition period. Energy efficiency has become a widely reviewed issue in these days because of its bilateral relationship with each of these components. There have been several legal regulations regarding to energy efficiency recently. By using existing energy resources effectively it is aimed to:

- reduce energy imports and thus;
  - .to reduce import dependency
  - .to ensure energy security
  - .to promote renewable energy resources
  - .to improve technology
- mitigate greenhouse gas emissions to combat climate change which has been a global threat and thus;
  - .to promote renewable energy resources
  - .to improve technology

.to develop new policies, regulations and laws

.to create awareness

All of these targets are the requirements for sustainable economic, environmental, social, political and security policies. The rising share of electricity within the world's final consumption has been promoting new investments, providing employment and leading to more competitive, fully integrated and qualified energy markets which contributes sustainability goals in turn.

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