Kadir Has University
Center for Energy and Sustainable Development

GSCESD-2024

6TH GRADUATE STUDENT CONFERENCE ON ENERGY AND SUSTAINABLE DEVELOPMENT

20 December 2024
KHAS Cibali Campus, İstanbul

PROGRAM & ABSTRACTS

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PROGRAM

9:00-9:20 Opening Session
Gözde Sevinç, *Organizing Committee Chairperson*
Asst. Prof. Dr. Burcu Ç. Yılmaz, *Scientific Committee Chairperson*

Session I Energy Security & Geopolitics
Moderators and Discussants: *Prof. Dr. Volkan Ş. Ediger & Asst. Prof. Dr. Burcu Ç. Yılmaz*

09:20–09:40 Integrating Global Governance and Energy Policies for Climate Change Mitigation
Lina Altawell, Marmara University, Türkiye

09:40–10:00 The Role of Electricity Capital in Energy Governance in the Case of Geothermal Investments in Turkey
Deniz Mine Öztürk, Kadir Has University, Türkiye

10:00–10:20 The International Political Power of the Natural Gas-Exporting Countries: Russian Case
Necla Serter, Kadir Has University, Türkiye

10:20–10:40 Analysis of Azerbaijan's Achievements Towards Its 2050 Zero Emissions Target
Huseyn Salahova, Kadir Has University, Türkiye

10:40-11:00 Coffee Break

Session II Green & Sustainable Energy
Moderators and Discussants: *Prof. Dr. Volkan Ş. Ediger & Asst. Prof. Dr. Burcu Ç. Yılmaz*

11:00–11:20 The Importance of Plastic Production in the Energy Transition
Gözde Sevinç, Kadir Has University, Türkiye

11:20–11:40 Net Zero Energy Building (NZEB): Emergence, Challenges, and Practical Applications
Oluremi S. Oyejide, Kadir Has University, Türkiye

11:40–12:00 Exploring the Impact of Hybrid Taxis on Fuel Consumption and Driver Profits: A Case Study of Istanbul and Amman
Muhammed Nadir Kemal, Kadir Has University, Türkiye

12:00–12:20 Innovative Applications of Solar Energy in Urban Environments: A Path Towards Development
Ibrahim Mourtaga, Kadir Has University, Türkiye

12:40–13:20 Lunch Break

Session III Energy Markets & Utilization
Moderators and Discussants: *Prof. Dr. Ahmet Yücekaya & Asst. Prof. Dr. Emre Çelebi*

13:20-13:40 Fact or Dream: Assessing the Alignment of Vodafone Türkiye with the Business Case of Global Net-Zero Targets by 2040
Yiğit Karataş, Kadir Has University, Türkiye

13:40-14:00 Financial Analysis of Energy Performance Contracts and Sample Projects in Light of Carbon Regulations
İdil Su Terzi, Sermin Onaygil, Istanbul Technical University, Türkiye

14:00-14:20 Our Common Yet Fragmented Future
Nezihe Melis Bostanoğlu, Kadir Has University, Türkiye

14:20-14:40 Coffee Break

Session IV Energy Technology and Innovations

Moderators and Discussants: *Assoc. Prof. Dr. Gökhan Kirkil & Asst. Prof. Dr. Zeynep Bektaş*

14:40–15:00 Contributions of Innovative Design Strategies for Plastic Recycling in Turkey
Çağlar Saatli, Kadir Has University, Türkiye

15:00-15:20 Prediction of Electrical Power Consumption by Using ARIMA Model
Ahmed Alhayek, Kadir Has University, Türkiye

15:20-15:40 Design and Simulation of a DC-to-DC New Topology with One Input: Solar Panel and Two Outputs
Amir Bagherana, Kadir Has University, Türkiye

15:40-16:00 Minimizing the Switching Losses of Electric Vehicles Onboard Charger via Triple Phase Shift Modulation Scheme
Saiqa Dilawaiza, Kadir Has University, Türkiye

16:00-16:20 Energy-Efficient Path Planning Strategies for Search and Rescue (SAR) Robots
Yousef Hani Hassan Khalil, Kadir Has University, Türkiye

16:20-16:40 Closing Remarks

Yiğit Karataş, Organizing Committee Chairperson

ABSTRACTS

C.E.S.D.
6thGraduate Student Conference on Energy and Sustainable Development
20 December 2024, Kadir Has University Cibali Campus, Istanbul

Integrating Global Governance and Energy Policies for Climate Change Mitigation

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A B S T R A C T

Global warming is one of the most significant problems of the 21st century, which requires collective international action. This study seeks to understand how international organizations regulate climate change by promoting transformative energy policies. This paper explores how INDCs drive transitions to sustainable energy forms by projecting targets and building partnerships with international entities like the United Nations Framework Convention on Climate Change (UNFCCC) and key agreements like the Paris Agreement (International Energy Agency, n.d.).

The research focuses on policy analysis, energy economics as well as environmental science to evaluate the efficiency of these frameworks. Outcomes indicate that, although agreements offer a strong letter, 'soft' framework, the implementation

depends on country-specific policy translations and intersectoral collaborations. Success stories present the successful experiences of the coordinated actions in launching initiatives and institution of policies to put into practice the use of renewable energies and carbon pricing systems as well as other promising practices that can instigate global transition in the energy sector.

Given this subject matter of climate change, energy policy, and global governance this study adds to the existing knowledge on goals of sustainable development (SDGs) and its management. Hence, the studies raise the relevance of crossing epistemological boundaries to develop integrated, socially just solutions for a just transition to a more sustainable energy system (International Energy Agency, n.d.)

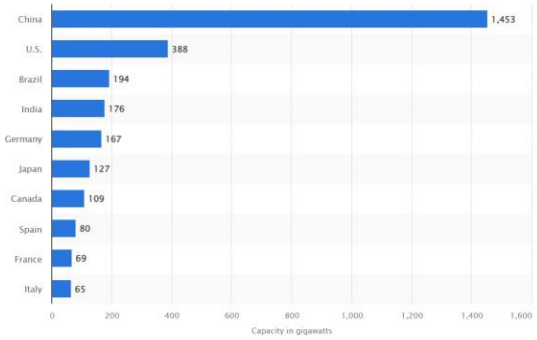

Figure 1. Leading countries in installed renewable energy capacity worldwide in 2023 (Ferna´ndez, 2024)

Keywords: Climate Change, Global Warming, International Politics, Sustainable Development Goals.

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C.E.S.D.
6thGraduate Student Conference on Energy and Sustainable Development
20 December 2024, Kadir Has University Cibali Campus, Istanbul

The Role of Electricity Capital in Energy Governance: A Case Study of Geothermal Investments in Turkey

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A B S T R A C T

As the planet's boundaries are transgressed, the international climate regime, focusing on climate change and fossil fuel carbon emissions, develops new regulations for sustainable development. The European Green Deal, created following the Paris Agreement, is the most recent and popular one. The aim is to achieve net zero emissions and increase renewable energy capacity by 2050). Therefore, there is a dramatic increase in various renewable energy technologies and investments. It is also argued that renewable resources such as solar and wind, which are relatively more evenly distributed worldwide than fossil fuels, could enhance cooperation by enabling regional integration through integrated networks (Högselius 2019; Singh 2022).

On the other hand, Leonard et al. (2022) emphasized that RE projects are prone to corruption, food insecurity, income inequality, land expropriation, habitat loss, technology, and transport dependency on other institutions and countries without structural changes. Therefore, the RE investments, realized with a fossil-based imagination intertwined with a capitalist relation based on profit-driven capital growth, lead to the transfer of this curse (Sachs and Warner 2001; Daggett 2021; Leonard et al. 2022). Additionally, many scholars have pointed out that 'energy,' green or not, (re)produces an asymmetric distribution of economic and political power (Boyer, 2014; McCarthy, 2015; Bridge et al., 2018, Newell, 2019). Moreover, the privatization of electricity services has resulted in the global commodification of electricity. This has been accompanied by the requirement of large-scale, profit-oriented investments and the creation of energy markets based on financial mechanisms (Newell and Phillips 2016; Eren 2018; Spivey 2020; van den Bold 2022; Luke and Huber 2022). This deepens existing inequalities at national and international levels, especially in the Global South.

Like other countries in the Global South, Turkey requires financial funds and credits from international financial institutions to invest in renewable energy. The country is rich in geothermal energy due to its geographic location and geological structure. The majority of geothermal resources (90%) are low- and medium-enthalpy geothermal areas that are appropriate for direct applications (heating, balneology, thermal tourism, industrial use, etc.), whereas only 10% are suitable for electricity production. However, electricity investments have increased dramatically relative to other resource applications over the past 15 years (MENR, 2022).

In this context, this study aims to find out why geothermal electricity investments are booming rather than other applications of geothermal energy since the 2010s in Turkey to help the

reader better understand the interrelationship of national and international power dynamics with electricity capital and states' energy policy in general. For this purpose, national and international geothermal investments have been traced, and different forms of geothermal utilization have been evaluated. Geothermal outlook reports, official documents of the Ministry of Energy and Natural Resources and the Mineral Research and Exploration Centre, and energy investment projections and plans in relevant institutions' development and strategic reports were analyzed. Then, these investments and their impacts are assessed from the perspective of political ecology and the concept of *"electricity capital*". Finally, this study argues that the dramatic increase in electricity investments instead of other geothermal energy applications results from the influence of "electricity capital" and *the global 'electrification trend'* and currently, it deepens existing socio-ecological and economic inequality in Turkey.

Keywords: Electricity Capital, Energy Governance, Energy Transition, Geothermal Energy, Turkey

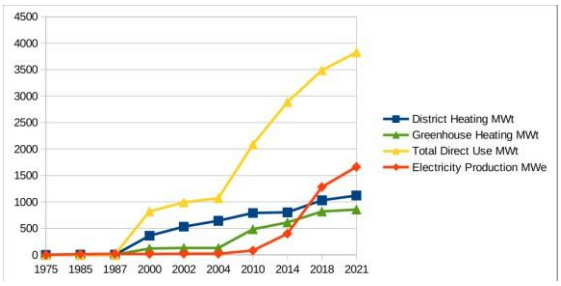

Figure 1. Geothermal energy production capacity in Turkey by years. Source: Öztürk,2023

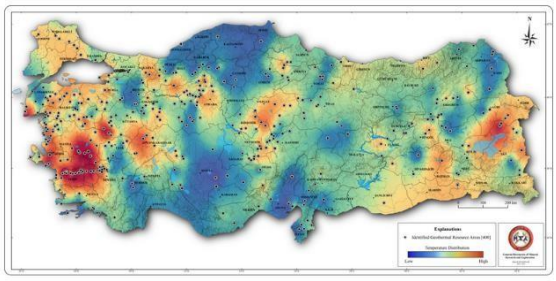

Figure 2. Identified Geothermal Resource Areas in Turkey. Source: MTA, 2024.

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The International Political Power of the Natural Gas-Exporting Countries: Russian Case

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A B S T R A C T

When it is compared to coal and oil, natural gas plays a role as a cleaner alternative to fossil fuels. Thus, the demand for gas is expected to rise at least until 2030 to meet the world's energy needs. Due to its importance in global trade, natural gas is crucial for the green transition and energy politics. Through the lenses of energy politics, this paper aims to analyze how being a gas exporter country affects the distribution of international political power. Since it is the second largest natural gas exporter country, Russia is the case study for this research. While looking at the relationship, there will be three dimensions to examine: First, the weaponization of gas for the benefit of the government.

Second, interdependency between gas central and other countries in the sector. These two relate to how energy can be used as a foreign policy tool. Finally, sanctions against the gas central country. This will be examined under the umbrella of pacifying effect.

LNG will not be included in the research. It is flexible in the free market and there is no need to construct networks like pipelines and make long-term agreements. Because of these characteristics of LNG, it does not fit the extent of international political power meant to be measured in this paper. Thus, throughout the paper, the focus will be just on pipelines.

Keywords: Energy Politics, Export, Natural Gas, Pipeline

Ranking	Country	quadrillion Btu
1	United States	37.662
2	Russia	23.437
3	Iran	9.818
4	China	7.995
5	Canada	6.98
6	Qatar	6.654
7	Australia	5.728
8	Norway	4.603
9	Saudi Arabia	4.506
10	Algeria	3.778

Figure 1. Total natural gas production 2022 Source: EIA

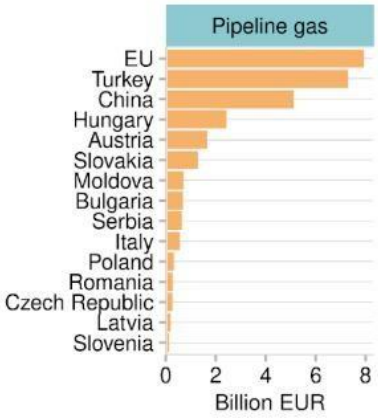

Figure 2. Countries that bought Russian pipeline gas after EU bans in December 2023. Source: CREA

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C.E.S.D.
Graduate Student Conference on Energy and Sustainable Development
17 November 2024, Kadir Has University Cibali Campus, Istanbul

Analysis of Azerbaijan's Achievements Towards Its 2050 Zero Emissions Target

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A B S T R A C T

The Paris Agreement, adopted by 196 parties in 2015, has bound different countries worldwide to halt the rise in the global average temperature [1]. The Paris Agreement's parties have been divided into Annex I and Non-Annex I parties [2]. The former includes developed countries, which must set quantified greenhouse gas reduction targets and provide financial, technological, and capacity-building support to Non-Annex I parties. On the other hand, the latter are mainly developing countries whose commitments to United Nations Framework Convention on Climate Change (UNFCCC) agreements are more flexible and eligible to get support from Annex I countries. One of the examples of Non-Annex I parties is Azerbaijan. Azerbaijan is a developing country on the west side of the Caspian Sea, well-known for its abundant oil sources. During the existence of the Soviet Union, Baku, the capital of Azerbaijan, was one of the most essential oil points of the country. Nowadays, Azerbaijan is an independent country whose dominating exports are oil and natural gas, which comprise 95% of total export revenues. Although the country is in the 63rd position out of 193 countries based on its overall score of total progress towards sustainable development goals (SDGs [3], such extremely high dependency on oil is one of the biggest challenges for Azerbaijan's path to zero emissions target and a severe threat to its sustainable energy development [4]. Additionally, Azerbaijan suffers from social imbalance, which is a factor that hinders sustainable development in the country since unequal access to resources and extreme differences in financial means hurt the leveling up of human potential, specifically among the middle class [5]. Nevertheless, Azerbaijan is taking steps to switch from fossil fuels to renewable energy sources. It has already set its target to increase the shares of investments in renewable energy up to 30% of the total energy balance by 2030 [6]. In this paper, I will look at the steps taken by the Azerbaijani government toward sustainable development, including its proposed policies for the sustainability of renewable energy sources and certain inadequate aspects of these policies [6].

Keywords: Azerbaijan, Emission, Energy, Policy, Sustainability.

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The Importance of Plastic Production in the Energy Transition

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A B S T R A C T

Petrochemical products, particularly plastics, are abundant, comprising 74% of total petrochemical production alongside fertilizers. (Center for Environmental Law [CIEL], 2022). Plastics, produced mainly from fossil fuels (99%), have become a critical driver of crude oil consumption, with the International Energy Agency projecting that petrochemicals will account for 44% of the growth in crude oil demand by 2040. According to the 2023 numbers, 'the petrochemicals caused a serious increase in oil demand (500 kb/d), almost double the average growth over the last 5 years (International Energy Agency [IEA], 2024).

This dependence underscores plastics' role as a significant contributor to greenhouse gas emissions, from production to disposal, exacerbating the climate crisis. If current trends persist, annual plastic production could reach 1.2 billion tonnes by 2060, consuming up to 31% of the remaining carbon budget to limit global warming to 1.5°C (Figure 1, Karali, Khanna, & Shah, n.d.). It is also evident, as shown in Figure 2, according to the estimations made by IEA by world oil demand assumptions, "total oil demand is nevertheless forecast to rise by 3.2 mb/d between 2023 and 2030, supported by increased use of jet fuel and feedstocks from the booming petrochemical sector." (IEA, 2024)

Despite global commitments under the Paris Agreement to achieve net-zero emissions by 2050, the role of the petrochemical sector, particularly plastics, needs to be addressed in energy transition strategies. This research examines the implications of continued plastics production on the fossil fuel phase-out and evaluates the feasibility of achieving net-zero targets under existing consumption patterns. It underscores the complexity of the issue and the need for systemic interventions, including reducing plastic production at its source and scaling refill and reuse systems to transform consumption habits.

This study addresses a critical gap in sustainable development discourse by investigating the intersection of plastics, petrochemicals, and energy transition policies. It emphasizes that achieving net zero will require comprehensively integrating the petrochemical industry into climate action plans, challenging current production paradigms. The potential impact of this research is significant, as it can guide policymakers and industry leaders in making informed decisions for a sustainable future.

Keywords: *Greenhouse Gas Emissions, Energy Transition, Petrochemicals, Plastic Production, Sustainability*

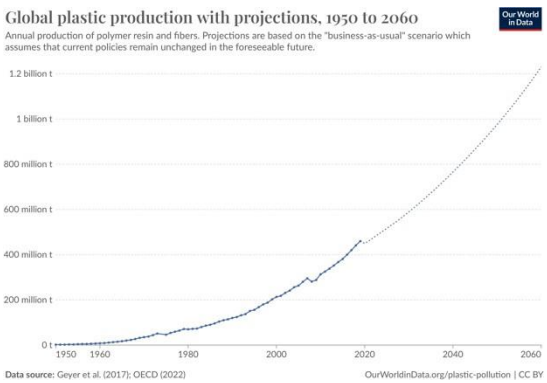

Figure 1. Global plastic production projections, 1950 to 2060. Source: Our World in Data

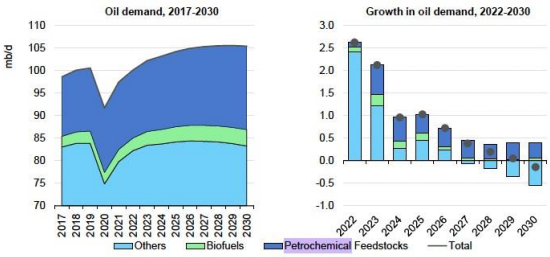

Figure 2. World oil demand forecast to plateau this decade. Source: IEA, Oil 2024

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Net Zero Energy Building (NZEB): Emergence, Challenges and Practical Applications

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A B S T R A C T

Net Zero Energy Buildings (NZEBs) balance the energy used with the energy produced on-site from renewable sources annually. With energy-efficient building materials, cutting-edge HVAC systems, high-performance insulation, and renewable energy sources like solar and wind, NZEBs seek to lessen the dependency on fossil fuels and their carbon footprints. This paper presents an overview of NZEBs, focusing on their evolution, current challenges, and a few success stories. The overview shows that adoption obstacles encompass exorbitant upfront expenses, legislative impediments, technology constraints, market impediments, and resistance to behavior. It also reveals that NZEB installations have been relatively effective in North America, Europe, and Australia. Recommendations were provided to promote the adoption/implementation of NZEBs, including strict energy performance standards, financial incentives, and streamlined regulatory procedures.

Summary

This work aims to investigate why Net Zero Energy Buildings (NZEBs) have not achieved widespread adoption despite their numerous environmental, climate, and other benefits (Fig. 1). To address this, the author examines the concept of NZEBs, their adoption process, and the current challenges they face. Key challenges include high upfront costs, behavioral obstacles, and technological barriers. To provide context and illustrate these challenges, the study evaluates and discusses case studies from regions like the US, Germany, and the UK, where NZEBs have been implemented.

Based on the study's findings, the following recommendations are proposed:

Enforce strict energy performance standards, provide financial incentives, and streamline regulatory procedures to encourage NZEB adoption.

Prioritize training courses, workshops, and seminars to educate stakeholders about the feasibility and advantages of NZEBs.

Increase investment in Research & Development to enhance NZEB technologies, reducing costs and improving performance. Lower costs will particularly benefit underdeveloped and developing countries.

Facilitate the creation and implementation of NZEB projects by fostering collaboration among public and private sectors and academic institutions.

Address behavioral barriers through targeted campaigns featuring demonstration projects, strategic marketing, educational initiatives, and clear communication. These efforts should raise

public awareness of NZEB benefits and highlight successful projects as case studies.

Keywords: Energy building, Net zero, Net energy, Sustainable energy, Zero Carbon

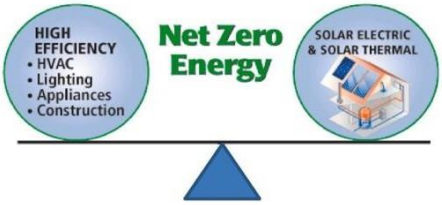

Figure 1. NZEB idea (Jaysawal et al., 2022)

Reference

Jaysawal, R.K., Chakraborty, S., Elangovan, D. & Padmanaban, S. (2022). Concept of net zero energy buildings (NZEB) - A literature review. *Cleaner Engineering and Technology 11,* 1005

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20 December 2024, Kadir Has University Cibali Campus, Istanbul

Exploring the Impact of Hybrid Taxis on Fuel Consumption and Driver Profits: A Case Study of Istanbul and Amman

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A B S T R A C T

This study investigates the potential impact of taxi adoption on fuel consumption and driver profits, focusing on a comparative case study between Istanbul and Amman. Hybrid taxis have become a significant part of Amman's taxi fleet, resulting in improved fuel efficiency and economic benefits for drivers. This paper aims to assess the feasibility of achieving similar outcomes in Istanbul. The research methodology includes data collection and analysis of fuel consumption and driver profit margins in both cities, enabling a comparative analysis of the two urban transportation systems. The study will explore hybrid taxis' environmental and economic implications, providing valuable insights for policymakers and stakeholders in urban transportation planning. This research aims to contribute to the broader discourse on sustainable urban mobility solutions by highlighting the potential benefits and challenges of implementing hybrid taxis in Istanbul.

Keywords: Efficiency, Energy, Fuel Consumption, Hybrid Electric Vehicles (HEVs), Transition

Figure 1. Electric Vehicles – Including HEVs - sold as a percentage of total vehicles sold in 2023

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Innovative Applications of Solar Energy in Urban Environments: A Path Towards Sustainable Development

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A B S T R A C T

The increasing global focus on sustainable energy solutions necessitates innovative approaches to harnessing renewable energy sources in urban environments. Solar energy has emerged as a cornerstone of sustainable urban development with its abundant availability and minimal environmental impact. This paper explores cutting-edge applications of solar energy technologies in densely populated cities, emphasizing photovoltaic (PV) integration in architectural designs, solar-powered urban mobility solutions, and community-scale solar projects (Fakour et al., 2023; Kobashi et al., 2021).

Particular attention is given to case studies demonstrating the feasibility and scalability of building-integrated photovoltaics (BIPVs), where solar panels are incorporated into rooftops, facades, and windows, transforming urban structures into energy generators. (Deroubaix et al., 2023; Hanergy, 2022) Additionally, the research examines the potential of solar-powered electric vehicle charging stations as a means of promoting clean transportation (Kobashi et al., 2021; Deroubaix et al., 2023).

The study also delves into the socio-economic impacts of these applications, highlighting their contribution to energy independence, urban resilience, and the reduction of greenhouse gas emissions. By addressing technical challenges such as energy storage and grid integration, the paper aims to present a holistic framework for adopting solar energy in urban settings, providing actionable insights for policymakers, researchers, and urban planners (International Energy Agency, 2021).

Through this research, the role of solar energy in advancing sustainable development goals is underscored, paving the way for greener, more sustainable cities (Sustainable Urbanism, 2023; Inflation Reduction Act, 2023).

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Fact or Dream: Assessing the Alignment of Vodafone Türkiye with the Business Case of Global Net-Zero Targets by 2040

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A B S T R A C T

This study evaluates Vodafone Türkiye's alignment with Vodafone Group's global commitment to achieving net-zero carbon emissions by 2040. Vodafone Group has set ambitious targets under its Climate Transition Plan, including a 90% reduction in absolute emissions and full value-chain net-zero status. As part of this commitment, Vodafone Türkiye has implemented several initiatives to reduce its environmental footprint, focusing on renewable energy, energy efficiency, and Scope 1, 2, and 3 emission reductions.

Vodafone Türkiye has made significant progress in its sustainability initiatives. The company has transitioned to 100% renewable electricity for its 12 data centers, 15 office buildings, and over 25,000 base stations, demonstrating leadership in renewable energy adoption in the telecommunications sector (Vodafone Group, 2020). Additionally, innovative projects like AI-powered Digital Thermal Management have enhanced energy efficiency in technology centers, achieving an annual savings of over 8 GWh and contributing to a 95% reduction in Scope 1 and 2 emissions compared to the 2020 baseline. These efforts are supplemented by initiatives targeting Scope 3 emissions, which include collaborations with suppliers to ensure adherence to sustainability goals.

This analysis highlights Vodafone Türkiye's proactive approach to sustainability and its alignment with the Vodafone Group's overarching strategy. However, challenges remain, particularly in addressing the complexities of Scope 3 emissions, which encompass upstream and downstream activities across the value chain. These include emissions from supplier operations, product use, and waste management. Furthermore, the study examines the broader implications of Vodafone Türkiye's environmental strategies within the context of Türkiye's regulatory and infrastructural framework, identifying areas where policy support and public-private cooperation could enhance progress toward the 2040 target.

In conclusion, Vodafone Türkiye exemplifies a solid commitment to environmental sustainability through measurable actions and innovative practices, positioning itself as a leader in the transition to net-zero in the Turkish telecommunications industry. This paper provides a detailed assessment of Vodafone Türkiye's current progress, challenges, and potential pathways for achieving the 2040 net-zero goal in alignment with global standards.

Keywords: Vodafone Türkiye, Net-Zero Carbon Emissions, Energy, Energy Efficiency, Scope 1 Emissions, Telecommunications, Sustainability, Carbon Reduction, Environmental Strategy,

Vodafone's Greenhouse gas (GHG) emissions and targets

	2020 baseline	2030 target	2040 Net Zero target
Scope 1 & 2 emissions	1.84 million t CO2e	100% reduction[1]	100% reduction
Scope 3 emissions	11.9 million tCO2e	50% reduction	100% reduction

Figure 1. Vodafone's Greenhouse gas (GHG) emissions and targets. 1. Includes a 5% reduction through carbon offsets. **Source**: Vodafone, Investor Relations Report, 2020

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Financial Analysis of Energy Performance Contracts and Sample Projects in Light of Carbon Regulations

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ABSTRACT

Energy efficiency and renewable energy projects are critical to sustainable development and environmental responsibility today. These projects are generally based on capital investments, and their payback periods are directly related to the energy savings provided by the projects. Energy Performance Contracts (EPC) are a standard model Energy Service Companies (ESCOs) use. It is also explained that EPCs are an essential indicator in the development of the energy service sector in a country. These contracts foresee the repayment of the investment with the income obtained from the energy costs saved to finance energy efficiency projects. EPC can be implemented with various financing instruments, including project financing, leasing, bank loans, capital investment, and government support. However, improvements are required in terms of financing sources and investor attractiveness to popularize energy efficiency projects. This study aims to conduct an economic analysis of the project-oriented EPC (Energy Performance Contract) model through a waste heat energy production and energy-efficient equipment replacement project.

Waste heat production is an important energy source frequently encountered in industrial facilities and is often overlooked. In industrial processes, especially in metal processing, chemistry, cement, and food processing, a large amount of heat is released as a by-product during the production process. This heat often remains idle and is released into the environment, causing energy loss. However, this waste heat can be converted into energy with appropriate technologies and systems. Waste heat recovery systems (e.g., heat exchangers and Organic Rankine Cycle) can reuse this energy to produce electricity or heat. This process increases energy efficiency, reduces energy costs, and minimizes environmental impacts.

The energy recovery from waste heat also helps reduce carbon emissions by decreasing fossil fuel consumption. Such projects increase the sustainability of industrial facilities by providing energy efficiency and offer the opportunity to meet energy needs using domestic resources. Furthermore, implementing these projects promotes the transition to environmentally friendly energy solutions and offers long-term economic benefits to businesses. Energy production from industrial waste heat delivers economic benefits and enhances environmental responsibility by investing in green technologies.

Energy-efficient equipment replacement significantly contributes to reducing operational costs and environmental impacts by increasing the energy efficiency of industrial facilities. Energy-efficient equipment designed with the eco-design approach reduces energy consumption and minimizes environmental impacts throughout the product life cycle. Such equipment enables more efficient production processes and operations with a low carbon

footprint due to its low energy consumption and sustainable material choices. Eco-design and energy efficiency play a critical role in enhancing the success of these projects while ensuring environmental sustainability.

The essential tools used in the financial evaluation of energy efficiency projects include financial indicators such as annual cost analysis, net present value (NPV), internal rate of return (IRR), and payback period. These indicators are used to evaluate the long-term economic benefits of the investment and to analyze the economic sustainability of the projects. In this study, the financial analysis of waste heat energy production and energy-efficient equipment replacement projects is conducted by comparing annual costs, and significant findings are reached regarding the economic feasibility of EPC. In addition, local and global environmental policies are also considered in the evaluations made on the financial sustainability of these projects. In particular, it examines how regulations such as the Carbon Border Adjustment Mechanism (CBAM) and the European Union Emission Trading System (EU ETS), which are expected to enter into force in 2026, could affect the financial model of the projects. Since these regulations may increase the costs associated with carbon emissions, they may further increase the interest in energy efficiency projects and are seen to reduce the payback period of the investment significantly. In this context, including carbon footprint reduction applications in the financial analyses of EPC projects has been an important parameter for investors and customers.

The financial model of the study is evaluated from two perspectives: investors and customers. Investors are individuals or institutions that finance the project and assume the financial risks. In this context, investors can be banks, investment companies, funds, ESCOs, or customers, each playing different roles. For investors, it is essential to consider payback periods, risk analyses, and cash flows in detail. For customers, in addition to the economic benefits of energy savings in the long term, environmental impacts and sustainability goals should also be taken into account. It is concluded that for EPC projects to be successfully implemented, investors should have easy access to financial resources, and the projects' risk management and financing conditions should be improved.

As a result, this study evaluates the economic and financial viability of EPC-based waste heat energy production and energy-efficient equipment replacement projects while revealing the effects of environmental policies and financial improvements on the projects' success. In addition, it is anticipated that these projects will play an important role, especially in the energy transition and transition to a low-carbon economy, and it will increase the applicability of energy efficiency and renewable energy projects on a broader scale in the future.

Keywords: Sustainability, Energy Performance Contracts (EPC), Energy Service Companies (ESCO), Carbon Border Adjustment Mechanism (CBAM), European Union Emission Trading System (EU ETS)

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Our Common Yet Fragmented Future: The Carbon Border Adjustment Mechanism of the EU

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A B S T R A C T

Scientific analyses indicate that climate change is rapidly intensifying and becoming more widespread worldwide. Global warming has already reached over 1.1 °C above the pre-industrial era, as the likelihood of global warming exceeding the Paris Agreement's 1.5°C target is increasing in the next five years, even if it would be a temporary breach.

As climate change knows no borders, global cooperation on environmental sustainability has been integral to the international agenda since the 1980s. However, several unilateral measures driven by national interests have also frequently challenged the global climate regime. Carbon pricing mechanisms are also sometimes perceived as unilateral measures and disputed by newly industrialized countries, with a notable example being the EU's Carbon Border Adjustment Mechanism (CBAM), recently introduced on certain emissions-intensive imported products.

This study explores the dual dynamics of climate action by examining the global cooperation on climate change and the disputes resulting from unilateral measures on climate and trade, with a particular emphasis on the EU CBAM. It first examines how global cooperation on climate change has shaped the current climate regime through the interplay of scientific works, evolving global and national policy frameworks, political engagements, and international negotiations and multilateral agreements. After that, it describes the process that has borne today's most ambitious and disputed climate measure, CBAM, and examines the resulting challenges and constraints.

The study has found that despite the urgency of collaborative global climate action, the fragmentation of international climate regimes Persists in implementing more ambitious climate policies. For instance, carbon pricing instruments are increasingly adopted as a measure to fight against climate change; however, CBAM has been met with differing perceptions by industrialized and newly industrialized countries. While the industrialized nations believe that the CBAM is a crucial climate policy to prevent carbon leakage, the newly industrialized countries voice their concerns on CBAM as it can result in trade barriers and contradict the "common but differentiated responsibilities" principle of the United Nations Framework Convention on Climate Change (UNFCCC).

The study further reveals that the global climate and trade measures that the global climate and trade measures are interlinked; therefore, a growing number of environment-related trade measures are likely to result in further disputes among the nations. Adherence to the World Trade Organization (WTO) rules and the common but differentiated responsibilities principles are critical when introducing new environmental measures to hinder such conflicts and strengthen

the multilateral climate regime. However, the study further reveals that the current multilateral climate and trade regimes do not have the necessary tools to address the disputes on environment-related measures such as CBAM. The study concludes that retaliatory measures and conflicts will likely increase and remain unsolved unless essential actions are taken to modernize the current climate and trade regimes.

Keywords: Carbon Pricing Mechanisms, Climate Change, Environment-Related Trade Measures, EU Carbon Border Adjustment Mechanism (CBAM), World Trade Organization (WTO)

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Contributions of Innovative Design Strategies for Plastic Recycling in Turkey

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A B S T R A C T

In Turkey, approximately 3.5 million tons of plastic waste are generated annually, with only 12.3% being fully recycled. In comparison, the European Union achieves an average plastic recycling rate of 49.6%. Increasing the recyclability rate of plastics is crucial for Turkey to meet its commitment under the Paris Agreement and its sustainable development goals, including a 21% reduction in greenhouse gas emissions by 2030. This study examines the contributions of innovative design strategies to plastic recycling processes and proposes solutions from an industrial design engineering perspective.

In Turkey, plastic recycling primarily involves PET (polyethylene terephthalate) at 35%, PP (polypropylene) at 25%, and PE (polyethylene) at 20%. PET is mechanically recycled into granules for reuse in bottles or textiles, while PP and PE are melted and reshaped. However, materials such as PS (polystyrene) and PVC (polyvinyl chloride) pose significant environmental and technical challenges in recycling. Specialized approaches can be developed within these dynamics to enhance plastic recycling rates through industrial design engineering.

From the perspective of industrial design engineering, approaches to improving plastic recycling can be categorized into three fundamental strategies:

1) Material Selection

To facilitate recycling, mono-materials with high recyclability should be prioritized. For instance, designing a shampoo bottle entirely from HDPE (high-density polyethylene) ensures full recyclability of the product.

1) Ease of Disassembly

End-of-life products must be easily disassembled. Connection methods and fasteners should enable separating parts from different materials to enhance recycling efficiency.

2) Life Cycle Assessment (LCA)

Integrating life cycle analysis into the design process minimizes environmental impact. For example, choosing PET over glass for beverage bottles can achieve a 40% lower carbon footprint.

By adopting these strategies, it is possible to increase Turkey's plastic recycling rate to 25% and reduce the carbon footprint of recycled plastics by up to 30%. This study highlights how industrial design engineering is pivotal in improving plastic recycling processes and achieving sustainable development goals.

Keywords: Carbon Footprint, Circular Economy, Industrial Design Engineering, Plastic Recycling.

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Prediction of Electrical Power Consumption by Using ARIMA Model

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A B S T R A C T

Istanbul's daily electrical energy consumption was predicted in this study using the statistical modeling technique ARIMA. The ARIMA model is more straightforward and less applicable than stationary time series. The data differenced to be stationary, and the p-value test was applied to determine whether it was stationary. The data was analyzed by autocorrelation and partial autocorrelation. Also, it is visualized to analyze the trend, residual, and seasonality. Future research will determine whether the developed model's accuracy can be further boosted.

Keywords: ARIMA Model, Electrical Power Consumption, Non-stationary Data Transformation, Seasonality, Time Series.

Introduction

In this current era of technological revolution, it is mandatory to maintain the balance between the production and consumption of electricity. Forecasting is needed to predict future electrical energy consumption because the availability of precise forecast analysis provides a mechanism for enhancing the accuracy and validity of management decisions. This study offers the ARIMA (autoregressive moving integrated moving average) technique to predict actual electrical consumption [1].

Electrical power system planning is indispensable, as this system includes the current supply of electricity and forecasting estimated future demand. Future demand for electrical energy requires analysis to obtain measures for electricity generation, from generating units to its transmission and then its distribution to consumer ends. Thus, estimating future electricity demand is essential for effective system planning. The future demand can also help build a policy for capital equipment. Furthermore, forecasted electricity consumption can help the government establish necessary policies, such as installing new power plants and infrastructure development to meet future electricity demand [2].

Currently, several models are widely used to predict electrical energy usage and are commonly classified into three categories: statistical methods, artificial intelligence methods, and hybrid techniques. Statistical methods incorporate distinguished statistics models or mathematical equations [3]. The Gray system method is also used, which enhances the order of the original sequence through Gray generation. Current input data, such as existing electric consumption, is modeled as equations in conventional statistical methods or mathematical equations. The futuristic output is attained as a prediction for future load demands, and this method is usually termed a white-box model. The widely used examples of this model include time series analysis, regression analysis including linear regression and multiple regression, and ARIMA [4].

Methodology

The fifteen months are available from February 2023 to April 2024 for processing and modeling our dataset. The dataset includes per hour (60 minutes) data daily for the electrical consumption in Istanbul city. This study's data was read using Python, and as Figures 4 demonstrate, the consumption data was plotted as a time series. On the x-axis, we have data indexes, and on the y-axis, we have electricity consumption. Moreover, equal time intervals were required on the y-axis.

The dataset has been taken from the EPI˙AŞ (Energy Markets Operator Company) that is responsible for the transparency platform, while the "Transparency Platform provides necessary data for the transparent, reliable, fair and predictable operation of energy markets; 6282-4 decision of the Energy Market Regulatory Board dated 13/05/2016; It is obliged to publish the "Procedures and Principles for Ensuring Transparency in Organized Wholesale Electricity Markets." This decision, which forms the basis of the transparency platform and includes the data set to be published on the Transparency Platform, entered into force by published in the Official Gazette dated May 28, 2016, and numbered 29725 and was lastly updated with the Board Decision no. 10711 dated 06.01.2022" [5].

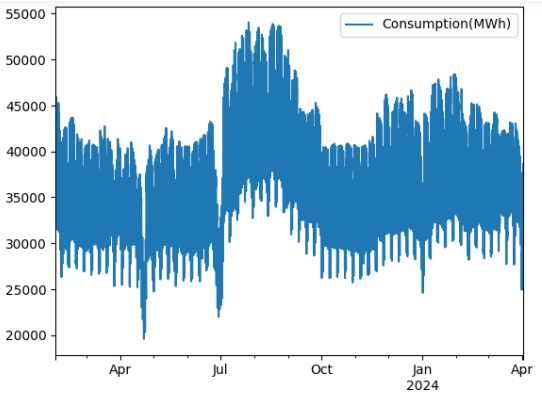

Figure 1. Time series analysis of available electrical power consumption data.

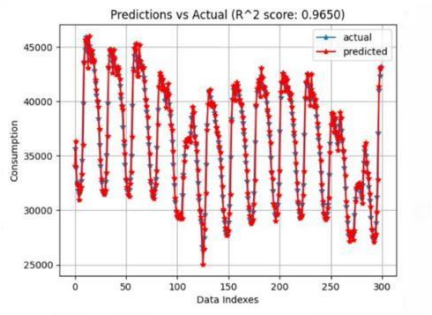

Figure 2. Flowchart of ARIMA model

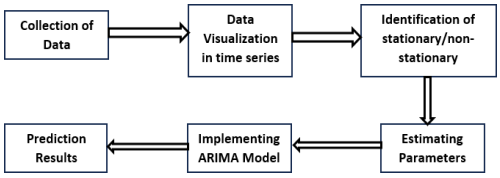

Figure 3. Prediction of electrical consumption.

The values of "p" and "q" can be found using the partial auto-correlation function (PACF) and auto-correlation function (ACF) to build a precise ARIMA model. The moving average (MA) or forecast error term is denoted by the value q, and the auto-regressive (AR) term is represented by p. The plots for ACF and PACF are displayed in Figures 7 and 8, respectively.

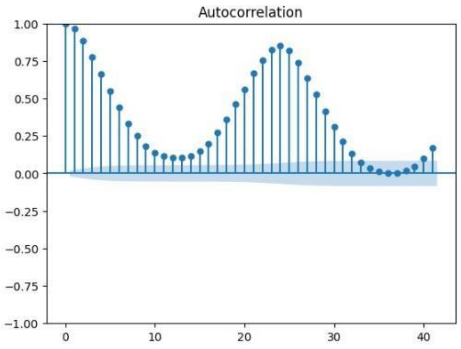

Figure 4. Auto-correlation plot

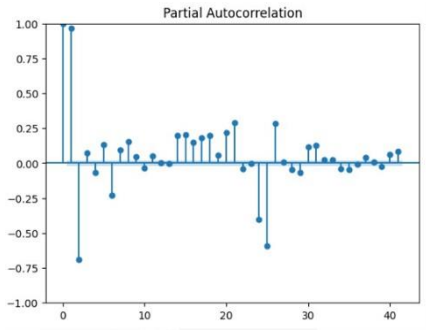

Figure 5. Partial Auto-correlation plot

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Design and Simulation of a DC to DC new topology with one input And two outputs

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A B S T R A C T

This paper introduces a novel DC-DC converter topology powered by solar photovoltaic (PV) energy to deliver dual outputs: one for battery charging and another for LED lighting. Solar PV technology, which converts sunlight into electricity through semiconductor-based solar cells, has become essential to modern renewable energy systems due to its clean, emission-free energy generation. Harnessing this technology, the proposed converter leverages solar energy to power LED lighting for homes and streets during the day while simultaneously charging a battery for nighttime use. This design significantly reduces dependency on fossil fuels and grid power, aligning with environmental goals by cutting greenhouse gas emissions and enhancing air quality. The proposed system operates in a single-stage configuration, integrating a high step-up Zeta converter for power factor correction (PFC) with a step-down forward converter. Using only one switch simplifies the circuit, minimizes component costs, and improves efficiency, making this converter highly economical and sustainable. This architecture is particularly advantageous in remote or off-grid areas with limited reliable grid access. Operating independently of grid electricity brings energy independence, price stability, and resilience, supporting economic growth through job creation in solar PV installation and maintenance. The system provides cost-effective and stable energy and reinforces energy security, enabling communities to generate and store their power, contributing to a sustainable, resilient future.

Keywords: Sustainability, Energy

1. Introduction

Solar photovoltaic (PV) technology has emerged as a transformative solution for generating clean and sustainable electricity by directly converting sunlight into electrical energy through semiconductor-based solar cells. This can be used directly in DC-powered applications or converted into alternating current (AC) for use in homes, businesses, and industrial settings. The adoption of solar PV technology has accelerated due to its significant environmental, economic, and technological benefits. Environmentally, solar PV generates electricity without producing emissions, reducing reliance on fossil fuels and contributing to lower greenhouse gas emissions. This transition improves air quality and is critical in global efforts to mitigate climate change. Economically, solar power offers predictable energy costs, as sunlight is a free and abundant resource. Technological advancements and economies of scale have significantly lowered the cost of solar panels, making them accessible and affordable for a wide range of applications. As a result, solar PV offers a viable means to achieve energy independence and protect against fluctuating fuel markets, providing long-term cost savings for individuals and businesses. Beyond environmental and economic benefits, solar PV also enhances energy security by enabling localized power generation.

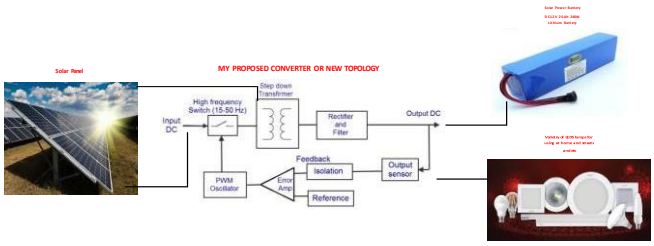
2. Proposed Topology Design

The proposed topology design leverages solar photovoltaic (PV) technology, which generates clean, renewable electricity by converting sunlight into direct current (DC). The system is specifically engineered to maximize the utility of solar power for dual-output applications: LED lighting and battery charging. This dual-output capability is achieved by integrating two power conversion stages into a single-stage topology designed to provide efficient energy distribution across both outputs. The design begins with a high step-up Zeta converter that performs power factor correction (PFC) and boosts the relatively low, variable DC voltage from the solar panel to a suitable level for both LED lighting and battery charging. This Zeta converter stage is essential for ensuring that the system maintains high efficiency and stability under fluctuating solar input conditions, aligning with environmental goals by maximizing the direct use of solar energy. Following the Zeta converter, a step-down forward converter is employed to regulate and manage the dual outputs. This forward converter is configured to deliver a steady output for LED lighting, ensuring consistent illumination throughout the day, while concurrently channeling energy for charging the battery. By consolidating these two converters into a single-stage architecture with only one active switch, the design minimizes component costs, simplifies control, and reduces power losses, all of which contribute to the converter's cost-effectiveness and reliability. This innovative topology allows the system to operate autonomously, with the solar panel supplying energy to both outputs during the day. The LED lighting is powered directly from the solar panel, providing emission-free illumination, while any excess energy is used to charge the battery. At night or during periods of low sunlight, the battery takes over as the power source for the LED lights, ensuring continuous lighting without reliance on grid electricity.

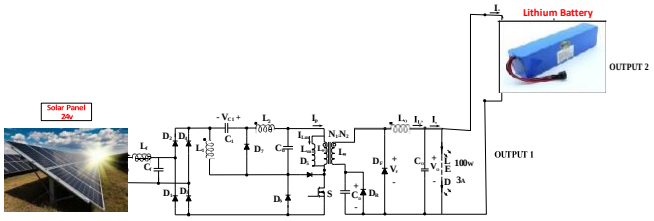
In summary, the proposed topology design effectively combines a high step-up Zeta converter with a forward converter into a compact, efficient single-stage configuration. This approach maximizes the use of solar PV technology by reducing energy dependence on fossil fuels, offering a sustainable, resilient solution for both urban and off-grid applications.

By reducing reliance on external power sources and offering a reliable lighting solution, the proposed topology contributes to the advancement of sustainable energy solutions.

As you can see in the schematic of Figure 1. (b), we are checking two intervals when the switch is on and when the switch is off. According to Figure 1. (b), we have one switch. But we support two functions with one switch. One function is to turn on the LED and the other function is to charge the battery.



(a)



(b)

Figure1. (a) Diagram of the proposed LED driver. (b) Schematic of proposed LED driver.

That is, when the switch is on, we pursue two goals. The first purpose is to transfer and convert DC voltage into output power to turn on the LED lamp, and the second purpose when the switch is on is that the battery starts to be charged by the solar panel. It means that when the switch is on, both the LED lamp is on, and the battery is being charged. But the next interval is that the switch is off. In this interval, the LED lamp is on again, because when the switch is off, the output capacitor supplies the current, and the lamp is on, in this interval, the battery is also charging, because the current required to charge the battery is supplied by the output capacitor the

same as LEDs LAMP. In general, A converters perform two different tasks with one switch, which reduces switching and conduction losses and the efficiency and reliability in this method are very high, and the cost of making the device is very low, and it is easy to produce it in markets with low prices (we do not need to buy two devices separately with high prices, with my new topology you only buy one device with low price that is cost-effective in comparison to buy two devices). This prototype works because when there is electricity in the city, both the application is on and covers the house, and the battery is charged, which means two things are done. But when the electricity in the city is disrupted and we don't have electricity, the rechargeable battery is full and we can connect it to the LED lamp, and this lamp is on when there is no electricity. Because this lamp is charged by a solar panel and has nothing to do with city electricity, that's why this battery is always charged and we can use it to light any type of LED lamp. This idea is completely new and does not exist in any market. Also, this method is quite economical and instead of buying two devices, we can buy only one device at a low price and use it at home.

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6th Graduate Student Conference on Energy and Sustainable Development
20 December 2024, Kadir Has University Cibali Campus, Istanbul

Reducing Switching Losses of EVs Onboard Charger with Triple Phase Shift Modulation

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A B S T R A C T

This paper is related to the design of a highly efficient onboard electric vehicle (EV) charger with Vehicle to Grid(V2G) capability for (EVs). EVs are gaining popularity because this latest technology reduces the greenhouse gas emission effect and the dependence on fossil fuels. The primary need for this EV technology is its fast charging. High-power bidirectional DC-DC converters are becoming increasingly popular as electric car and electrical equipment technology advances. The dual active bridge (DAB) is one of them, and it is currently frequently utilized due to its advantages of high-power density, electrical isolation, and ease of soft switching implementation. However, switching losses, electromagnetic interference (EMI), and lower efficiency become the main problems at the high switching frequency. These problems must be eliminated or reduced by using soft switching (SS) rather than hard switching (HS). Because the aim is to attain efficiency, the soft-switching techniques will achieve efficiency by minimizing power losses. Various modulation schemes have been proposed: Single-phase shift (SPS), dual-phase shift (DPS), extended phase shift (EPS), and triple-phase shift (TPS). Then, at the end, based on the literature review and testing, a simulation-based prototype for onboarding is proposed. TPS modulation schemes are applied to increase the efficiency of the DAB DC-DC converter for charging.

Keywords: Dual active bridge, Electric vehicles, Switching loss, TPS, Vehicle to grid.

Introduction

The unsustainable nature of fossil fuel and its horrendous effect on our environment creates a concern to find an environmentally friendly alternative energy source as dependency on fossil fuel is increasing exponentially. So, there is a need for Electric Vehicle technology that is cheaper and environment-friendly than conventional fuel Vehicles. Its primary concern and problem is its charging capability, which needs to be efficient, reliable, and cheaper [1]. As we know, the grid is a high-voltage AC source that needs to be converted to DC to charge batteries. So, this Bidirectional Rectifier is used, and the output of this rectifier will be fed to the Input of the DC-DC converter [2]. The converter is often described as a more common full bridge with a controllable rectifier. Due to the symmetry of this converter, with the same or identical primary and secondary bridges, it can control bidirectional power flow [3]. There are two types of bi-directional DC-to-DC converters based on efficient power flow and galvanic isolation between input and output: isolated bidirectional

DC-to-DC converters and non-isolated bidirectional DC-to-DC converters [4]. After the selection of converters, the next step is to implement soft switching techniques, which is the main objective. Various modulation schemes have been proposed: Single-phase shift (SPS), dual-phase shift (DPS), extended phase shift (EPS), and triple-phase shift. Compared to SPS control, DPS control can lower current stress and steady-state current, improve efficiency, and expand ZVS operation range [5].

Methodology

The DC-DC converters are widely used in industry. These converters give higher power density and frequencies, bidirectional power flow, faster transient response, and sizes of inductance, transformer, and capacitor become smaller due to higher frequency operations. However, there is a problem because the increasing frequency of converter causes a significant increase in switching losses, and Electromagnetic Interference EMI noises. So, to overcome switching losses and EMI noises converter needs to be operated with soft switching rather than hard switching.

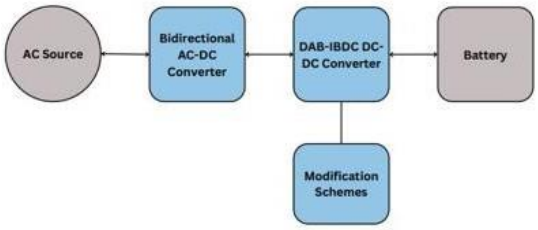

Figure 1. Main block diagram.

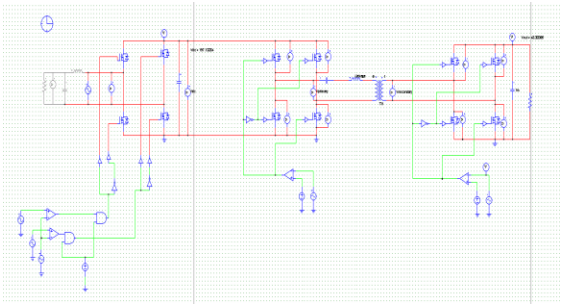

Figure 2. Simulation circuit diagram.

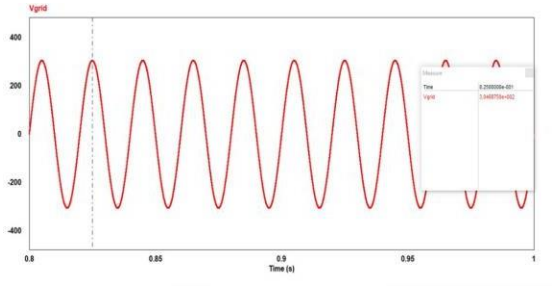

Figure 3. Input voltage waveform.

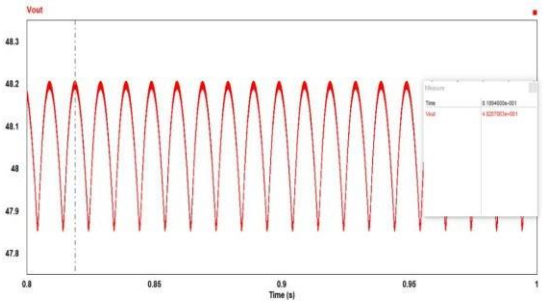

Figure 4. Output voltage waveform.

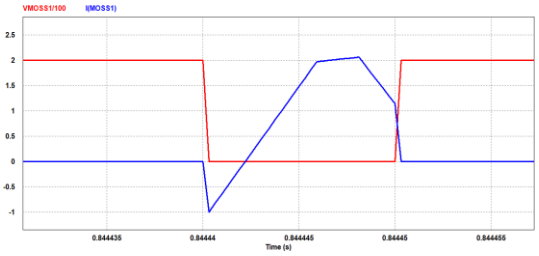

Figure 5. Zero voltage switching during turn-on through TPS modulation

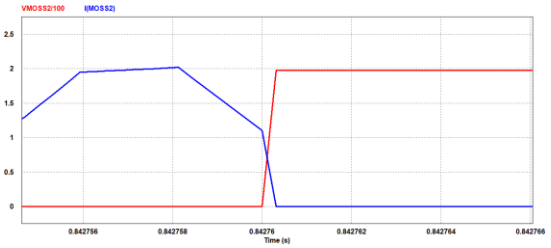

Figure 6. Hard switching during turn-off

Table 1. Parameter's values

V_{dc}	207.17 V
P_o	200 W
$\triangle V$	4.1434
V_{in}	207.17 V
V_{out}	24 V
N_s	1
N_p	9
d	35%

Acknowledgment

I sincerely thank Dr. Wahab Ali Shah, Assistant Professor at Hubei University of Technology, China, for his invaluable technical assistance in calculating the parameters and analyzing the circuit behavior.

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6thGraduate Student Conference on Energy and Sustainable Development
20 December 2024, Kadir Has University Cibali Campus, Istanbul

Energy-Efficient Path Planning for Rescue Robots

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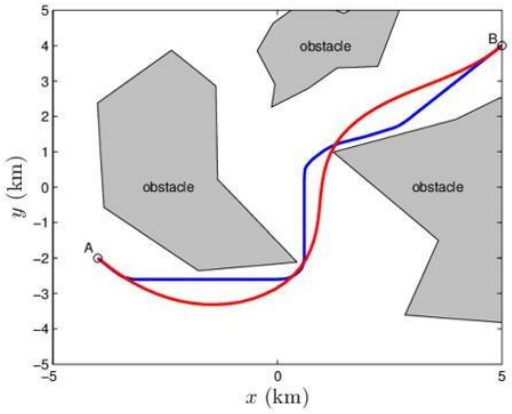
A B S T R A C T

SAR robots have been essential in disaster management, especially when human intervention is impractical and hazardous. However, given that SAR operations often occur in large, complex, and energy-intensive environments, one of the main problems in deploying SAR robots is their energy consumption. This paper investigates energy-efficient path-planning strategies for SAR robots, aiming to optimize energy consumption while preserving operational productivity. We present an approach for energy-optimized path planning that balances the robot's energy budget and mission requirements by looking at recent developments in motion planning, battery management, and decision-making algorithms. Our method combines techniques from other energy-efficient planning frameworks, for instance, Ackermann steering for ground vehicles and reconfigurable robots, focusing on reducing energy waste in dynamic and uncertain environments. The suggested approaches are assessed through simulation experiments, the results showed notable gains in energy efficiency compared to traditional path planning algorithms. This study highlights the importance of energy-conscious design in robotic systems and advances the creation of more efficient and sustainable autonomous robots for SAR missions.

Keywords

Autonomous Search and Rescue Robots, Battery Management, Dynamic Environments, Energy-efficient Path Planning.



Source: Zhao and Tsiotras (2011)

Figure 1. Path smoothing

Table 1. Comparison simulation results between energy efficient planner and distance optimal A∗

Map Size	planner	Avg Path Length (m)	Avg Energy Cost (j)	Avg Reduction Rate (%)
1000x1000	Ours	148	28791	26.7%
1000x1000	Opt. A*	145	39271	26.7%
1500x1500	Ours	223	43333	27.6%
1500x1500	Opt. A*	219	59889	27.6%
2000x2000	Ours	297	56939	26.3%
2000x2000	Opt. A*	292	77234	26.3%

Acknowledgment: This study was prepared within the first author's thesis scope.