

Energy Days Symposium

03-04 October 2022 / Sivas Cumhuriyet University, Türkiye



PROCEEDINGS BOOK

EDITORS

Assist. Prof. Dr. Derya Betül UNSAL
Atabek MOVLYANOV

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SYMPOSIUM ID

SYMPOSIUM TITLE

International Energy Days Symposium

DATE and PLACE

October 3-4, 2022 / Sivas, Turkey

PARTICIPATION

Keynote & Invited

ORGANIZATION

Renewable Energy Research Center Sivas Cumhuriyet University, Türkiye

Sustainability Office, Sivas Cumhuriyet University, Türkiye

IKSAD-Institute of Economic Development and Social Research, Türkiye

PARTICIPANTS COUNTRY

Türkiye, Oman, India, Iran, Iceland, Algeria, Morocco, France, Romania, Serbia, Tunisia,
Saudi Arabia, Pakistan, Nigeria, UK,

Number Of Accepted Papers-**31**

Number Of Rejected Papers-**6**

The number of participants from foreign countries-**19**

The number of participants from Türkiye-**12**

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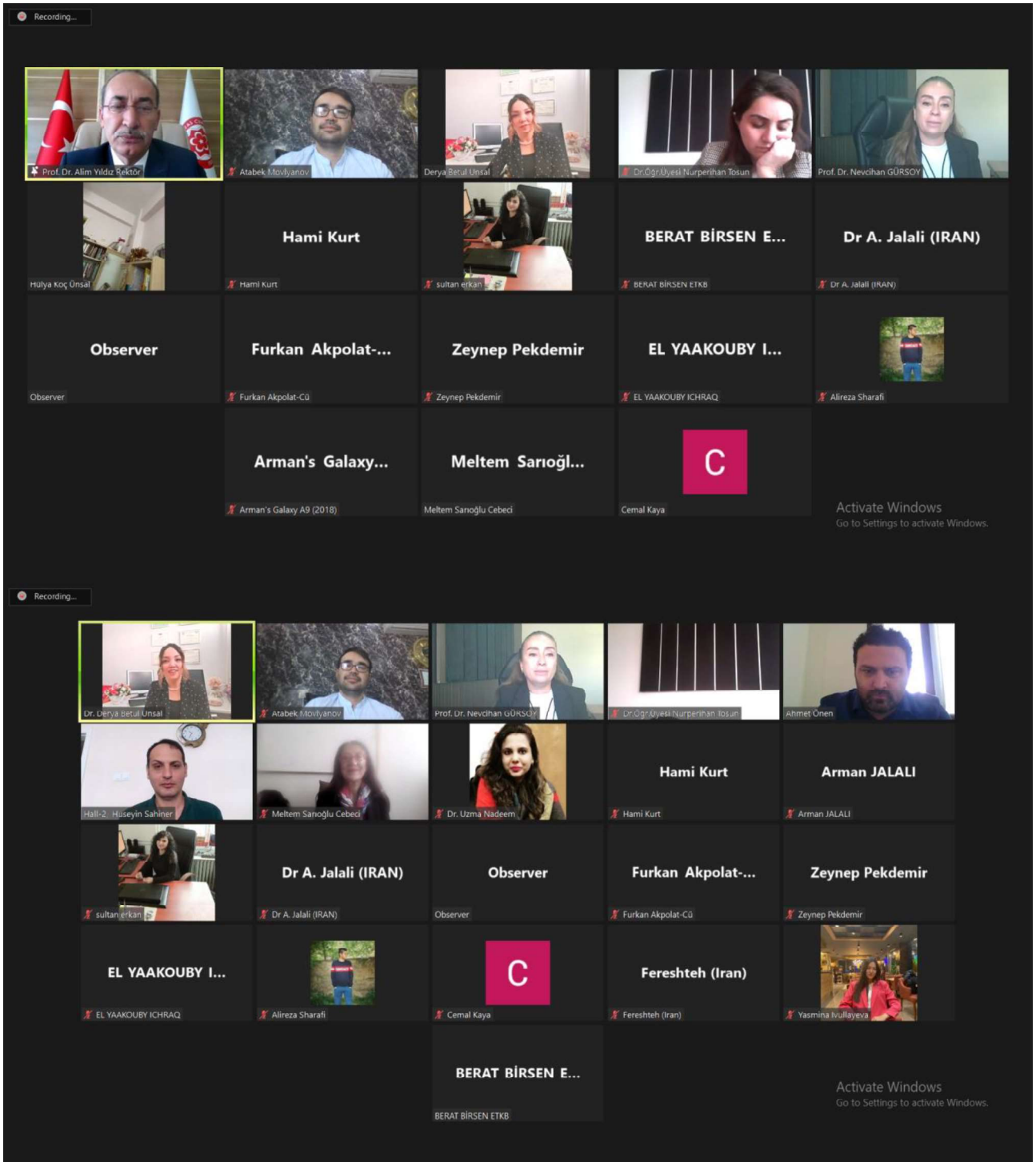
M.Sc. Zeynep CERAN ÇAMAYAZ

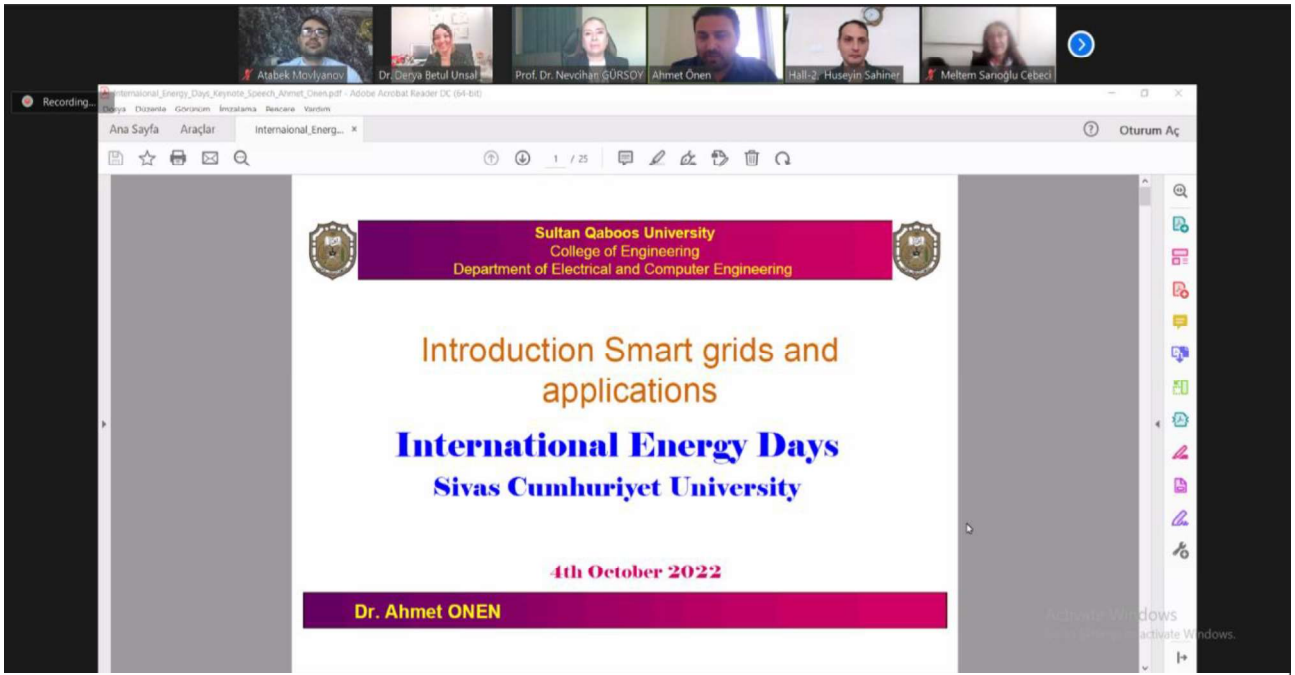
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PHOTO GALLERY









ENERGY EFFICIENCY SUPPORTS

MINISTRY OF ENERGY AND NATURAL RESOURCES
Department of Energy Efficiency and Environment

Emrah Berat BİRSEN
Mech.Eng.,M.Sc.



EL YAAKOUBY ICHRAQ - Microsoft PowerPoint

Hassan II University Ain Chock - Faculty of Science Ain Chock Casablanca
Department of Chemistry

International Energy Days Symposium
Sivas Cumhuriyet University
Istanbul, September 4th, 2022

DEVELOPMENT OF A RENEWABLE HETEROGENEOUS CATALYST FOR THE SUSTAINABLE PRODUCTION OF BIODIESEL FROM PALM FATTY ACID DISTILLATE

Ichraq El yaakouby, PhD

Cliquez pour ajouter des commentaires

Halli Ibrahim KAYA

Hall 1 - Observer

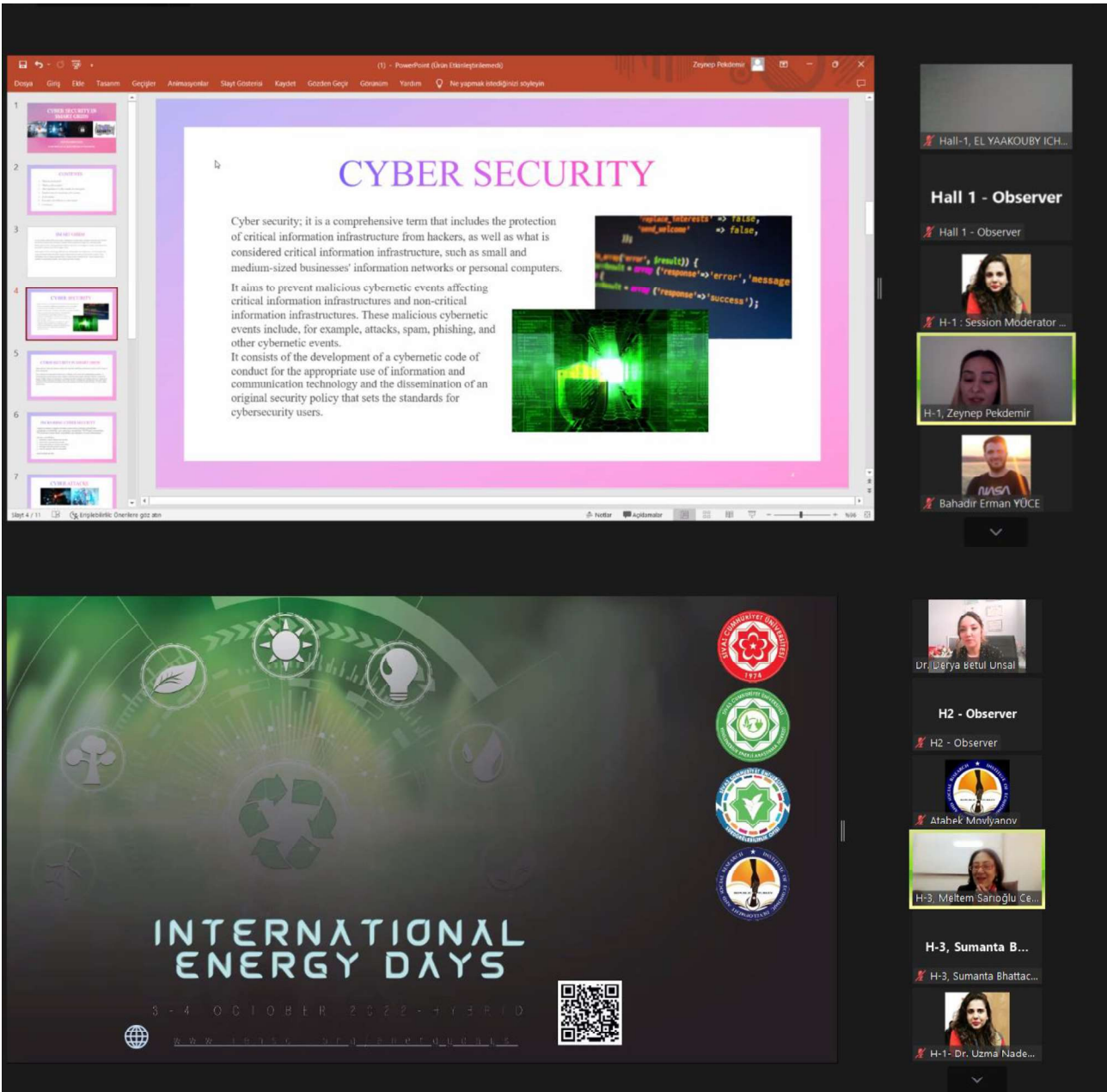
Hall-1, EL YAAKOUBY ICHRAQ

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H-1, Zeynep Pekdemir

H-1, Zeynep Ce...

H-1, Zeynep Ceran Çama...




Kaydediliyor...
Görüntüle




H2 - Observer


H2 - Observer




Hall-2, Huseyin Sahiner



H-2, Hamil Kurt



H-2, Serkan Akkoyun



H-2, Raouia Azzouz

Hall-2, abid hajer

Hall-2, abid hajer

BERAT BİRSEN E...

BERAT BİRSEN ETKB


Hall-2, İrem Şimşek

Furkan Akpolat-Cü

Furkan Akpolat-Cü

Eren Diler Çamlı...


Eren Diler Çamlıbel Edaş



sultan erkani

Veysel Yüzügüler

Veysel Yüzügüler



**AN ANALYSIS OF SYNTHESIS OF RENEWABLE CHEMICALS
FROM LIGNOCELULLUSIC BIOMASS**


AN INTERNATIONAL CONFERENCE PAPER

by
Isaac JATO
isaacjato620@gmail.com
Federal Polytechnic N'yak Shendam Plateau State Nigeria

Presented to:
**INTERNATIONAL BLACK SEA MODERN SCIENTIFIC RESEARCH
CONGRESS**

OCTOBER, 2022

2 atanmamış katılımcı



H-3, Sumanta Bhattachar...

Hall 3 - Observer

Hall 3 - Observer

H-3, Meltem Sar...

H-3, Meltem Sarıoğlu...

H-3, Fereshteh...


H-3, Fereshteh gareb...

H-3, Dr Arman J...

H-3, Dr Arman Jalali (...)

Hall 3 /Sara EZA...


Hall 3 /Sara EZAIRI



Isaac Jato

Hall 3 - Observer

Hall 3 - Observer



H-3, Meltem Sarıoğlu Çe...

H-3, Fereshteh...

H-3, Fereshteh gareb...

H-3, Dr Arman J...

H-3, Dr Arman Jalali (...)

H-3, Sumanta B...

H-3, Sumanta Bhattach...



INTERNATIONAL ENERGY DAYS

Sivas Cumhuriyet University
Tuesday, October 4th, 2022

Symposium Programme

Meeting ID: 954 7649 3631

Passcode: 102022

Important, Please Read Carefully

- To be able to attend a meeting online, login via <https://zoom.us/join> site, enter ID "Meeting ID or Personal Link Name" and solidify the session.
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exp. Hall-1, Ethem KILIÇ

- Welcome Greetings -

Date- 04.10.2022

All schedule is according to GMT +3 time zone (Istanbul)

Assist. Prof. Dr. Derya Betul UNSAL- (10.00-10.10)

Director of Renewable Energy Research Center and
Coordinator of Sustainability Office in Sivas Cumhuriyet University, Turkey

Symposium Organizing Committee Chair

Prof. Dr. Alim YILDIZ- (10.10-10.30)

Sivas Cumhuriyet University Rector

Symposium Honorary Chair

- Keynote Speeches-

Date- 04.10.2022

All schedule is according to GMT +3 time zone (Istanbul)

Prof. Dr. Ahmet ONEN- (10.30-11.00)

Sultan Qaboos University, Oman

-/-

Dr. Abdullah Buğrahan KARAVELİ- (11.00-11.20)

Ministry of Energy and Natural Resources,

Head of the Department of Energy Efficiency and Environment (EVÇED), Türkiye

-/-

Prof. Dr. Meltem SARIOĞLU CEBECİ- (11.20-11.40)

Sivas Cumhuriyet University, Türkiye

-/-

Assist. Prof. Dr. Meryem Seferinoğlu-(11.40-12.00)

Sinop University, Türkiye

-/-

Assist. Prof. Dr. Uzma Nadeem-(12.00-12.20)

Environmental Studies of Mata Sundri College for Women, University of Delhi, India

-/-

Mechanical Engineer, M.Sc. Emrah Berat BİRSEN-(12.20-12.40)

Ministry of Energy and Natural Resources,

Consultant Mechanical Engineer Energy Manager, Türkiye

-/-

Assist. Prof. Dr. Arman JALALI (12.40-13.00)

Tabriz University, Iran

-/-

Assist. Prof. Huseyin Sahiner-(13.00-13.20)

Sinop University, Türkiye

-/-

Prof. Zhao Yuan-(13.20-13.40)

University of Iceland, Iceland

-/-

Prof. Dr. Nevcihan GÜRSOY-(13.40-14.00)

Head of Graduate Institute of Natural and Applied Sciences

Sivas Cumhuriyet University, Türkiye

04.10.2022 / Hall-1 / TSI Time - 14³⁰:16³⁰



Zoom ID: 954 7649 3631 / Passcode: 102022



Moderator: Assist. Prof. Dr. Uzma Nadeem

Authors	Affiliation	Presentation title
Assoc. Prof. Dr. Yassine YAKHELEF Assoc. Prof. Dr. Fares NAFA	Boumerdes University, Algeria	ADAPTIVE MPPT CONTROL OF MULTILEVEL CONVERTER BASED SOLAR MICROGRID SYSTEM USING ANFIS ALGORITHM
Ichraq El yaakouby Youness Abouliatim Miloudi Hlaibi Nourredine Kamil	Hassan II University of Casablanca (UH2C), Morocco National School of Applied Sciences, Safi, Morocco University of Rouen, France	DEVELOPMENT OF A RENEWABLE HETEROGENEOUS CATALYST FOR THE SUSTAINABLE PRODUCTION OF BIODIESEL FROM PALM OIL DISTILLATE
Halil İbrahim KAYA Şerife Merve KOŞAROĞLU	Sivas Cumhuriyet University, Türkiye	THE RELATIONSHIP OF ENERGY IMPORTS, CURRENT DEFICIT AND ECONOMIC GROWTH: THE CASE OF TURKEY
Yağmur Arıkan Yıldız	Sivas Cumhuriyet University, Türkiye	ENERGY EFFICIENCY WITH REGENERATIVE ENERGY UTILIZATION METHOD IN RAIL SYSTEM VEHICLES
Andrei Sărăcuț-Ardelean Marius Lolea Kristijan Cincar	University of Oradea, Romania Školski centar "Nikola Tesla", Serbia	ENERGY COST AND ENERGY EFFICIENCY STATUS OF BUILDINGS USING HEAT PUMPS
Mustafa ŞEKER	Sivas Cumhuriyet University, Türkiye	OPTIMAL CAPACITOR PLACEMENT DEPENDING ON SYSTEM CONFIGURATION IN RADIAL ELECTRIC SYSTEMS USING NOVEL ARTIFICIAL HUMMINGBIRDS ALGORITHM (AHA)
Dr. Marius LOLEA Dr. Cornelia ANGHEL-DRUGARIN Eng. Daniela NEGREA	University of Oradea, Romania University "Babeş – Bolyai" of Cluj Napoca, Romania	NEW CHALLENGES IN REDUCING THE ECONOMIC AND SOCIAL IMPACTS OF ENERGY CRISIS IN ROMANIA
Assit. Prof. Dr. Bahadır Erman Yüce Serkan ÖZEL	Bitlis Eren University, Türkiye	THERMAL ANALYSIS OF CERAMIC COATED EXHAUST MANIFOLD
Zeynep CERAN ÇAMAYAZ Derya Betül ÜNSAL	Sivas Cumhuriyet University, Türkiye	ENERGY EFFICIENT SMART BUILDING SOLUTIONS FOR GRID CONNECTED SMART GRIDS
Derya Betül ÜNSAL Zeynep PEKDEMİR	Sivas Cumhuriyet University, Türkiye	PROTECTION OF MICROGRIDS WITH RENEWABLE CONNECTION
Assist. Prof. Dr. Sovik Mukherjee	St. Xavier's University, India	THE ROLE OF INCENTIVES IN RENEWABLE ENERGY POLICIES IN EUROPEAN COUNTRIES: SPECIAL EMPHASIS ON WHAT INDIA CAN LEARN

04.10.2022 / Hall-2 / TSI Time - 14³⁰:16³⁰



Zoom ID: 954 7649 3631 / Passcode: 102022



Head of Session: Assist. Prof. Dr. Derya Betül ÜNSAL

Authors	Affiliation	Presentation title
Kübra Harman Muhammed Mustafa Orhan Serkan Akkoyun	Sivas Cumhuriyet University, Türkiye	ESTIMATING THE NET CAPACITIES OF REACTORS WITH ARTIFICIAL NEURAL NETWORKS
Dr. Marius LOLEA Dr. Cornelia ANGHEL-DRUGARIN Eng. Daniela NEGREA	University "Babeş – Bolyai" of Cluj Napoca, Romania University of Oradea, Romania	FINANCIAL COSTS OF IMPROVEMENT THE ENERGY EFFICIENCY OF INSTALLATIONS FOR BUILDINGS
Dr. Marius LOLEA Andrei SĂRĂCUȚ-ARDELEAN Kristijan Cincar	University of Oradea, Romania Školski centar "Nikola Tesla", Serbia	CONTRIBUTION OF SMART CONTROL TO INCREASING THE ENERGY EFFICIENCY OF BUILDINGS
Hami KURT Derya Betül ÜNSAL	Sivas Cumhuriyet University, Türkiye	ELECTROMAGNETIC FIELD LEVELS ANALYSIS FOR GRID CONNECTED SMART DEVICES
Mohamed Dhia Massoudi Mohamed Bechir Ben Hamida	University of Monastir, Tunisia Ibn Saud Islamic University (IMSIU), Saudi Arabia University of Sousse, Tunisia	NUMERICAL STUDY OF COMBINED EFFECTS OF RADIATIVE NANOFLUID AND FINS ARRANGEMENTS CASES ON HEAT SINK EFFICIENCY
Hajer ABID Mohamed Bechir BEN HAMIDA	University of Monastir, Tunisia Ibn Saud Islamic University (IMSIU), Saudi Arabia University of Sousse, Tunisia	A NEW DESIGN OF A HYBRID SYSTEM FOR SOLAR- POWERED WATER DESALINATION
Raouia AZZOUZ Mohamed Bechir BEN HAMIDA	University of Monastir, Tunisia Ibn Saud Islamic University (IMSIU), Saudi Arabia University of Sousse, Tunisia	THREE- DIMENSIONAL HEAT TRANSFER STUDY OF SHELL AND TUBE HEAT EXCHANGER
Assist. Prof. Huseyin Sahiner	Sinop University, Türkiye	WASTE ESTIMATION FOR BREEDER TYPE MOLTEN SALT REACTORS
Gahgah Mounir Bouzaouit Azzedine Rahai llyes	University of August 20, 1955, Algeria	STATISTICAL ANALYSIS FOR THE STUDY OF THE RELIABILITY OF A DIFFERENTIAL FILTER
İrem ŞİMŞEK Ahmet UYAROĞLU Tayfun TURAL Eren DİLER Yunis TORUN Burak SEÇKİN Bünyamin ÇAM	Sivas Cumhuriyet University, Türkiye	YER ALTI ENERJİ HATLARINDA GÜZERGAH TESPİT CİHAZLARININ GÜNCEL DURUMU VE GELECEĞİ

04.10.2022 / Hall-3 / TSI Time - 14³⁰:16³⁰



Zoom ID: 954 7649 3631 / Passcode: 102022



Moderator: Prof. Dr. Meltem Sarıoğlu Cebeci

Authors	Affiliation	Presentation title
Sefa Furkan Selçuk Zinnur Yılmaz Berk Köker Prof. Dr. Meltem Sarıoğlu Cebeci	Sivas Cumhuriyet University, Türkiye	PRIMARY ENERGY CONSUMPTION: CROSS-COUNTRY TREND ANALYSIS
Haseeb Ur Rehman Arslan Khalid Danish Zaman Muhammad Irfan Ghulam Murtaza	University of Engineering and Technology, Pakistan Swedish College of Engineering and Technology, Pakistan	DESIGN AND FABRICATION OF WIND TREE TURBINE BLADE
Berk Köker Prof. Dr. Meltem Sarıoğlu Cebeci Zinnur Yılmaz Sefa Furkan Selçuk	Sivas Cumhuriyet University, Türkiye	CLEAN ENERGY GENERATION FROM PRESSURE RETARDED OSMOSIS WITH OSMOTIC POWER
Dr. Sara EZAIRI Dr. Assaad ELOUAFI Prof. Dr. Fatima LMAI	Hassan II University of Casablanca, Morocco	OPTICAL PROPERTIES, INFLUENCE OF THE POLARIZATION AND THE TEMPERATURE ON HETEROJUNCTION ORGANIC SOLAR CELL
Isaac JATO	Federal Polytechnic N'yak Shendam, Nigeria	AN ANALYSIS OF SYNTHESIS OF RENEWABLE CHEMICALS FROM LIGNOCELLULOSIC BIOMASS
Dr. Sumanta Bhattacharya	Maulana Abul Kalam Azad University of Technology, India	CLEAN ENERGY – VITAL TO HALTING CLIMATE CHANGE, ENSURING ENERGY SECURITY, AND PROMOTING SUSTAINABILITY
Prof. Dr. Valentina MARINESCU Dr. Bianca FOX Dr. Ramona MARINACHE	University of Bucharest, Romania Nottingham Trent University, UK	COMMUNICATION AND RESPONSIBILITY ABOUT OIL AND GAS USING YOUTUBE
Dr. Ramona MARINACHE Prof. Dr. Valentina MARINESCU Dr. Bianca FOX	University of Bucharest, Romania Nottingham Trent University, UK	NARRATIVES OF THE ENERGY CRISIS IN ROMANIA
Dr. Olaore Kayode Olatunde Prof. Danshehu Bagudu Gwadangwaji Usman Abdulkarim Dr. Sunday Abayomi John	Kwara State Polytechnic, Nigeria Usmanu Danfodiyo University, Nigeria	ELECTRICITY GENERATION USING A CENTRIFUGAL PUMP WITH AN OPEN IMPELLER AS TURBINE IN REVERSE MODE
Fereshteh Gharehbaghi Maleki Mousa Mohammadpour Fard Arman Jalali	University of Tabriz. Iran	BIOGAS PRODUCT SIMULATION USING ADM1 AND FEASIBILITY STUDY OF USING BIOGAS IN A POWER GENERATION UNIT WITH ASPEN PLUS

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Adaptive MPPT Control of Multilevel Converter Based Solar Microgrid System Using Anfis Algorithm

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ABSTRACT

Photovoltaic systems are used to convert solar energy into electrical energy. They consist of a PV cell array that uses the sunlight to generate direct current (DC) power with a known lower conversion efficiency rate. In order to maximize the efficiency of energy conversion of these systems, a technique of using a maximum power point tracking (MPPT) algorithm is developed to deliver maximum power from the photovoltaic (PV) panel to the load regardless of the intensity of the sunlight or of temperature or any weather condition. The main objective of this work is to improve the efficiency of the PV systems by designing and comparing two Maximum Power Point Tracker (MPPT) Controllers that improve the efficiency of solar energy conversion system built around the Modular Multilevel power converter and connected to utility Grid. These MPPT controllers are Adaptive Neuro Fuzzy Inference System (ANFIS) and Perturbation and Observation algorithm, which are simulated using Matlab/Simulink to show their performances as well as their behaviour at different weather condition of temperature and irradiance variation.

Key Words: *Solar energy system, Microgrid, Modular Multilevel Converter, MPPT, ANFIS, Perturb and Observe algorithm*



Development of a renewable heterogeneous catalyst for the sustainable production of biodiesel from palm oil distillate

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ABSTRACT

Due to the rapid depletion of fossil fuel resources and environmental problems associated with toxic emissions from conventional diesel, biodiesel has received increased attention in recent times as a renewable fuel, environmentally friendly and sustainable energy source. In the present study, a solid carbon-based heterogeneous acid catalyst was developed for the production of biodiesel from the by-product of fatty acid-rich palm oil refining (PFAD) through the esterification reaction. The stability of the catalyst and the effects of temperature, reaction time, methanol to PFAD ratio, and catalyst loading on the production efficiency were examined individually. The experimental results confirmed that the acid catalyst efficiently converted the fatty acids in the palm oil distillate to methyl ester. With a maximum conversion of 96% under the optimum conditions (reaction temperature of 70°C, reaction time of 3h, methanol : PFAD of 15:1, and catalyst loading of 3% by weight). In addition, the catalyst was successfully reused up to 3 cycles. Furthermore, the fuel properties of the biodiesel produced are within the limits prescribed by the international standard. It can be concluded that the carbon-based acid catalyst is reusable and has proven to be a very efficient and environmentally friendly catalyst. It has a strong potential to esterify high fatty acid feedstocks, mainly palm oil distillate, to produce a sustainable and low cost biodiesel.

Keywords : PFAD, Heterogeneous catalyst, Esterification, Sustainable biodiesel



The Relationship of Energy Imports, Current Deficit and Economic Growth: The Case of Turkey

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ABSTRACT

The developments in the world economy, the globalizing economic structure, the increase in the population, the acceleration of technological advances cause the energy demand to increase regularly. The need for energy resources is not realized at the same level for every country. As a result of the unequal distribution of energy resources, it makes energy imports compulsory for many countries. High energy imports cause significant imbalances in macroeconomic level as well as energy supply security. Countries with high energy imports are adversely affected by fluctuations in energy prices, especially current account deficit and economic growth. In this context, Turkey's current account deficit, whose economic growth potential has changed over the years, has become a chronic problem. Considering the high share of energy imports in total imports, the relationship between these variables seems important. For this reason, in the related study, the relationship between Turkey's energy imports, current account deficit and economic growth variables for the years 1974-2015 was investigated by NARDL method. According to the results of the analysis, positive shocks in energy imports have a positive effect on the current account deficit, while negative shocks have a negative effect on the current account deficit. In addition, there is an inverse relationship between the current account deficit and economic growth. Considering the results, it is important to expand renewable energy production in Turkey. This situation, which will reduce energy imports, will play a major role in ensuring economic stability.

Keywords—Energy Imports, Current Account Deficit, Economic Growth, NARDL.



Energy Efficiency with Regenerative Energy Utilization Method in Rail System Vehicles

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ABSTRACT

Rail systems are one of the most frequently used public transportation vehicles, especially in metropolitan cities, due to their many advantages such as being punctual, reliable and economical, and having high capacity. Energy efficiency in rail systems has become an important issue because of increasing in rail networks, intensive operation of vehicles and the growth of the rail system market. Since rail systems have a complex structure, many methods are used in the literature to ensure energy efficiency in these systems. One of the prominent method among all methods is the utilization of regenerative energy. Regenerative energy, or in other words, regenerative braking is the kinetic energy that emerges when the vehicle is braking up to a certain speed and is generally lost in most systems by burning it into heat energy. This energy can be stored and used later by saving it into energy storage systems, or it can be used immediately by giving it back to the line with time optimization or reversible substations. In this study, the methods used in the effective use of this energy in the literature have been investigated and classified. A general evaluation has been made by comparing these methods in terms of their contribution to energy efficiency and cost effects.

Keywords—*rail systems, energy efficiency, regenerative energy, energy storage systems, timetable optimization, reversible substation*



Energy Cost and Energy Efficiency Status of Buildings Using Heat Pumps

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ABSTRACT

The authors present in this paper, the results of their own research regarding the costs of energy obtained on the basis of heat pumps that are used for heating and cooling spaces in buildings. Various stages of energy efficiency are also analyzed for several categories of heat pumps used in buildings and comparisons are made with other heating and cooling systems. Are highlighted the advantages and disadvantages of energy systems of buildings using heat pumps, with the establishment of their technical and economic implications.

After the introductory part, an analysis is made of the constructive characteristics and the mode of operation of the heat pumps. Several categories of heat pumps are compared from a technical point of view, such as: water-water, soil-water, air-air, water-air. With a dedicated software, simulations are made regarding the operation, energy consumption and efficiency of various types of heat pumps. For the analyzed heat pumps, a market study is also carried out by category, in order to determine the purchase prices for the same thermal power per unit. From the technical characteristics offered by the manufacturer, each pump category will be ranked based on energy efficiency and financial implications.

The paper also presents the results of the study of the integration and operation of the heat pumps in several residential buildings that the authors visited in order to establish their energy status. At the end of the paper, observations will be made regarding the profitability and efficiency of heat pumps. The authors' conclusions and recommendations regarding the integration of heat pumps in buildings are presented. These are focused especially on the financial savings brought by heat pumps, which have the technical advantage that they can work reversibly, that is, they can also produce cold, without the need for additional devices, thus being able to be integrated into the air conditioning systems of buildings.

Keywords: *Energy cost, Energy efficiency, Heat pumps.*



Optimal Capacitor Placement Depending on System Configuration in Radial Electric Systems using Novel Artificial Hummingbirds Algorithm (AHA)

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ABSTRACT

While transferring electrical energy from the point where it is produced to the end consumer; In addition to the continuity of the transmitted power, it is desired that the supplied voltage is at a certain frequency value and within the desired fluctuation limits. Electricity transmission and distribution systems are operated in a radial structure, although they are designed in the ring structure, to ensure that the minimum consumer is de-energized and energy continuity in case of failure at any point of the system. This study presents a novel algorithm for a system configuration-dependent approach to determine capacitors' optimal positions and sizes using Artificial Hummingbirds Algorithm (AHA) in radial distribution systems. The analysis is aimed to determine the optimum capacitor locations and sizes for fixed and switched capacitors. To solve this problem; the Radial system losses according to electrical system constraints have been configured using load sensitivity index and Backward/Forward Sweep algorithm. Artificial Hummingbirds Algorithm (AHA) was used to determine optimal switching positions. In addition, the obtained results were compared with the calculations obtained by genetic algorithm and particle swarm optimization. The simulation findings reveal that the Artificial Hummingbirds Algorithm (AHA) is a more efficient tool for the minimization of losses, voltage profiles, and costs in distribution systems. The presented strategy is recommended for planning radial systems and prioritizing investments.

Keywords— *Optimal Capacitor Placement, Artificial Hummingbirds Algorithm (AHA), Radial System Reconfiguration, Genetic Algorithm (GA), Particle Swarm Optimization (PSO)*



New Challenges in Reducing the Economic and Social Impacts of Energy Crisis in Romania

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ABSTRACT

The paper follows two directions: economic and social, both under the influence of the energy and fuel crisis. Starting from the year 2020, in Romania, as in other countries in Europe or in the world, a great energy and fuel crisis was triggered, which had and still has a strong economic and social impact by increasing prices. In Romania, the conflict situation in Ukraine has increased this crisis. Also, the pandemic period generated changes in the labor market and salary fluctuations, layoffs or new jobs that could be performed from home.

The year 2022 led to the biggest increases in energy and fuel prices and triggered fears among the poor population who perceive the future as uncertain. In order not to affect social life at a very negative level, the government had to generate and adopt a series of fiscal measures. These include: subsidizing part of the price of fuel sold to the population, imposing ceilings on electricity and natural gas prices, direct financial aid to some vulnerable social categories such as people with low incomes, encouragement through tax reduction for companies that employ people with increased social risk, etc

The authors conducted research in public databases, government reports or on various markets to identify the degree of price increase and which products were most affected by the crisis. The evolution of inflation, which reached the highest value in the last 10 years, was also analyzed. Other situations researched by the authors are focused on the impact on the purchasing power of Romanians and the aid to refugees from Ukraine, including the possibility of absorption on the Romanian labor market of Ukrainians who left their country. At the end of the paper, are presented the most important conclusions resulting from the study.

Keywords: *Energy crisis, fuels prices, economic impact, social life*



Thermal Analysis of Ceramic Coated Exhaust Manifold

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ABSTRACT

Exhaust manifolds have an essential role in safely removing waste gases after combustion in internal combustion engines. The exhaust manifold is subjected to thermal stress as the exhaust gases carry a high thermal load. In order to prevent damage to the manifold as a result of these loads, the coating process which is an engineering solution is applied and a thermal barrier is obtained on the manifold. In this study, the thermal analysis of the exhaust manifold covered with 500 μ ZrO₂-Y₂O₃ ceramic material under convective thermal loads was investigated. The study was performed with ANSYS-Fluent, a commercial Computational Fluid Dynamics (HAD) software. The insulating performance of the coating material with a low thermal conductivity coefficient was compared with an uncoated manifold. It was observed that ZrO₂-Y₂O₃ significantly reduced the thermal loads on the manifold. As a result, the temperature values on the outer surface of the manifold coated with ZrO₂-Y₂O₃ decreased compared to the uncoated manifold.

Keywords: Coating, ZrO₂-Y₂O₃, Manifold, Thermal Analysis.



Energy efficient solutions for grid-connected smart buildings

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ABSTRACT

Today, in the technological field, innovations are made and developed day by day in line with the increasing population and needs. With the technological activities that have developed in the last 20 years, environmentally friendly, sustainable buildings that provide optimum comfort to users and minimize the use of energy from external sources have begun to be developed. Demand for smart buildings has increased due to the fact that they respond to the needs and requirements of users, have a long life and are low cost. A smart building is an independent structure with air conditioning, ventilation, lighting and security systems that can manage itself. It should be integrated with renewable energy sources, which have become a necessity to use, and turn them into green, sustainable and environmentally friendly buildings. There are many parameters required for buildings to be smart. In this study, the requirements and usage areas of smart buildings according to different standards have been determined. The building efficiency of the devices used in the construction of smart buildings and the solutions required for the use of smart buildings to be environmentally friendly and energy efficient have been researched.

Keywords—Smart Grid, Smart Buildings, Renewable Integration.



Protection of Microgrids with Renewable Integration

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ABSTRACT

Smart grids aim to control electricity generation-transmission-distribution systems by using electronic communication for reliable and efficient energy supply. In today's world, where the availability of renewable energy sources is increasing, the transition to renewable energy at the macro level with its integration into smart grids is of great importance. The reliability of a smart grid is based on the reliability of its control and communication systems. As communication systems become more complex to provide better control and high reliability, smart grids require a higher degree of connectivity to external networks to support new features. However, dependence on these external networks also brings with it cyber security vulnerabilities and breaches. Therefore, these connections must meet the requirements of various standards developed within the scope of cyber security requirements. In this study, the proposals for providing cyber security in renewable energy sources in smart grids and resolving attacks that threaten this security are discussed. By mentioning the importance of cyber security today, the types of attacks that threaten this security, the solutions produced for these attacks and the problems that may arise in these solutions, the importance of cyber security in energy systems is emphasized.

Keywords—Smart Grid, Micro Grid, Cyber Security, Renewable Integration.



The Role of Incentives in Renewable Energy Policies in European Countries: Special Emphasis on what India can Learn

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ABSTRACT

This study focuses on the evaluation of the main energy scheme policies that promote electric renewable energy production. In particular, the objective is to analyse heterogeneous non-hydroelectric RES-E (solar, wind, geothermal and biomass) support scheme policies common in the European countries and evaluate their effects on promoting capacity and production of electricity in twenty-seven European countries for the years 2000- 2019.

To this end, we investigate the relative effectiveness of premium (FIP), fixed- price (FIT) and quota (RPS) incentives, taking into account the timing of adoption of these policies, by applying panel data analysis. The results suggest that price-based incentives (FIP and FIT), compared to the quantity-based incentives (RPS), are the most effective kind of incentive mechanisms for promoting development of non-hydroelectric renewable energy technologies in the EU context. One novelty result of the research concerns the strong incidence of feed-in premium (FIP). In fact, for countries adopting FIP incentives, the production of electric energy from renewable technologies register better performances compared to those adopting FIT and RPS. The paper comes to a close by highlighting the effectiveness of such policies in bringing about a new renewables based “Industrial Revolution” in the Indian context.

Key words: *renewable electric sources; energy policy; feed-in tariffs; feed-in premium; renewable portfolio standard; panel data analysis.*

JEL classification: *Q42; O33, Q48; 052*



Estimating The Net Capacities Of Reactors with Artificial Neural Networks

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ABSTRACT

The electricity consumption needed in all countries is increasing with the developing industry. Energy production is obtained from different sources as well as from Nuclear Power Plants. Recently, the decrease in fossil fuels and climate changes due to harmful gases released to the environment have increased the interest in Nuclear Power Plants. For this reason, newly developing countries want to meet their electricity needs with nuclear energy. The aim of this study is to determine the net capacity that can be obtained from a reactor according to the type of reactor needed by the countries by using artificial neural networks. Thus, it will be possible to predict whether the energy production capacities requested by the countries can be met with the reactors built. According to the data received from the IAEA (International Atomic Energy Agency), the artificial neural network model is used to predict whether the reactor to be built will meet the electricity demand in the country. It is seen that the determination of the net capacity of the reactors to be built according to the obtained data can be estimated safely by using this method.

Keywords— *Artificial neural network, nuclear reactors, electricity need, net capacity*



Financial Costs of Improvement the Energy Efficiency of Installations for Buildings

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ABSTRACT

The paper presents details from the authors' investigations regarding the costs required in Romania for raising the energy performance of buildings and especially for making buildings more efficient. To increase energy efficiency, certain solutions are needed that require significant investments in people's personal homes. Therefore, in order to highlight them in the paper, we deal with the following issues:

- Evaluation of energy consumption for electricity and heat of installations in buildings in Romania;
- The expenses necessary to modernize the houses on the energy side, including thermal insulation;
- Investment depreciation calculations;
- Preparation of expense reports that can serve other investors to go through the same stages so that it can be established what is the purpose of the investments in the rehabilitation of the buildings and how they can be amortized/recovered.

At the end of the paperwork, following the analyzes performed, the authors formulated the conclusions that resulted from the study.

Among the principles of energy efficiency in buildings, we mention in the paper: an important condition for achieving interior comfort is the provision of the building with a heating system that provides heat during the cold season. The heat supplied must be maintained inside the building, so that the energy consumption of the heating system is the minimum necessary. But the characteristic of thermal energy transfer (or heat, popularly called "heat transfer") is that it is generated by any temperature difference and can take place in any direction.

Keywords: *Energy efficiency, buildings installations, financial investments*



Contribution of Smart Control to Increasing the Energy Efficiency of Buildings

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ABSTRACT

In this paper, the authors propose and analyze some solutions for increasing the energy performance of buildings based on the introduction of smart control. Several categories of installations are of interest such as: air conditioning, heating, lighting, electricity or water supply. The energy performances of all the analyzed installations are added up and at the end the energy savings obtained on a technical basis are highlighted with the generated financial implications.

The work is structured in four parts. In the introductory part, are presented the importance of the theme and research trends in the field. The second part presents the characteristics of smart buildings and explains how to control them. In the third part of the paper, are described the categories of installations that can be intelligently coordinated to contribute especially to the increase of the energy performance of buildings. In the fourth part, ways and schemes of interconnecting the installations in the buildings are presented so that the introduction of intelligent control can be carried out on the building ensemble. At the end of the paper, are presented the conclusions of the authors that could be formulated regarding the topic addressed.

Smart buildings require connectivity between all their equipment and systems so that control is total and they can be optimally coordinated. An example is even the optimization of the cooling installation in summer time, which increases the efficiency of the cooling operation by incorporating weather data. Another example is using data from a security system to turn off lights and reduce cooling when no one is inside the building. Significant energy savings can thus be found. The result of communication between equipment and subsystems is a building where lighting, security, and heating-cooling installations allow data to flow freely back and forth, resulting in greater efficiency, greater safety and comfort, and lower utility costs.

Keywords: *Energy performance, smart buildings, efficiency.*



Electromagnetic Field Levels Analysis for Grid Connected Smart Devices

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ABSTRACT

All over the world, there is a revolution in power transmission and distribution driven by environmental and economic concerns. This revolution is led by the development of the smart grid. The smart grid is bringing radical change to both power systems and many related industries. This article reviews the development of the smart grid and its relationship to magnetics, including the electromagnetic compatibility issue, magnetic field-based measurement/monitoring, and magnetic energy storage/conversion. The difficulty of the magnetic field and the use of the latest magnetic technology in the development of the smart grid are discussed. In most cases, electromagnetic pollution emitted from smart electronic devices is much stronger than any natural electromagnetic field or radiation source. Wireless and radio communication, power transmission or devices in daily use such as smart phones, portable computers in tablets expose people to electromagnetic pollution every day. In this study, the technologies used in smart grids were examined in order to comply with the standards given in the World Health Organization reports, and the solutions of electromagnetic pollution caused by the electromagnetic fields produced by these technologies and the resulting electromagnetic radiation were focused on. Electromagnetic sources were simulated in the Magnet program and the results were interpreted.



Numerical Study of Combined Effects of Radiative Nanofluid and Fins Arrangements Cases on Heat Sink Efficiency

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ABSTRACT

The purpose of this paper is to discuss numerically the efficiency of employing MHD radiative nanofluid within inclined heat dissipator box fitted with wavy fins with various arrangement cases. The study is established using the Comsol Multiphysics software. The effects of Rayleigh number ($10^3 \leq Ra \leq 10^6$), Hartmann number ($0 \leq Ha \leq 30$), the radiation parameter ($0 \leq R_d \leq 2$), the heat dissipator box inclination ($0^\circ \leq \gamma \leq 90^\circ$) and the wavy fins dispositions on the heat sink efficiency are studied. The data obtained shows that increasing Rayleigh number and the radiation parameter support the convection cooling efficiency, by contrast, the presence of Lorentz forces reduce it. In addition, relying on the dissipator box inclination, various scenarios are obtained related on the best wavy fins dispositions.

Keywords: Heat sink; Free convection; Thermal radiation; MHD; Nanofluid; Wavy fins dispositions.



A new design of a hybrid system for solar-powered water desalination

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ABSTRACT

The main objective of this work is to introduce a new design of a hybrid system for solar-powered water desalination. The main idea is to use different hybrid systems that operate in different operating temperature ranges. The low-temperature solar desalination system will use the residual thermal energy from the higher temperature system.

In addition, new and more efficient techniques will be invented to enhance the performance of solar distillers. Gaps in the knowledge of existing solar distillers will be investigated and filled using nano-polymer materials.

The resolution will be done using a mathematical model will be developed for the proposed configuration. Then, an energy balance will be established and the resolution will be done using CFD software. It is simulated using the commercial software COMSOL Multiphysics with MATLAB. We conclude an increase in performance with this new design of a hybrid system of water desalination using solar energy.

Keywords: *Water desalination, Hybrid system, Solar energy, nano-polymer materials, COMSOL Multiphysics*



Three- Dimensional heat transfer study of Shell and Tube Heat Exchanger

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ABSTRACT

The purpose of this paper is to perform and increase the efficiency of the Shell and Tube Heat Exchanger. For this, we simulate this exchanger type using the commercial software Comsol Multiphysics 5.6. After the validation of our model with the experimental results, we study the effect of some parameters on heat transfer rate by using the shell and tube type of heat exchangers. The influence of the number of tubes was investigated. Further, the effect of the number of baffles and spacing were studied. Then, the action of tube form and diameter were also explored. We conclude that the increase in tube numbers records an increase in the heat transfer rate of the studied heat exchanger. In addition, the partially increasing of the tube radius maintains too an increase in the heat exchanger. Also, the change set in the form of tubes to different ellipses affects the heat exchange within the heat exchanger. The most heat transfer rate was reached at the ellipse with radius one equal to 0.0045357 and radius two equal to 0.0041413. Further, baffle spacing, as well as baffle number, affect sincerely the value of the heat transfer rate. So, it is found that the most important rate is seen with 11 baffles with the littlest spacing suggested which is 0.021333 m. Finally, we choose the optimal parameters to make an ideal arrangement of the shell and tube heat exchanger to assimilate the maximum value of the transfer rate.

Keywords: *Shell and Tube Heat Exchanger, Transfer rate, tube diameter, baffles, baffle spacing, Comsol Multiphysics.*



Waste Estimation for Breeder Type Molten Salt Reactors

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ABSTRACT

The majority of commercial reactors rely on the fission of uranium (mainly uranium-235). The process of fission produces radioactive byproducts because of the ratio of protons to neutrons that is out of equilibrium. Over time, radioactive isotopes decay and become stable. However, it takes millennia for some radioisotopes to reach stability. The radioactive waste from those reactors is crucial for future generations as a result. Limiting waste is one benefit offered by Generation-IV reactors. Thorium breeder reactors were selected as one of the Gen-IV reactors. The mass number of thorium is 232. It transforms into thorium-233, which has a half-life of 22 min, after absorbing one neutron. Additionally radioactive, protactinium-233 breaks down into uranium-233 which is not naturally occurring. However, it has good fissioning characteristics. Even though there are only two neutrons separating uranium-233 from uranium-235, the waste produced by uranium-233 fission has a substantially shorter half-life. Therefore, the reactor can breed its own fuel and produce less waste if thorium is added to the fuel along with fissioning isotopes. In the reactor, uranium and thorium can be combined as a molten salt. It is simple to remove useful isotopes from the molten fuel salt and use them as fresh fuel in the reactor. Since the molten salt reactors have not yet been made commercially available, there are no experimental results. The waste concentrations and amount can be estimated using Monte Carlo simulations. Nuclear engineers frequently employ Monte Carlo methods to solve the neutron transport equation. Since the 1940s, a number of codes have been created and tested for Monte Carlo calculations. One of the codes created by Oak Ridge National Lab in the US is SCLAE. The EVOL design was chosen as the reference model in Monte Carlo simulations since it is the design that comes closest to commercial-scale energy generation. It was discovered that the average half-life of waste from molten salt reactors was shorter than that of waste from conventional reactor types. Additionally, minor actinides from the fission process with qualities that favor neutron multiplication can be fed to the fresh fuel salt to increase the number of neutrons in the fuel. However, this necessitates the use of uncertainty analysis in future research on neutronics as well as chemical behavior.

Keywords: *Molten Salt Reactors, SCALE, Monte Carlo, Nuclear Waste*



Statistical Analysis for The Study Of The Reliability Of A Differential Filter

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ABSTRACT

We present from this work the results obtained from an in-depth analysis and an experimental study, on a very influential phenomenon affecting the majority of hydraulic systems and in particular the hydraulic filters which clean the hydraulic oil by retaining contaminants which can damage machine components.

Hydraulic oils are used in various industrial equipments (motors, machine tools, pumps, etc.). The main purpose of hydraulic fluid is to transfer the energy needed to operate machinery. The system studied, located in a workshop, is designed with a medium pressure pump used to supply energy to a rotating machine. Therefore we have analyzed the power of conservation of the particles of the filter, namely that the mesh of the filtering part is 15 micrometers in diameter. The influence of the service time and consequently the ratio of the number of polluting particles retained by the filter on the singular pressure loss of the element have been characterized.

The statistical study clearly reveals that the pressure losses at the level of the filter increase following a beta law. Obtaining this result, which gives us the evolution of the pressure drop phenomenon according to this law, will be useful to us for the proposal of a rigorous preventive maintenance policy.

Key words: *hydraulic oil; filter, pressure, pressure loss, distribution law, pump.*



Yer Altı Enerji Hatlarında Güzergâh Tespit Cihazlarının Güncel Durumu Ve Geleceği

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ÖZET

Elektrik, telekomünikasyon ve görüntü sistemlerinde enerjinin ve verilerin iletilmesinde kablo sistemleri yoğun olarak kullanılmaktadır. Kabloların güvenlik ve çevresel kirlilik gibi sorunlara neden olmaması için yer altına yerleştirilmesi gerekmektedir.

Yer altında yapılacak altyapı ve inşaat projeleri gibi uygulamalarda kazı yapılacak alanda bulunan hatların bilinmesi iş güvenliği ve maliyet açısından çok önemlidir. Yerleşim yerlerinin yoğun olduğu bölgelerde, havai hatlardan yeraltı hatlarına geçiş yapılması için çalışmaların artırılması yeraltında kablo tespiti yapacak cihazlara ihtiyaç olduğunu göstermektedir. Yer altı kabloları dış etkenler sebebiyle arızalara açıktır. Yer altı kablolarında ezilme, eskime, dış darbeler, imalat hataları, ek yeri arızası, nem gibi birçok sebepten kaynaklı arızalar zaman içerisinde oluşabilmektedir. Oluşan arızalar, elektrik enerjisinin bozulmasına veya uzun süreli kesintilere, özellikle de sanayi bölgesindeki tüketicilerde büyük zararlara sebep olmaktadır. Bu arızaların giderilmesi için yapılan kazı çalışmalarında, arızalı kablonun çıkarılması işleminin en kısa sürede yapılması dağıtım şirketleri ve onların hizmet verdiği özellikle fabrikalar gibi iş merkezleri için oldukça önemlidir.

Arızalı kabloların derinlik tespitinin klasik kazı yöntemi ile yapılması uzun süren ve maliyetli bir iştir. Sistem restorasyonunu hızlı bir şekilde takip etmek, kesinti süresini en aza indirmek ve parasal kayıpları daha da azaltmak için hızlı ve doğru bir arıza tespit tekniğine ihtiyaç vardır. Kablo hatalarını ayırt etmek ve bulmak için kullanılan geleneksel stratejilerin zaman alıcı olduğu görülmüştür.

Arızalı kablonun arıza noktası tespiti yapmak için TDR gibi yöntemler kullanılırken, kablonun yer altındaki konumu manyetik kablo bulucular ile yapılmaktadır. İthal ürün olarak temin edilip dağıtım firmalarında kullanılan kablo bulucular, yüksek maliyetleri, tek bobinli yapılarından dolayı derinlik tespiti hataları ve bulunan kablonun, kablo haritasının hassas bir konumlandırma ile CBS' ye entegre edilememeleri gibi dezavantajlara sahiptir.

Bu çalışmada elektromanyetik induksiyon prensibi başta olmak üzere çeşitli yeraltı kablolarında arıza yeri ile ilgili teknikler araştırılmış olup yer altı enerji hatlarında güzergâh tespit cihazlarının güncel durumu ve geleceği hakkında bir literatür araştırması yapılmıştır.

Anahtar Kelimeler: Yer Altı Kablo Tespiti, Kazı Çalışmaları, Arıza ve Bakım Çalışması Güvenliği, GNSS RTK, CBS

ABSTRACT

Cable systems are used extensively in the transmission of energy and data in electricity, telecommunication and display systems. Cables should be placed underground in order not to cause problems such as safety and environmental pollution.

Knowing the lines in the area to be excavated is very important in terms of work safety and cost in applications such as infrastructure and construction projects to be made underground. Increasing the number of studies for transitioning from overhead lines to underground lines in densely populated areas shows that there is a need for devices to detect underground cables. Underground cables are prone to malfunctions due to external factors. Failures in underground cables can occur over time due to many reasons such as crushing, aging, external impacts, manufacturing errors, joint failure, moisture. The resulting malfunctions cause long-term interruptions, especially in the industrial area, causing great damage to consumers. It is very important to remove the defective cable as soon as possible in excavation works for distribution companies.

Depth detection of defective cables with the classical excavation method is a long and costly task. While methods such as TDR are used to detect the fault point of the defective cable, the underground location of the cable is made with magnetic cable finders. Cable finders, which are supplied as imported products and used in distribution companies, have disadvantages such as high costs, inability to integrate the cable map of the found cable into the GIS with a precise positioning.

In this study, techniques related to fault location in various underground cables, especially the electromagnetic induction principle, were investigated and a literature search was conducted on the current status and future of route detection devices in underground power lines

Keywords: Underground Cable Detection, Excavation Studies, Failure and Maintenance Operation Safety, GNSS RTK, CBS



Birincil enerji tüketimi: Ülkeler arası trend analizi

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ÖZET

Enerji tüketimi bir ülkenin ekonomik faaliyetlerinin en büyük belirteçidir. Ülkelerin ekonomik faaliyetlerinin zamansal değişiminin bir göstergesi olarak birincil enerji tüketimindeki değişimler analiz edilebilmektedir. Bu çalışmada Türkiye, İtalya, Brezilya, Mısır, Suudi Arabistan ve Güney Kore'nin toplam birincil enerji tüketiminin istatistiki analizleri yapılmıştır. Analizi yapılacak ülkelerin seçiminde gelişmişlik düzeyleri ve ülkelerin konumları dikkate alınmış, çeşitlilik sağlayabilecek ve karşılaştırılabilir ülkeler seçilmiştir. Birincil enerji tüketim verilerinin 1966-2021 yılları arasındaki uzun vadeli değişim trendleri ampirik olarak Mann Kendall (MK) ve Sen'in eğim tahmin testleri kullanarak analiz edilmiştir. Bu amaç doğrultusunda; ülkelerin toplam birincil enerji tüketimine ait yıllık verileri kullanılmıştır. Analiz sonuçları ile oluşturulan grafikler birlikte incelendiğinde birincil enerji tüketimi için çalışılan tüm ülkelerde ve Dünya'da istatistiki olarak anlamlı düzeyde ve artan yönlü bir trend olduğu gözlemlenmiştir. Sonuç olarak nüfus, sanayi ve insanların refahındaki artışı ile teknolojik gelişmeler neticesinde ülkelerin birincil enerji kullanımının gün geçtikçe artacağı öngörülmektedir.

Anahtar Kelimeler— Enerji tüketimi, Trend analizi, Ülke

Primary energy consumption: Cross-country trend analysis

ABSTRACT

Energy consumption is the most important indicator of a country's economic activities. The changes in primary energy consumption can be analysed as an indicator of the temporal variation of the economic activities of the countries. In this study, statistical analysis of Global primary energy consumption and the primary energy consumption of Turkey, Italy, Brazil, Egypt, Saudi Arabia and South Korea were performed. In the selection of the countries to be analysed, the development level, geographical locations of the countries, diversity and comparability were considered. The long-term trends of change of primary energy consumption data between 1966-2021 were analysed empirically using Mann Kendall (MK) and Sen's slope prediction tests. The annual data of the total primary energy consumption of the countries were used in the analyses. Analysis results and graphics were examined and it has been determined that there is a statistically significant and increasing trend for primary energy consumption in all countries. As a result, because of the increase in population, industry and people's welfare and technological developments it is predicted that the primary energy consumption of countries will increase in future.

Keywords— Country, Energy consumption, Trend analysis



Design and Fabrication of Wind Tree Turbine Blade

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ABSTRACT

As the world is going towards renewable energy sources for energy production, the production of electricity from wind energy has proven to be an efficient, competitive, and pollution-free source of electricity production. The requirement for energy increases day by day as the population increases. Wind power technology is the process that promotes the usage of wind generation for mechanical power and electricity. An efficient aero generator would only be able to convert a maximum of 60% of available energy into mechanical energy. If blades are well designed the efficiency will be 70% probably. The objective of this research is to design a blade that convert more than 60% of available energy into mechanical work. The design of turbine blades has a great impact on enhancing the production of electricity. Our design was found more convenient and affordable. Available features and materials used in the fabrication of blade make it cost-effective as well. This research work expresses the complete design of savory wind turbine blades. We design this for the generation of 25W electricity. We approximately achieved our targeted output of 21.6W which is nearly equal to the theoretical output (25.2W).

Keywords: *Energy Generation, Renewable Energy, Vertical Axis Wind Turbine (VAWT), Wind Energy, Wind Tree Turbine*



Clean Energy Generation from Pressure Retarded Osmosis with Osmotic Power

Ozmotik Güç ile Basınç Geciktirmeli Osmozdan Temiz Enerji Üretimi

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ABSTRACT

Global energy consumption is increasing every day. However, the reserves of fossil fuels are decreasing and restrictions are increasing due to the environmental problems they cause. The demand for renewable energy sources is increasing significantly around the world. As a completely renewable and sustainable energy source with low operating costs, osmotic energy has gained popularity as a new approach, especially in 10 years. Osmotic energy takes advantage of the free energy released when mixing water flows of different salinities separated by a semi-permeable membrane. Although many countries produce significant amounts of energy from renewable energy sources such as wind, solar etc. it is estimated that osmotic energy technologies can provide more than 10% of the world's current energy demand with its global potential of approximately 1700-2000 TWh/year. In this study, osmotic energy was introduced and operations of pilot plants around the world were examined.

Keywords— *Osmotic energy, PRO, membrane, renewable energy*

ÖZET

Küresel enerji tüketimi her geçen gün artmaktadır. Fakat fosil yakıtların rezervleri azalmakta ve ortaya çıkardıkları çevresel problemler nedeniyle kısıtlamalar artmaktadır. Dünya genelinde yenilenebilir enerji kaynaklarına olan talep ciddi şekilde artmaktadır. İşletme açısından neredeyse maliyetsiz, tamamen yenilenebilir ve sürdürülebilir bir enerji kaynağı olarak osmotik enerji yeni bir yaklaşım olarak özellikle 10 yılda popülerlik kazanmıştır. Osmotik enerjisi, yarı geçirgen bir membran ile ayrılmış farklı tuzluluklara sahip su akışlarının karıştırılması sırasında açığa çıkan serbest enerjiden yararlanmaktadır. Günümüzde birçok ülke rüzgar, güneş vd. yenilenebilir enerji kaynaklarından ciddi miktarlarda enerji üretmekte olsa da henüz emekleme aşamasında olan bu teknolojinin sahip olduğu yaklaşık 17000-2000 TWh/yıl küresel potansiyel ile dünyanın mevcut enerji ihtiyacının %10'undan fazlasını karşılayabileceği tahmin edilmektedir. Bu çalışmada osmotik enerji tanıtılmış ve dünya genelinde işleme alınan pilot tesislerin verileri incelenmiştir.

Anahtar kelimeler — *Osmotik enerji, PRO, membran, yenilenebilir enerji*



Optical properties, influence of the polarization and the temperature on heterojunction organic solar cell

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ABSTRACT

We investigate the dark current-voltage properties of P3HT: PCBM based solar cell at different temperatures. The experimental data were fitted using two methods: Analytical Lambert Method, and Two Regions Method. Several electrical parameters such as: ideality factor n , series resistance R_s and shunt resistance R_{sh} were determined. The ideality factor for this device is bigger than unity which is discussed in terms: (i) existence of trap levels due to impurities in the band gap and (ii) the presence of tunneling conduction. It is shown that the J-V curves are driven by different effects depending on voltage and temperature ranges. By fitting the temperature dependence of the equivalent circuit's, we extract many essential parameters such as: potential barrier (Φ_b), Poole Frenkel coefficient β_p , mobility μ , and carrier concentration. It is shown that at low temperature the transport properties are governed by Schottky effect while at high temperature the Poole-Frenkel effect is prevailing.

Keywords: *Organic solar cells, Hole transport, mechanism of charge transport, Pool effect, P3HT: PCBM, Dark I-V characteristics.*



An Analysis of Synthesis of Renewable Chemicals from Lignocelulosic Biomass

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ABSTRACT

The primary reliable and cost-effective energy source that now ensures the production of required product quality is fossil fuels. According to statistics from the last ten years, the transportation sector uses more than 25% of the global energy, primarily diesel and gasoline. Recent years have seen a rise in interest worldwide in the use of renewable resources to displace petroleum as the principal feedstock for liquid fuels, chemicals, and materials. The rising price of oil and the harm that petroleum causes to the environment, and the benefits of renewable resources, such as their quantity and sustainability, make it attractive. The potential for bio-based compounds made from renewable resources is examined in this article. Since they make up around 95% of the biomass produced each year, carbohydrates are the most widely used feedstock for both commodities and specialized chemicals. Direct extraction, chemical and biological conversion pathways, as well as a few recent technological developments are covered. Examples of specific bio-chemicals are given, along with their conversion processes from biomass, derivatives, and prospective applications.

Keywords: Renewable, Chemicals, Lignocelulosic and Biomass.



Clean energy – Vital to halting climate change, ensuring energy security, and promoting sustainability

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ABSTRACT

With a growing population comes a greater demand for energy, and while 9 out of 10 people now have access to electricity, those in rural and semi-urban areas still do not. Extreme greenhouse gas emissions and water consumption caused by non-renewable energy sources have a negative impact on the planet. Sustainable development necessitates the use of renewable energy sources like solar, wind, and hydropower that are gentler on the planet. Because 60% of the world's energy comes from non-renewable sources, 3 billion people use biomass fuels like wood, coal, charcoal, and animal waste for cooking and heating, and 4 million people die each year from exposure to toxic air in their homes, it is imperative that we find ways to produce clean energy so that everyone can enjoy the basic human right to a healthy and safe environment. There is a widespread electricity shortage in South Asian and African countries, but renewable energy sources can reach even the smallest villages. Rural electrification made possible by clean energy helps ease the food security, water security, and poverty crises. Sustainable agricultural growth is possible with the help of clean energy, which also benefits people and the economy. Various countries use solar energy and solar pump irrigation systems to ensure the long-term availability of nutritious food. This highlights the importance of investing in the necessary infrastructure and upgrading technology to meet the growing demand for modern and sustainable energy services in developing nations, especially in the world's least developed, smallest, and most geographically isolated regions. We need to set up renewable energy hubs for various renewable resources like wind and solar if we want to decrease electricity subsidies. We can potentially affect waste management, employment, cost-effectiveness, and power consumption all by building a biomass centre. Biomass fuel is readily available, efficient, environmentally friendly, and burning clean. Wind energy is clean and renewable, but there are concerns about its unpredictability and the noise created by wind turbines. To boost energy production, environmental sustainability, and this disadvantage-free strategy, we must create small, lightweight wind turbines for urban and rural areas which will reduce poverty and generate economy for all .

Keywords: Energy, electricity, sustainable agricultural growth, energy hubs, clean energy, solar energy



Communication and Responsibility About Oil and Gas Using YouTube

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ABSTRACT

Online social networks have become essential channels in business strategies. Companies have incorporated new social media in their relations with the citizens. Companies increasingly communicate about Corporate Social Responsibility through interactive online media. Corporate Social Responsibility communication faces new challenges in these spaces of the Web 2.0, where companies can interact with users, generate a brand community, increase their visibility, and strengthen their position in the market. This research discusses the use of YouTube and the audiovisual contents in the channels of five international oil and gas companies (ExxonMobile, Chevron, Shell, British Petroleum Company, Total Energies). As method of research we have used the visual analysis of video materials. Our analysis shows that the companies use two main strategies in videos on their YouTube Channel: marketing and public relations. In addition, our analysis point out that there is a tendency to hybridise the two above-mentioned strategies. Also the results show that companies use these spaces as channels for business and advertising communication, but not so much for Corporate Social Responsibility communication, despite these social media offer many possibilities for interaction and dialogue with the public. In the conclusions we assess that, giving the existing energy (oil and gas) crisis it would be important that the international oil and gas companies to enter into a dialogue with the audience and to adapt to the requirements of Corporate Social Responsibility communication with their customers.

Keywords: *International Companies, Corporate Social Responsibility, Energy, YouTube*



Narratives of The Energy Crisis In Romania

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ABSTRACT

Crisis communication situations needs to be effective, because inefficiency can in this case results in problems at the organizational level, problems that can lead to serious, irreversible effects. Crisis resolution techniques and implicitly crisis communication within the academic context basically represent the management of these crises. The management of crisis situations is outlined by a series of measures, prepared in advance, measures that can allow an organization or institution to control, coordinate any crisis, emergency situation arising due to a triggering effect and also to minimize the chances of devastating effects on the organization. Also, crisis management can be seen as a process that is based on strategic communication, the objective being the elimination of risks and the uncertainty of subsequent consequences. In the case of the current energy crisis, crisis communication is particularly important. The present paper will present the narrative analysis of the political communication related to the gas and fuel crisis in the spring and summer of 2022 in Romania. The chosen method is the narrative analysis of the communications of the Government of Romania, respectively of the Ministry of Energy, in the time period January - June 2022. The analysis indicated that the political discourse is not focused on solving future situations, but on solving current problematic cases. The conclusions of our analysis indicate that the current energy crisis is presented in a narrative way through a discourse centered mostly on the actors involved, a contextual framework being outlined more externally and internally very few possible ways of solving the crisis were provided.

Keywords: *Crisis communication, Crisis management, Energy crisis, Romania*



Electricity Generation Using A Centrifugal Pump With An Open Impeller As Turbine In Reverse Mode

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ABSTRACT

Some countries in Africa are still plagued with the problem of epileptic electricity power supply which has crippled small and medium size businesses. It has also made enjoying social life in towns and cities very difficult. Most industries, where found generate electricity by themselves, causing enormous economic challenges and setbacks for these countries. The rural villages are not spared from this malady, a situation where some are yet to be connected to the national grid. The aim of this work is to investigate the operational parameters of a centrifugal pump as a turbine using an open impeller type for the purpose of generating electrical power. One of the most essential parts of a centrifugal pump is the impeller. The simplest type of impellers is the open impeller. The pump performance is dependent on the design parameters of the pump. The open impeller at the same diameter is lighter than any of the other type of impellers. They operate at a higher efficiency because of their lighter weight. In the method, performance tests were carried out on the centrifugal pump using an open impeller. Investigations were done to test and measure for the power input, power output, flow rate, velocity head, efficiency and specific speed of the centrifugal pump. The characteristic test carried out on the centrifugal pump using an open impeller. The evaluated parameters measured through numerical simulation for the open impeller at a head of $13 \cdot 70 \text{ m}$ were speed (1700 rpm) flow rate ($13 \cdot 61 \text{ m}^3/\text{s}$), velocity ($6 \cdot 7 \text{ m/s}$), shaft work ($111 \cdot 38 \text{ W}$), power input ($4224 \cdot 58 \text{ W}$), and power output ($3447 \cdot 18 \text{ W}$) at the best efficiency point of 76% .

Keywords: *Centrifugal Pump, Open Impeller, Electricity Generation, Pump as Turbine*



Biogas product simulation using ADM1 and feasibility study of using biogas in a power generation unit with Aspen plus

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ABSTRACT

Anaerobic digestion could be a renewable energy that produces biogas from organic waste. The little compatibility of anaerobic digestion efficiency with simulation is because of the dearth of a basic model, occurs from the complexity of the processes that include thousands of reactions and many microorganisms promoting anaerobic reactions; Therefore, closing simulation using the biogas production process model to seek out the foremost important factors involved in anaerobic digestion and selecting the foremost effective ones to extend the efficiency of the method, and methane production. The requirement of simulating anaerobic digestion becomes significant when it's difficult to form balanced conditions within the system and therefore the costs of conducting experimental and practical tests are very high and time-consuming. On the opposite hand, selecting thousands of microorganisms of various substrates and many biochemical reactions involved within the process is practically difficult and even impossible. During this research, the ADM1 model was used as a simulation model. The effect of pH changes on methane production rate and methane production processes were investigated. The aim of this research was to supply an integrated modelling platform during which an anaerobic digester might be linked to the opposite unit operations which serve it, both in maintaining the physical—chemical conditions within the digester and in transforming the digestion products to useful fuel and nutrient sources.

A simulation of Biogas Digestion process has been meted out through Aspen Plus. The anaerobic metabolism, its inhibitions and its parameters are studied. Then a model of digestion has been performed using the knowledge found in IWA Anaerobic Digestion Model No. 1 and Angelidaki et al. 1998 model of anaerobic digestion where Acidogenic, Acetogenic and Methanogenic step has been implemented following the reactions shown in both models, also amino-acid degradation reactions are implemented. The research developed an energy model which linked ADM1 to the mechanical processes for biogas upgrading, Combined Heat and Power (CHP) production. This integration of the method components allows accurate sizing of the CHP and direct heating units required for an anaerobic digestion plant designed for fuel grade methane production.

Keywords: Biogas, Aspen, Anaerobic Digestion.



Green Information and Communication Technology for Future

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ABSTRACT

For future generations, it must safeguard the natural nature of our planet from environmental issues. Information and Communication Technologies account for around 2.5% of all greenhouse gas emissions, according to calculations. Green Information and Communication Technology (Green ICT, Green IT) is an approach to the use of ICT that is concerned with the protection and sustainability of the environment, and consists of practices aimed at achieving corporate social responsibility by minimizing carbon footprint, ICT waste, and energy consumption. In this paper, proposals for implementing Green ICT in institutions of higher education that utilize information processing technology extensively are explored.

Keywords: ICT : Information and Communications Technology, Future, Green data.

ÖZET

Gelecek nesiller için dünyamızın doğal halini çevresel sorunlardan korumamız gereklidir. Yapılan hesaplamalarda Bilgi ve İletişim Teknolojilerinin toplam sera gazı salınımının yaklaşık % 2,5 kadarından sorumlu olduğunu ortaya koymaktadır. Yeşil Bilgi ve İletişim Teknolojisi (Yeşil BİT, Green ICT), çevrenin korunması ve sürdürülebilirliği ile ilgili BİT kullanımına yönelik bir yaklaşım olup, karbon ayak izini, BİT atıklarını en aza indirerek ve enerji tasarrufu sağlayarak kurumsal sosyal sorumluluğu gerçekleştirmeye yönelik uygulamalardan oluşmaktadır. Bu çalışmada, yüksek oranda bilgi işlem teknolojileri kullanan Yüksek Eğitim Kurumlarında Green ICT'nin uygulanmasına yönelik öneriler ele alınmaktadır.

Anahtar Kelimeler: BİT : Bilgi ve İletişim Teknolojisi, ICT : Information and Communications Technology



Progress in morphology control of active layer for hybrid organic/inorganic photovoltaic solar cells

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ABSTRACT

Organic solar cells hold the promise to provide renewable solar energy at low cost from abundant and environmentally benign materials. Currently, the most successful organic solar cells are using active layers that are based on two complementary materials including electron donating (donor) and electron accepting (acceptor) components. Polymeric hybrid organic solar cells combine a conjugating polymer with an inorganic semiconductor to highlight the light-absorbing properties and the processability of the polymer, and high electron mobility and morphological stability of the inorganic semiconductor. Improvement of photovoltaic cell performance can be achieved when the morphology of the donor and acceptor in the active layer is tuned to enhance charge generation, separation and transport. In this regards, the main goal of morphology control is providing efficient transport pathways for holes and electrons from the polymer domains and inorganic materials. In general, the activities that have been reported in the literature to control the morphology of hybrid solar cells are based on two different ways: The first approach is morphology engineering of active layer with the aim of optimizing the organic/inorganic hybrid nanostructure and the second approach is morphology engineering of the organic/inorganic hybrid interface with HTL or ETL layers with the aim of creating a better connection and charge transfer paths. Our research focuses mostly on the first approach. From this perspective, the morphology of the active layer depends critically on solubility, miscibility, and tendency to crystallize. These parameters can be influenced and optimized both by formulation and the processing conditions for example time, temperature, atmosphere. Thus, it is very essential to employ proper methods to control and tune the morphology of the organic/inorganic materials. A number of methods have been developed and widely used for morphology control, such as tuning the organic/inorganic materials molecular structure, optimizing organic/inorganic materials ratio, ternary strategy, choosing solvent and additive before the film processing and thermal annealing (with different annealing temperature and time), solvent annealing (different solvent and annealing atmosphere) and post-solvent treatment after the film processing. In summary, it seems that morphology control in polymeric hybrid solar cells could increase significantly the efficiency and open the gate for high efficient flexible solar cells.

Keywords: Hybrid solar cells, Polymeric cell, Morphology control, Active layer, Charge pathway, Cell efficiency



The Impact of Energy Researches on Current Interdisciplinary Sciences

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ABSTRACT

While energy research has been continuing at an increasing pace in recent years, the use of renewable energy resources, which is of great importance in our country and around the world, is progressing with the aim of finding a solution to the energy resource shortage that humanity will face in the future. It seems wise to use self-renewing resources such as the sun and wind, which are provided to us as energy sources in our world, to sustain life. However, although there has not been much research on the cultural reflections of these studies in our country, it is clearly seen that they contain interrogations that will be associated with interdisciplinary sciences in the international arena. One of the main purposes of this study is to explain the concepts of "sustainability" and "energy" and serve as a guide for their use in studies related between to social and natural sciences.

Keywords—Renewable Energy, Interdisciplinary, Energy effect.



Waste-to-Energy in Worldwide: Current and Future sustainable technologies

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ABSTRACT

Energy resources are rapidly consumed by human beings with technological developments and the desire for a modern life depending on these developments. When the need for energy is increasing day by day, the limited fossil fuel resources, the difficulties in ensuring the security of energy resources and the damage of these resources to the environment are evaluated in terms of cause and effect relationships, it has become inevitable to turn to renewable energy sources in order to ensure continuity in energy and prevent environmental pollution. Renewable energy production and the reduction of greenhouse gas emissions and energy needs associated with fossil fuels have made anaerobic digestion of biomass an attractive option. Methane produced from renewable biomass by anaerobic digestion has attracted attention as a rich biofuel. Waste-to-biogas conversion as an important example of waste-to-energy technology for renewable energy sources. This review explains waste sources (sludge, agricultural, animal waste etc), use of biomass in energy production (biogas) and overview of waste and waste management issues and then compared country wise. Future of waste to energy technologies is given according to current sustainable technologies with the examples in the several countries.

Keywords—Renewable Energy, Waste, Biomass, Biogas, Sustainable

ÖZET

Enerji kaynakları teknolojik gelişmeler ve bu gelişmelere bağlı olarak daha modern yaşama arzusuyla insanoğlu tarafından hızla tüketilmektedir. Enerjiye olan ihtiyacın her geçen gün artması, fosil yakıt kaynaklarının sınırlı oluşu, enerji kaynakları güvenliğinin sağlanmasındaki zorluklar ve bu kaynakların çevreye verdiği zararlar sebep sonuç ilişkileriyle değerlendirildiğinde enerjide sürekliliğini sağlamak ve çevre kirliliğini önlemek için yenilenebilir enerji kaynaklarına yönelim kaçınılmaz olmuştur. Yenilenebilir enerji üretimi ve sera gazı emisyonlarının ve fosil yakıtlarla ilişkili enerji ihtiyacının azaltılması, biyokütlenin anaerobik çürütülmesini cazip bir seçenek haline getirmiştir. Yenilenebilir biyokütleden anaerobik çürütme yoluyla üretilen metan zengin bir biyoyakıt olarak ilgi çekmiştir. Yenilenebilir enerji kaynakları için atıktan enerji teknolojisinin önemli bir örneği olarak atıktan biyogaza dönüşüm. Bu derleme, atık kaynaklarını (çamur, tarım, hayvan atıkları vb.), biyokütlenin enerji üretiminde (biyogaz) kullanımını ve atık ve atık yönetimi konularına genel bir bakışı açıklar ve ardından ülke bazında karşılaştırır. Atıktan enerji teknolojilerinin geleceği, çeşitli ülkelerdeki mevcut sürdürülebilir teknoloji örneklerine göre verilmektedir.

Anahtar kelimeler — Yenilenebilir enerji, Atık, Biyokütle, Biyogaz, Sürdürülebilir



Birincil enerji tüketimi: Ülkeler arası trend analizi

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Özet

Enerji tüketimi bir ülkenin ekonomik faaliyetlerinin en büyük belirteçidir. Ülkelerin ekonomik faaliyetlerinin zamansal değişiminin bir göstergesi olarak birincil enerji tüketimindeki değişimler analiz edilebilmektedir. Bu çalışmada Türkiye, İtalya, Brezilya, Mısır, Suudi Arabistan ve Güney Kore'nin toplam birincil enerji tüketiminin istatistiki analizleri yapılmıştır. Analizi yapılacak ülkelerin seçiminde gelişmişlik düzeyleri ve ülkelerin konumları dikkate alınmış, çeşitlilik sağlayabilecek ve karşılaştırılabilir ülkeler seçilmiştir. Birincil enerji tüketim verilerinin 1966-2021 yılları arasındaki uzun vadeli değişim trendleri ampirik olarak Mann Kendall (MK) ve Sen'in eğim tahmin testleri kullanarak analiz edilmiştir. Bu amaç doğrultusunda; ülkelerin toplam birincil enerji tüketimine ait yıllık verileri kullanılmıştır. Analiz sonuçları ile oluşturulan grafikler birlikte incelendiğinde birincil enerji tüketimi için çalışılan tüm ülkelerde ve Dünya'da istatistiki olarak anlamlı düzeyde ve artan yönlü bir trend olduğu gözlemlenmiştir. Sonuç olarak nüfus, sanayi ve insanların refahındaki artışı ile teknolojik gelişmeler neticesinde ülkelerin birincil enerji kullanımının gün geçtikçe artacağı öngörülmektedir.

Anahtar Kelimeler— enerji tüketimi, trend analizi, ülke

Abstract

Energy consumption is the most important indicator of a country's economic activities. The changes in primary energy consumption can be analysed as an indicator of the temporal variation of the economic activities of the countries. In this study, statistical analysis of Global primary energy consumption and the primary energy consumption of Turkey, Italy, Brazil, Egypt, Saudi Arabia and South Korea were performed. In the

selection of the countries to be analysed, the development level, geographical locations of the countries, diversity and comparability were considered. The long-term trends of change of primary energy consumption data between 1966-2021 were analysed empirically using Mann Kendall (MK) and Sen's slope prediction tests. The annual data of the total primary energy consumption of the countries were used in the analyses. Analysis results and graphics were examined and it has been determined that there is a statistically significant and increasing trend for primary energy consumption in all countries. As a result, because of the increase in population, industry and people's welfare and technological developments it is predicted that the primary energy consumption of countries will increase in future.

Keywords— country, energy consumption, trend analysis

I. GİRİŞ

Modern dünyada neredeyse tüm ekonomik faaliyetler enerji tüketimine bağlıdır. Bu durum enerji tüketiminin önemini göz ardı edilmez bir boyuta taşımaktadır. Enerji, fabrikaların çalışmasından evlere, her türlü taşımacılık işlemlerinin yürütülmesine kadar hem gelişmiş hem de gelişmekte olan ekonomiler için en önemli faktör olarak karşımıza çıkmaktadır. Temelde tüm bu ekonomik aktiviteler insanı yaşam standardının sürdürülmesi ve geliştirilmesi için ürün ve servislerin üretilmesini için vardır. Bu nedenle enerji tüketimi, ekonomik gelişmişliğin bir belirteci olarak kabul edilmektedir [1].

Endüstri devrimi sonucunda üretimin mekanize edilmesi ve seri üretimin ortaya çıkması ile enerjiye olan talebin artmasına neden olmuştur. Enerji bir ülkenin üretim seviyesi ve ekonomik gelişmişliği açısından tek girdi olmasa da ekonomik büyüme açısından ciddi önem arz etmektedir. Ülkelerin belirli bir ekonomik büyüme düzeyine ulaşması

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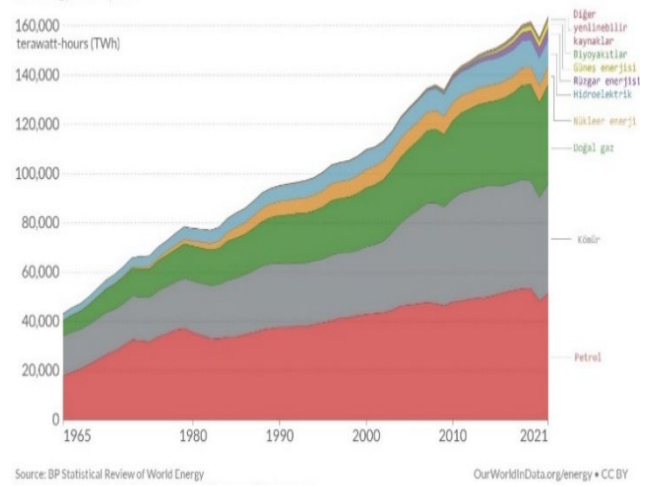
ancak belirli bir miktarda enerji tüketerek mümkündür. Günümüz dünyasında enerji olmadan mal ve hizmet üretmek, üretim sürecini sürdürmek veya bu mal ve hizmetleri tüketicilere uygun bir şekilde sunmak mümkün değildir. Bu nedenle, ülkeler sürdürülebilir büyüme hedeflerine ulaşmak ve yaşam standartlarını iyileştirmek için yeterli miktarda enerji tedarik etmelidir. Fakat ülkelerin her geçen gün artan enerji taleplerine karşın kaynaklar sınırlıdır. Ülkeler arasında sosyoekonomik yapılarındaki değişim ve büyüyen ekonomilerine uygun olarak artan enerji ihtiyacını karşılamak için güvenli ve sürdürülebilir kaynaklara erişme konusunda rekabet söz konusu olmaktadır.

Ayrıca dünya üzerindeki enerji rezervlerinin dağılımı homojen değildir ve hem miktar hem de enerjiye uzaklık olarak dengesizlik söz konusudur. Bu nedenlerden dolayı enerji ihtiyacını gidermek için yalnızca enerji kaynaklarına sahip olmak yeterli olmamakta, bu ham enerjinin işlenerek kullanılabilir hale getirilmesi ve sürekli tedarığın sağlanması da önem taşımaktadır [1-3].

Enerjinin tüketimini etkilemekte olan birçok faktör bulunmaktadır. Kaynakların kullanılabilirliği, teknolojik gelişmeler, politik ilişkiler, ekonomik ve sosyolojik gelişmişlik, kültür, iklim koşulları vb. faktörlere bağlı olarak ülkeden ülkeye ve hatta farklı coğrafyalara göre farklı enerji tüketim trendleri ortaya çıkmaktadır. Bu faktörler arasında teknolojik gelişmeler, nüfus artışı, enerji fiyatlandırılması gibi örnekler makro ölçekte enerji tüketimini etkilerken; bireylerin yaşam tarzı, tüketimlerine yönelik tutumlar, enerji konusunda bilgileri vb. mikro ölçekte etkilemektedir [4].

Dünyada kullanılan enerjinin büyük bir bölümü birincil enerji kaynaklarından elde edilmektedir. Birincil enerji, herhangi bir enerji dönüşümünden geçmemiş enerjileri kapsamaktadır. Bunlar temel olarak biyokütle, fosil yakıtlar (Kömür, petrol, doğal gaz), jeotermal enerji, hidrolik enerji, nükleer enerji, güneş enerjisi, gelgit enerjisi, dalga enerjisi, rüzgâr enerjisi şeklindedir. 2021 yılında fosil yakıtlar kullanılan toplam enerjinin %82'sini karşılamıştır. Bu değer bir önceki yıl %83 ve 5 yıl önce %85 olarak bildirilmiştir.

Enerjiye olan talebin yıllara göre arttığı da göz önüne alındığında 2019-2021 yılları arasında yenilenebilir enerji üretimi 8 EJ artmıştır. Birincil enerji üretimi ise 2020 yılına göre 31 EJ artmış olmakla beraber artışın büyüklüğünde, pandemi nedeniyle yaşanan düşüşün etkili olduğu da unutulmamalıdır. 1965-2021 yılları arasında Dünya genelinde gerçekleşen enerji tüketim trendi, birincil enerji kaynakları ayrı ayrı belirtilerek Şekil 1'de verilmektedir [5, 6].



Şekil 1. 1965-2021 yılları arasında Dünya geneli toplam enerji tüketimi [7]

Datalarımız farklı kıtalardan farklı gelişmişlik seviyesine sahip 8 ülkenin 1965-2020 yılları arasındaki enerji tüketim verilerini kapsamaktadır. Bu ülkeler Avrupa'dan Türkiye ve İtalya, Güney Amerika'dan Brezilya, Afrika'dan Mısır, Orta Doğu'dan Suudi Arabistan, Asya'dan Güney Kore'dir.

IMF verilerine göre bu ülkelerden İtalya ve Güney Kore gelişmiş ülke ve Türkiye, Brezilya, Mısır ve Suudi Arabistan gelişmekte olan ülke olarak sınıflandırılmaktadır. Bu 6 ülke ise birbirlerine yakın enerji tüketim miktarlarına sahip ülkelerdir. Ayrıca ülkeler buldukları kıtaları temsil edecek şekilde belirlenmiştir. BP 2022 istatistiklerine göre seçilen ülkelerin birincil enerji tüketim payları Tablo 1'de verilmiştir [8, 9].

Tablo 1'de görüldüğü üzere seçilen ülkelerin 2021 yılında enerji tüketimlerinin büyük kısmını petrol, doğal gaz ve kömür karşılamaktadır. İtalya'da petrol ve doğal gaz tüketiminin toplam enerji tüketimine oranı sırasıyla %36.9 ve %41'sini oluştururken, Mısır'da %33.7 ve %58.7 olduğu görülmektedir. Brezilya'da ise petrol ve Hidroelektrik enerjisi sırasıyla %35.5 ve %27.2 oranında enerji tüketimini karşılamaktadır. Suudi Arabistan ise enerji tüketiminin %60.9'sunu petrol ve %39'unu doğal gazdan karşılamaktadır. 2021 yılında Türkiye'de ise enerji tüketimi fosil yakıtlar arasında dengeli şekilde dağılmış ve petrol, doğal gaz ve kömür için sırasıyla %27.7, %30.2 ve %25.5 olarak bildirilmiştir. Türkiye, İtalya ve Mısır'ın nükleer enerji üretimi bulunmamaktadır. Brezilya'nın toplam enerji tüketiminde yenilenebilir ve hidroelektrik enerjinin oranını sırasıyla %19.2 ve %27.2'dir [6].

Bu ülkelerin 1966-2021 yılları arasındaki birincil enerji tüketim verilerine ait zaman serileri grafikler üzerinden yorumlanmıştır. Mann-Kendall, Sen'in eğim tahmin metodu ve yenilikçi trend analizi yöntemleri kullanılarak Türkiye ve çalışmaya konu olan diğer ülkelerin belirtilen yıllar arasında enerji ihtiyacındaki değişimin trend analizi yapılmıştır.



Tablo 1. 2021 yılı birincil enerji tüketim verileri [6]

	Brezilya	İtalya	Türkiye	Mısır	Suudi Arabistan	Güney Kore
Petrol	35.5	36.9	27.7	33.7	60.9	42.8
Doğalgaz	11.6	41.0	30.2	58.7	39.0	17.9
Kömür	5.6	3.6	25.5	1.3	0.0	24.2
Nükleer Enerji	1.0	0.0	0.0	0.0	0.0	11.4
Hidroelektrik	27.2	6.4	7.6	3.7	0.0	0.2
Yenilenebilir enerji kaynakları	19.0	11.9	8.9	2.6	0.1	3.5

Tablo 2. Ülkelerin birincil enerji tüketim verilerine ait belirleyici istatistikler

Ülke	Ortalama	Güven Aralığı		Ortanca	Min	Max	Aralık	Çarpıklık	Basıklık
		Alt Limit	Üst Limit						
Brezilya	6.859	5.862	7.857	6.405	1.08	12.73	11.65	0.142	-1.226
Türkiye	2.765	2.246	3.284	2.325	0.38	6.83	6.45	0.639	-0.755
S. Arabistan	4.749	3.815	5.683	3.840	0.86	11.16	10.30	0.644	-0.938
G. Kore	5.908	4.722	7.095	5.580	0.33	12.68	12.35	0.178	-1.565
Mısır	1.806	1.487	2.124	1.460	0.26	3.84	3.58	0.377	-1.218
İtalya	6.450	6.194	6.706	6.550	3.63	7.92	4.29	-0.862	1.058

II. MATERYAL VE METOT

A. Veri

Bu çalışmada farklı kıtalardan farklı gelişmişlik seviyesine sahip 6 ülkenin 1966-2021 yılları arasındaki enerji tüketim verilerini kapsamaktadır. Bu ülkeler Avrupa'dan Türkiye ve İtalya, Güney Amerika'dan Brezilya, Afrika'dan Mısır, Orta Doğu'dan Suudi Arabistan, Asya'dan Güney Kore'dir. Ülkelerin birincil enerji kullanım verileri BP'nin "Dünya Enerjisinin İstatistiksel İncelemesi" raporundan yıllık değerler olarak alınmıştır [6]. Buna göre ülkelerin birincil enerji tüketim verilerine ait belirleyici istatistikler Tablo 2'de sunulmuştur.

B. Mann-Kendall Analizi ve Sen'in Eğim Tahmin Metodu

Ülkelerin birincil enerji tüketim (BET) miktarlarının zamansal değişiminde istatistiksel olarak anlamlı bir trendin varlığı Mann-Kendall yöntemiyle araştırılmıştır. Bu trendlerin büyüklüğü Sen'in eğim tahmini yöntemiyle hesaplanarak ülkeler için karşılaştırılabilir veriler elde edilmiştir. Çalışmada Mann-Kendall yöntemi sırasıyla (1), (2) ve (3)'de verilen protokole göre hesaplanmıştır [10, 11].

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^n \text{sgn}(x_j - x_i) \quad (1)$$

Denklemden, n veri sayısını, x_j ve x_i ise x_1, \dots, x_n zaman serisindeki verileri temsil etmektedir. Pozitif S değerleri artış

eğilimlerini, negatif S değerleri ise azalış eğilimlerini göstermektedir.

$$\text{Var}(S) = \frac{[n(n-1)(2n+5) - \sum_{i=1}^m t_i(t_i-1)(2t_i+5)]}{18} \quad (2)$$

$$Z = \begin{cases} \frac{S-1}{\sqrt{\text{var}(S)}}, & S > 0 \\ 0, & S = 0 \\ \frac{S+1}{\sqrt{\text{var}(S)}}, & S < 0 \end{cases} \quad (3)$$

Burada m, veri setindeki bağıl grupların sayısını ve t_i , i uzunluğundaki bir seride frekansı sembolize etmektedir. Sen'in trend eğilim tahmin metodunda ortalama eğilimin tahmini (4) ve (5) kullanılarak yapılmıştır [12].

$$Q_i = \frac{x_j - x_k}{j - k} \text{ for } i = 1, \dots, N \quad (4)$$

$$N = n(n-1)/2 \quad (5)$$

Burada n, zaman periyotlarının sayısını; x_j ve x_k , $j > k$ olmak koşuluyla j ve k zamanlarındaki verileri temsil etmektedir. Q_i 'nin N değerleri küçükten büyüğe sıralanır ve N'nin çift sayı olması durumunda (6), N'nin tek sayı olması durumunda ise (7) ile Q_{med} hesaplanır.

$$Q_{\text{med}} = Q_{(N+1)/2} \quad (6)$$

$$Q_{\text{med}} = \frac{1}{2}(Q_{N/2} + Q_{(N+2)/2}) \quad (7)$$

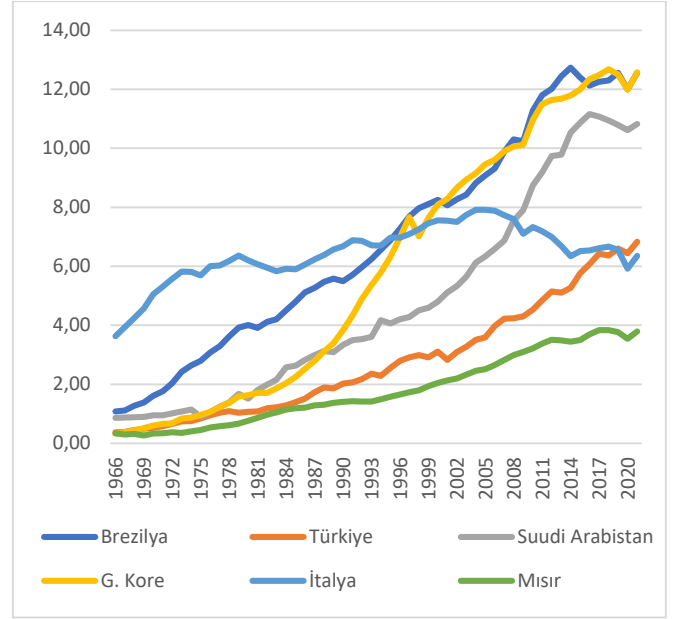


III. BULGULAR

Sanayi devrimi sonrası ülkelerin enerji kaynaklarını verimli olarak kullanabilmesi uygarlığın benzersiz bir şekilde gelişmesini sağlamıştır. Bununla birlikte modern dünyada aşırı tüketim bir alışkanlık haline gelmiştir. Ülkelerin ekonomileri hızla gelişmiş, endüstriler hızla büyümüş, artan dünya nüfusuyla da birlikte enerji ihtiyaçları katlanarak artmıştır. Bu çalışmada ülkelerin BET miktarlarının zamansal değişimi zaman serileri ve istatistiksel trend analizleri ile değerlendirilmiştir.

A. Birincil Enerji Tüketim Değerlerinin Zamansal Değişimi

Şekil 2’de BET miktarları birbirine yakın olan Brezilya, Türkiye, Suudi Arabistan, Güney Kore, İtalya ve Mısır’a ait verilerin zamansal değişim grafikleri verilmiştir. Brezilya ve Güney Kore’nin tüketim grafikleri 1994 yılından itibaren oldukça benzerlik göstermekte ve 2021 yılında yaklaşık 12.5 mtep tüketim değerine ulaşmaktadır. Bu ülkelere benzer bir şekilde inceleme dönemi boyunca genel olarak tüketimini artıran Suudi Arabistan Türkiye ve Mısır 2021 yılında sırasıyla 10.82 mtep, 6.83 mtep ve 3.79 mtep tüketime ulaşmıştır. İtalya’nın tüketim değerlerindeki değişimler Avrupa Birliği üyesi ülkelerin toplam tüketimindeki değişimlerle benzerlik göstermektedir [13]. İncelememize Avrupa ülkelerini temsilen dâhil edilmiş İtalya’nın BET miktarındaki zamansal değişim ise diğer ülkelere göre oldukça farklı seyretmekte, tüketim miktarlarında azalmalar göze çarpmaktadır. Bu durumun iklim değişikliği anlaşmalarındaki taahhütlerin karşılanması ve işçilik maliyetlerindeki avantajlar nedeniyle ağır sanayinin Avrupa dışına taşınmasından kaynaklandığı düşünülmektedir. Ayrıca Avrupa Birliği’nin enerji verimliliği ve tasarrufu ile ilgili politikalarının da etkili olduğu söylenebilir.



Şekil 2. Diğer ülkelerin birincil enerji tüketim miktarı zamansal değişimi

B. Mann-Kendall Testi ve Sen’in Eğim Tahmin Metodu Sonuçları

Tablo 3’te Mann-Kendall Testi ve Sen’in eğim tahmin yöntemi ile elde edilmiş sonuçlar listelenmiştir. Ülkelerin tüketimlerinde trendlerin varlığı Mann-kendall testi ile 0.05 anlamlılık seviyesine göre değerlendirilmiştir. Buna göre, $z \geq 1.96$ şartı sağlanan zaman serilerinde istatistiksel olarak anlamlı artış trendi olduğu, $z \leq -1.96$ şartı sağlanan zaman serilerinde ise istatistiksel olarak anlamlı azalış trendi olduğu kabulü yapılmıştır. Beklendiği üzere incelenen tüm ülkelerde istatistiksel olarak anlamlı artış trendi bulunmaktadır. Sen’in eğim tahmin metoduyla bu trendlerin eğimleri hesaplanmıştır. Elde edilen sonuçlara göre tüketim verilerinin zamansal değişiminde en yüksek eğim G. Kore’ye (0.26), en düşük eğim ise Mısır’a (0.06) aittir.

Tablo 3. Mann-Kendall Testi ve Sen’in eğim tahmin analizlerinin sonuçları

	Brezilya	Türkiye	Suudi Arabistan	G. Kore	Mısır	İtalya
alpha	0.05	0.05	0.05	0.05	0.05	0.05
MK-stat	1542	1564	1544	1578	1544	884
z-stat	10.60801	10.75946	10.62178	10.85583	10.62178	6.078439
p-value	2.74E-26	5.35E-27	2.36E-26	1.87E-27	2.36E-26	1.21E-09
trend	evet	evet	evet	evet	evet	evet
Sen's slope	0.219827	0.108007	0.185361	0.26474	0.069293	0.052517



IV. SONUÇLAR

Bu çalışmada 6 ülkeye ait yıllık birincil enerji tüketim verilerinin zamansal değişimleri değerlendirilmiştir. Bu değişimlerin trend analizleri Mann Kendall ve Sen's slope yöntemi kullanılarak 0.05 anlamlılık seviyesinde yapılmıştır. Ülkelerin yıllık birincil enerji tüketiminin Mann-Kendall testinde tüm ülkelerde artan trend belirlenmiştir.

BET miktarları birbirine yakın olan Brezilya, Türkiye, Suudi Arabistan, Güney Kore, İtalya ve Mısır'a ait veriler birlikte değerlendirilmiştir. İtalya hariç bu ülkelerin tüketimlerinde genel olarak sistematik artış olduğu görülmüştür. Avrupa ülkelerini temsilen incelemeye alınmış İtalya'da da artış olduğu tespit edilse de 2005 yılından itibaren tüketimin azaldığı belirlenmiştir. Bu durumun ağır sanayinin Avrupa dışına taşınmasından kaynaklandığı düşünülmektedir. Ayrıca Avrupa Birliği'nin enerji verimliliği ve tasarrufu ile ilgili politikalarının da etkili olduğu söylenebilir. Ancak bazı sanayi faaliyetlerini geliştirmekte olan ülkelere taşıyarak iklim değişikliği anlaşmalarının şartlarını sağlayan Avrupa ülkelerinin bu faaliyetleri sonucunda hala tüketim yaptığı unutulmamalıdır.

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Clean Energy Generation from Pressure Retarded Osmosis with Osmotic Power

Osmotik Güç ile Basınç Geciktirmeli Osmozdan Temiz Enerji Üretimi

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Özet

Küresel enerji tüketimi her geçen gün artmaktadır. Fakat fosil yakıtların rezervleri azalmakta ve ortaya çıkardıkları çevresel problemler nedeniyle kısıtlamalar artmaktadır. Dünya genelinde yenilenebilir enerji kaynaklarına olan talep ciddi şekilde artmaktadır. İşletme açısından neredeyse maliyetsiz, tamamen yenilenebilir ve sürdürülebilir bir enerji kaynağı olarak osmotik enerji yeni bir yaklaşım olarak özellikle 10 yılda popülerlik kazanmıştır. Osmotik enerjisi, yarı geçirgen bir membran ile ayrılmış farklı tuzluluklara sahip su akışlarının karıştırılması sırasında açığa çıkan serbest enerjiden yararlanmaktadır. Günümüzde birçok ülke rüzgar, güneş vd. yenilenebilir enerji kaynaklarından ciddi miktarlarda enerji üretmekte olsa da henüz emekleme aşamasında olan bu teknolojinin sahip olduğu yaklaşık 17000-2000 TWh/yıl küresel potansiyel ile dünyanın mevcut enerji ihtiyacının %10'undan fazlasını karşılayabileceği tahmin edilmektedir. Bu çalışmada osmotik enerji tanıtılmış ve dünya genelinde işleme alınan pilot tesislerin verileri incelenmiştir.

Anahtar kelimeler — Osmotik enerji, PRO, membran, yenilenebilir enerji

Abstract

Global energy consumption is increasing every day. However, the reserves of fossil fuels are decreasing and restrictions are increasing due to the environmental problems they cause. The demand for renewable energy sources is increasing significantly around the world. As a completely renewable and sustainable energy source with low operating costs, osmotic energy has gained popularity as a new approach, especially in 10 years. Osmotic energy takes advantage of the free energy released when mixing water flows of different salinities separated by a semi-permeable membrane. Although many countries produce significant amounts of energy from renewable energy sources such as wind, solar etc. it is estimated that osmotic energy technologies can provide more than 10% of the world's current energy demand with its global potential of approximately 1700-2000 TWh/year. In this study, osmotic energy was introduced and operations of pilot plants around the world were examined.

Keywords— Osmotic energy, PRO, membrane, renewable energy

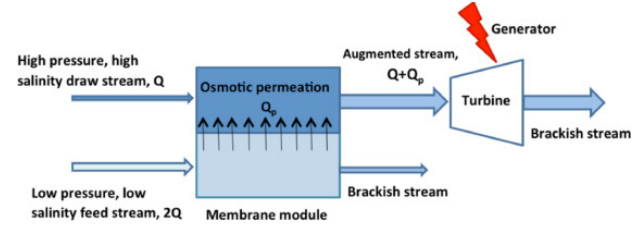
I. INTRODUCTION

Global enerji tüketiminin hızlanarak artması ile yenilenebilir enerji kaynaklarından enerji elde etmenin önemi de hızla artmaktadır. Global enerji tüketiminin %56 oranında büyüyeceği ve 2040 yılında toplam enerji kullanımının 240 kTWh'ye yükseleceği tahmin edilmektedir. Fakat geleneksel fosil yakıtların rezervleri azalmakta ve sera gazı emisyonları küresel iklimi değiştirmektedir. Sıkı çevre düzenlemeleri ve yüksek enerji maliyeti karşısında, alternatif yenilenebilir enerji kaynaklarına olan talebin ciddi şekilde artması söz konusudur. Yenilenebilir bir enerji kaynağı olarak osmotik basınç gradyan enerjisi, farklı tuzluluklara sahip su akışlarının karıştırılması sırasında açığa çıkan serbest enerjiden yararlanmaktadır. Bu enerji, basınç geciktirmeli osmoz (PRO) gibi membran tabanlı teknolojiler kullanılarak elektrik üretimi için toplanabilmektedir [1]

Yenilenebilir enerji kaynakları arasında osmotik enerji, yaklaşık 1700-2000 TWh/yıl küresel potansiyele sahip olan ve hala geliştirilme aşamasında olan bir kaynaktır. Bu değer, dünyanın mevcut enerji ihtiyacının %10'undan fazlasını karşılayabileceğini göstermektedir [2]-[4]. Teoride metreküp başına 0,75-14.1 kWh kadar enerji elde edilebilir ki bu 280 metrelik yüksekliğe sahip bir barajdan düşen sudan üretilen enerjiye eşdeğerdir [5]. Ve bu proses sırasında atmosfere hiçbir sera gazı açığa çıkmamaktadır. Süreç neredeyse maliyetsiz, tamamen yenilenebilir ve sürdürülebilir bir enerji kaynağı olarak bilinmektedir. Ayrıca sistemin çevresel etkileri minimal düzeydedir. Örneğin bir nehir ile deniz suyunun birleştiği noktaya kurulan PRO tesisi, su kaynaklarını sadece içerisinde devir ettirmekte ve doğal şekilde olduğu gibi aynı noktadan deşarj etmektedir [6], [7].

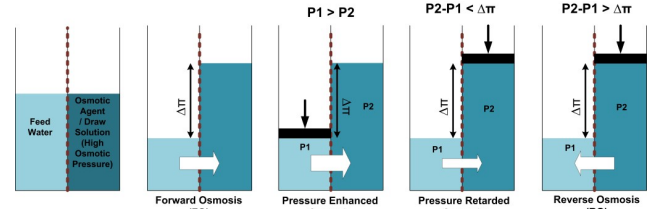
Osmotik enerji, nehir suyu ve deniz suyu gibi farklı tuzlulukta iki sulu çözelti arasındaki tuz konsantrasyonu farkından kaynaklanır. Benzer temellere dayalı birçok yaklaşım olmakla beraber basınç geciktirmeli osmoz (pressure-retarded osmosis, PRO) ve ters elektrodiyaliz (reverse electrodiyaliz, RED) gibi yöntemler son yıllarda önem kazanmıştır [8]. RED ile karşılaştırıldığında, PRO daha yüksek verimlilik ve daha yüksek güç yoğunluğu gösterir ve yüksek tuzluluk gradyanlarından güç elde etmek için daha uygundur [1]. Deniz suyu-nehir sistemleri için pratik uygulama potansiyelleri hakkında hala tartışmalar olmasına rağmen PRO'nun özellikle ters osmoz kullanılan laboratuvar ölçekli denemelerinde, çeşitli tuzluluk oranlarında sürdürülebilir enerji elde etme potansiyeli olduğu ve membran kirlenmesi probleminin önemli ölçüde azaltıldığı sonuçları ortaya konulmuştur [8], [9].

Daha önce bahsedildiği gibi hem PRO hem de RED proseslerinde osmotik basınç gradyan enerjisinden yararlanır. Tipik bir PRO prosesinde su, yarı geçirgen bir membran ile ayrılmış besleme bölgesinden basınçlı tuzlu suyun olduğu bölgeye kimyasal potansiyel gradyanı nedeniyle kendiliğinden nüfus etmektedir. Bunun sonucunda seyreltilmiş tuzlu suyun hacmi ve hidrolik basıncı artmakta ve basınçlı su bir hidro-türbin aracılığıyla elektrik üretilmesini sağlanmaktadır [1].



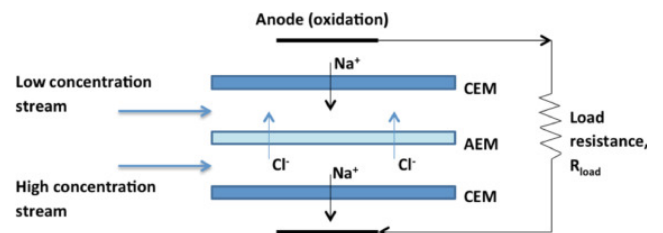
Şekil 1. Elektrik üretimi için basınç geciktirmeli osmoz işleminin şeması [10].

Membran prosesleri yarı geçirgen bir membran boyunca uygulanan hidrolik basınç farkına (ΔP) ve efektif osmotik basınç farkına ($\Delta \pi_{eff}$) bağlı olarak ters osmoz ($\Delta \pi_{eff} < \Delta P$), basınç geciktirmeli osmoz ($0 < \Delta P < \Delta \pi_{eff}$), ileri osmoz ($\Delta P = 0$) ve basınç destekli osmoz ($\Delta P < 0$) gibi farklı şekillerde işletilebilirler. PRO, ters osmozun tersi olarak kabul edilebilir. Ters osmoz ve basınç destekli osmozda suyun membranından geçmesini sağlamak adına mekanik bir enerjinin uygulanması ve enerjinin tüketilmesi gerekmektedir. Fakat PRO'da işlem bunun tersi şeklindedir. Su, basınç gradyanına karşı nüfus etmektedir ve düşük tuzluluğa sahip taraftan yüksek tuzluluğa sahip olan ve basınçlandırılmış tarafa geçmektedir. Buradaki basınçlı su ile bir türbini çalıştırmak için kullanılarak elektrik enerjisi üretmektedir [8].



Şekil 2. Farklı osmotik proseslerin gösterimi [11]

RED prosesinde ise iyon değişim membranları ile yüksek tuzluluğa ve düşük tuzluluğa sahip iki çözelti ayrılmaktadır. Membran içerisinden suyun geçtiği PRO'dan farklı olarak, membran içerisinden iyonlar geçmektedir. İki çözelti arasındaki konsantrasyon farkı nedeniyle ters yüklü iyonlar membranlara hareket etmekte ve membranlardan geçmektedir. İyonların membranlardan geçmesi sırasında oluşan elektrik akımı sayesinde enerji elde edilmektedir.

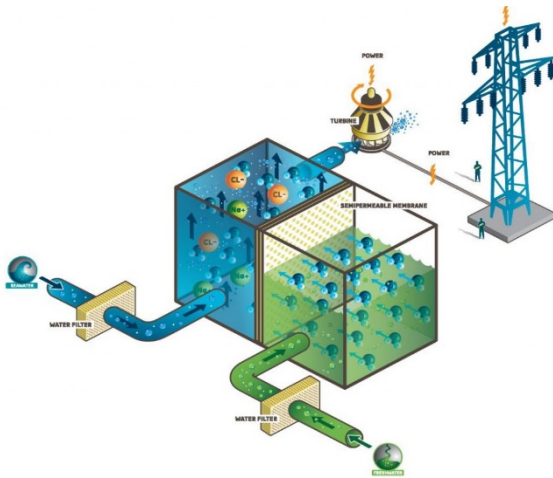


Şekil 3. İyon değişim membranı yoluyla ters elektrodiyaliz fonksiyonunun şeması [10]

Bu iki proses arasında PRO'nun RED'e karşı baskın bir üstünlük olduğu bilinmektedir. Yip & Elimelech [12], PRO membranlarının su geçirgenliğini sağlamak adına tuzluluk gradyanını daha etkin bir şekilde kullanabildiğini ve tuz sızıntılarının daha az olduğunu belirtmiştir. Daha önemlisi, PRO'nun hem yüksek verimliliğe (%54-56) hem de yüksek enerji yoğunluğuna ($2,4-38 \text{ W/m}^2$) sahip olduğunu belirtmektedir. RED'in enerji verimliliği ve güç yoğunluğu sırasıyla %18-38 ve $0,77-1,2 \text{ W/m}^2$ 'dir.

II. PRO

PRO konseptinin gelişimi 1970'li yıllara kadar girmektedir. 1974 yılında Norman temiz suyun yarı geçirgen bir membrandan geçerek basınçlandırılan deniz suyu hücrelerine geçişinden enerji elde edilebileceğini bir diyagram ile ortaya koymuştur. Deniz suyu hücrelerinden taşınan su bir su çarkını döndürmekte jeneratörü çalıştırmaktadır. Bu şekilde sudaki kimyasal potansiyelin hidrostatik potansiyele dönüştürülmesini göstermiştir. Bir yıl sonra Loeb ve Norman prosese "basınç geciktirmeli osmoz (PRO)" ismini vermişlerdir [3]. 1976 yılında Loeb vd. U-şeklindeki hollow fiber membran ile elektrik üretimi için PRO konseptinin uygulanabilirliğini göstermiştir. Fakat dahili konsantrasyon polarizasyonu sorunu nedeniyle su akışı sürekli düşmekte ve buna bağlı olarak güç yoğunluğu önemli ölçüde azalmaktadır. Bu da uygulanmasını sınırlamıştır. Fakat membran teknolojisinin sürekli gelişim trendinde olması ve ileri osmoza uygun şekilde dizayn edilen selüloz asetat membranlar ile dahili konsantrasyon polarizasyon etkisinin azaltılması sonucunda PRO araştırma ve geliştirmeleri tekrar canlanmıştır. Nehir suyu/deniz suyu için güç yoğunluğu 1 Wm^{-2} 'den $2,7 \text{ W/m}^2$ 'ye çıkmış; deniz suyunun geçirildiği ters osmoz membranı tuzlu suyunu $4-5,1 \text{ W/m}^2$ elde edilmiştir [5].



Şekil 4. PRO prosesinin şematik gösterimi [13]

Membran, tuzluluk gradyanı enerjisi veya osmotik enerjinin kontrol edilmesinde önem taşımaktadır. Geçmişte,

çalışmalarda ticari ters osmoz ve ileri osmoz membranları kullanılmaktaydı. Fakat ters osmoz membranlarının göreceli olarak kalın ve yoğun destek tabakaları nedeniyle düşük güç yoğunluğuna sahip olmaları ve ileri osmoz membranlarının mekanik dayanımlarının düşüklüğü nedeniyle yüksek basınç altında deforme olmaları osmotik basınç ile çalışan sistemlerde kullanıma uygun olmadıklarını göstermiştir. Günümüzde PRO prosesinde enerji eldesinde yüksek performanslı ve yöntemine göre tasarlanmış membranlar kullanılmaktadır. Büyük membran üreticileri PRO ve diğer proseslere uygun membranlar üretmekte ve geliştirmektedirler. Bu membranlar düz plaka membranlar ve hollow fiber membranlar olmak üzere iki temel tipte paketlenmektedir. Düz plaka tipi membranlar ince filmler şeklinde üretilmekte ve kolaylıkla temizlenebilir olmaktadır. Modüller kolaylıkla değiştirilebilir ve yüksek paket yoğunluğu ve mekanik dayanıma sahiptirler. Hollow fiber membranlar ise çok yüksek paketleme yoğunluğu nedeniyle kullanılmaktadırlar. Her iki membran tipi de yüksek su geçirimi ve tuz reddetme oranına sahiptirler [6], [14].



Şekil 5. Osmotik basınçla işletilen membran proseslerinde kullanılan membran tipleri (a) spiral sarımlı düz levha, (b) hollow fiber [15], [16].

Diğer membran proseslerinde olduğu gibi, sıcaklık, basınç, solüsyon konsantrasyonu ve akış hızları gibi işletme faktörleri, PRO membranlardan tuz ve suyun taşınmasındaki rolleri nedeniyle PRO proses verimliliği üzerinde büyük bir etkiye sahiptir. Örneğin sıcaklığın etkisini düz plaka ve hollow fiber membranlarda çalışan Garravand & Mulligan [17], 35 ve 5°C 'lerde düz plaka membran için sırasıyla $26,3$ ve $17,1 \text{ W/m}^2$; hollow fiber membranlar için sırasıyla $16,8$ ve $14,2 \text{ W/m}^2$ güç yoğunluğu elde etmiştir. Membran tipinden farklı olarak sıcaklığın düşmesi güç yoğunluğunu düşürmektedir fakat bu değerler en düşük değerlerde bile PRO prosesinden ekonomik olarak enerji elde etmek için gerekli olan $3-5 \text{ W/m}^2$ güç yoğunluğundan fazla olarak belirlemleridir.

Prosesin önündeki en büyük engellerde biri ise ileri osmoz membran modüllerini tedarik edilmesindeki sorunlardır. Membran üreticileri PRO için optimize edilmiş ileri osmoz membranları ticari olarak ucuz ve büyük miktarlarda üretmemektedir. Yöntemin gelişmesinde membran özelliklerinin gelişmesi çok önemlidir fakat membran üreticileri açısından küçük boyutlu piyasanın membran geliştirme için harcanacak araştırma ve geliştirme yatırımlarını karşılamama durumu söz konusudur. Nitto

Denko/Hydranautics, HTI ve Aquaporin gibi bazı üreticilerin PRO yöntemine uygun ticari membran çalışmaları yaptığı bilinmektedir [14].

III. DÜNYA'DA UYGULAMALARI

PRO prosesi enerji üretimi açısından büyük bir potansiyele sahiptir. Özellikle de birçok büyük şehrin nehir kenarlarına kurulu olduğu düşünüldüğünde osmotik basınç ile enerji elde edilebilir olması ve bu enerjinin göreceli olarak yakındaki şehre taşıma sırasında kaybının düşük olması en önemli avantajlarından biri olarak görülmektedir. Osmotik enerji, rüzgar ve güneş enerjisine kıyasla, 24 saat üretilebilmekte ve atmosferik değişimlerden etkilenmemektedir.

Statkraft, Avrupa'nın en büyük yenilenebilir enerji üreticisi ve Norveç'teki büyük enerji sağlayıcılardan biri, ile SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology) 2000'li yılların sonlarında PRO tesisleri ile ilgili çalışmalarını yayınlamışlardır. Firma, osmotik enerji potansiyelinin dünya genelinde 1600-1700 TWh olduğu ve bu değer Norveç'in mevcut hidroelektrik üretiminden 13 kat fazla, Avrupa Birliği'nin ürettiği enerjinin yarısı ve dünya enerji üretiminin %10'u olduğunu bildirmektedir. İnce film kompoziti ve asimetrik selüloz asetat olmak üzere iki farklı membranın denendiği proste membranların güç yoğunluklarının 4-6 W/m² olduğu belirlenmiştir. İnce film kompoziti membranda 0,1 W/m² güç üretimi ile başlayarak 5 W/m²'li bir potansiyel ölçülmüştür. Selüloz asetat membranda ise yaklaşık 0,5 W/m²'den başlayıp 1,3 W/m²'li bir değer ölçülmüştür [14], [18].

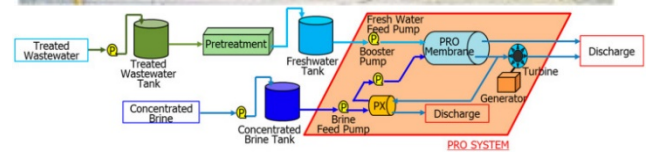
2009 yılında ise ilk prototip PRO uygulaması Norveç'te kurulmuştur. Tesisin planı orijinal konfigürasyonla aynıdır. Bu tesiste 10 kW güç üretilmiştir. Fakat ünitenin enerji üretimi 2-3 kW'a kadar düşmüştür. Tesisin tamamını işletmek için güçten daha azı üretilmektedir. Fakat tesis birkaç test sistemine de sahiptir ve enerjinin bir kısmını bu sistemler kullanmaktadır. Ticari uygulamalarında bu sistemler olmayacaktır [7].



Şekil 6. Norveç'teki Statkraft osmotik güç prototipi [7]

Fakat beklentilerin karşılanmaması nedeniyle tesis 2013 yılında kapatılmıştır. Sistem güvenilir, basit ve işletimi ucuzdur fakat membran maliyetleri nedeniyle kurulum maliyeti yüksektir. Elde edilen enerji çıkışı hedeflenen değerlerin altında kalmıştır ve ekonomik olarak yeterli olmadığı bildirilmiştir [19], [20].

Jeotermal ve desalinasyon tesisi tuzlu sularının yüksek tuz içeriğinden yararlanmaya yönelik çalışmalar sürdüren Danimarkalı SaltPower firması, 2014 yılında ilk ticari yüksek tuzlu su ile çalışan PRO tesisini kurmuştur. 2020 yılında yayınladıkları raporda jeotermal su, deşarj tuzlu suyu ve ham tuzlu su alanları olmak üzere 3 farklı test gerçekleştirilmiştir. Projeden nanofiltrasyon membranları kullanılmıştır. Yüksek basınçlı PRO ve düşük basınçlı PRO olmak üzere iki aşamadan oluşmaktadır. Bu sistem ile 4-5 m³/h'lik zenginleştirilmiş tuzlu su ile türbinlerde 10 kW'm üzerinde enerji elde edilmiştir [21]. Diğer bir uygulama potansiyeli ise desalinasyon ile beraber kullanımdır. Dünya genelinde birçok desalinasyon tesisi bulunmaktadır. Su içerisindeki tuzu, mineralleri ve diğer safsızlıkları gidererek içme veya kullanma suyu elde edilen bu prosesler ortalama 3-4 kWh/m³ enerji harcamaktadır. Bu suyun içilebilir veya kullanılabilir hale getirilmesi için maliyeti yüksek bir işlemdir. Fakat desalinasyon tesisinde ortaya çıkan tuzluluk açısından konsantrasyon olan suyun PRO prosesinde kullanılması mümkündür. Desalinasyon tesislerinde harcanan enerjinin bir kısmını geri kazanılabilir. Ayrıca her iki tesiste de kullanılan membranlar, modüller vb. teknoloji aynıdır. Bu da iki ayrı tesis olarak inşa etmek yerine birbirine kombine edilerek inşa edilebilir ve işletilebilir [7], [22].



Şekil 7. Fukuoka'daki Kyowakiden Industry Co., Ltd PRO tesisi [22]

Kyowakiden Industry Co., Ltd. Nagasaki/Japonya'daki deniz suyunu tuzdan arındırma tesislerinde PRO denemesi gerçekleştirmiştir. Bu teste, bir yıldan fazla bir süre boyunca Fukuoka Deniz Suyu Arıtma Merkezinden denize boşaltılan konsantrasyon deniz suyu kullanılarak PRO performans değerlendirmesi yapılmıştır. Bu test sırasında farklı iklimsel değişimlerde (1-40°C arasında giriş solüsyonu sıcaklıkları) büyük miktarda güç üretimi (10 inç hollow fiber membran modülünde 13,3 W/m² enerji yoğunluğunda) elde edilmiştir [14], [22].



Suudi Arabistanlı SWCC ile Japon NEDO birlikte deniz suyu desalinasyonunda enerji tasarrufu sağlayacak bir teknoloji projesi geliştirmeye başlamıştır. Projede düşük basınçlı ters osmoz membranları geliştirilerek %40 olan geri kazanım oranını %65'e yükseltmek ve toplam enerji tüketiminin %20 azaltılması ile konsantrasyon edilen suyun PRO prosesinde kullanılması ile %10 enerji geri kazanımı amaçlanmaktadır [14].

IV.SONUÇ

PRO teknolojisi hala emekleme aşamasındadır. Günümüzde kullanılmakta olan güneş, rüzgar ve diğer temiz enerji kaynaklarından daha maliyetlidir. Geleneksel enerji santrallerinden 36 kat daha maliyetlidir [7]. Bu maliyette membranın kendisi büyük bir faktördür. Ayrıca membrana gelen çözeltinin partiküllerden temizlenmesi de bu maliyette yeri büyüktür. Fakat atmosferik olaylardan etkilenmemesi, 24 saat enerji üretiminin devam etmesi, çevreye minimal düzeyde zarar vermesi, tamamen sürdürülebilir olması ve dünya çapında uygulanabilir ve potansiyeli yüksek olması nedeniyle önemli bir yenilenebilir enerji kaynağı olmaktadır. Membran teknolojisinin her geçen gün gelişmesi ve ucuzlaması sistemin verimliliğinin giderek artması ve limitasyonların azalmasını sağlamaktadır. Özellikle desalinasyon tesisleri, arıtma tesisleri ve jeotermal enerji tesisleri ile entegre çalışabilecek modüler bir sistem olması sayesinde hem sistemin ek enerji sağlaması ve teknoloji gelişimini sürdürmesi sağlanabilir.

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Thermal Analysis of Ceramic Coated Exhaust Manifold

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Abstract— Exhaust manifolds have an essential role in safely removing waste gases after combustion in internal combustion engines. The exhaust manifold is subjected to thermal stress as the exhaust gases carry a high thermal load. In order to prevent damage to the manifold as a result of these loads, the coating process which is an engineering solution is applied and a thermal barrier is obtained on the manifold. In this study, the thermal analysis of the exhaust manifold covered with 500 μ ZrO₂-Y₂O₃ ceramic material under convective thermal loads was investigated. The study was performed with ANSYS-Fluent, a commercial Computational Fluid Dynamics (HAD) software. The insulating performance of the coating material with a low thermal conductivity coefficient was compared with an uncoated manifold. It was observed that ZrO₂-Y₂O₃ significantly reduced the thermal loads on the manifold. As a result, the temperature values on the outer surface of the manifold coated with ZrO₂-Y₂O₃ decreased compared to the uncoated manifold.

Keywords— Coating, ZrO₂-Y₂O₃, Manifold, Thermal Analysis.

I. INTRODUCTION

Today, with increasing energy consumption, energy efficiency is gaining more and more importance. Various engineering solutions have been developed to ensure that each element works in the most efficient way and to increase its lifetime in systems that generate energy or convert energy into work. Due to high oil prices, studies are also carried out on different vehicle components. Many studies have been carried out on the exhaust manifold, which is one of these components and the subject of this study (Sahoo and Thiya 2019; Valarmathi et al. 2020).

The coating process is generally carried out on engine components that are exposed to the thermal load, and the coating layer provides a thermal barrier to the component, making it more thermally resistant. Coating application was

used to increase the thermal resistance of gas turbines and aircraft engine components (Muthusamy, Venkadesan, and Panithasan 2022) first, but especially in recent years, there have been many studies aiming to reduce heat losses by coating application on combustion chamber components of diesel engines (Baldissera and Delprete 2018; Dhinesh et al. 2018; Gehlot and Tripathi 2016; Gok and Karabas 2022; Muthusamy et al. 2022; Shen, Nie, and Hu 2012; Wang et al. 2021).

Today, only 45% of the thermal energy generated by the combustion of fuel in diesel engines can be converted into mechanical work, and the rest of the energy is lost by the piston, cylinder head, valves, etc., cooled by the cooling liquid. Approximately 20% of the generated thermal energy is discharged in the cooler and 30% in the exhaust. This 30% energy also can cause to overheat to the exhaust manifold. A study in the literature has shown that for a standard engine studied, the exhaust gas temperature is 150°C at no load and 460°C at full load, and in this case, the exhaust gas temperature can rise from 181°C to 590°C (Kumar and Sundareswaran 2011). In another study, it was stated that the maximum temperature value of the exhaust gas could be up to 760°C (Ekström et al. 2015). By insulating the exhaust manifold, this thermal energy carried by the exhaust gases can be used to drive the turbocharger, increasing the volumetric efficiency and thus the overall efficiency (Godiganur, Nayaka, and Kumar 2021).

The bond coating is applied to provide a bond between the manifold surface and the coating material in coating applications. While the primary coating aims at thermal insulation, the intermediate coating consists of metallic substances that provide a bond between the manifold surface and the main coating layer (Masera and Hossain 2019), and the bond coating layer prevents corrosion and oxidation that may occur on the manifold surface (Saint-Ramond 2001). In addition, a bond layer is required as an intermediate element to prevent possible damage due to thermal shock between the substrate and the top coating layer. Besides, the thermal expansion coefficients of metals are higher than ceramics, so the manifold material will expand more than ceramic coating

under thermal load. In order to minimize this thermal expansion difference, sub-coating is made between the coating layer and the manifold surface with a material that has a value between the coefficient of thermal expansion of both materials (Masera and Hossain 2019)

In this study, the temperature distribution of an exhaust manifold coated with $ZrO_2-Y_2O_3$ was investigated numerically under thermal loads. A comparison was made with the temperature distribution of an uncoated manifold under the same thermal loads.

II. METHOD

The exhaust manifold is modeled in three dimensions and shown in Fig. 1. The design reflects the essential features of the exhaust manifold, and it is designed for a four-cylinder engine. The manifold geometry is modeled both with and without coating. The base model was modeled as uncoated, and an additional 500μ layer was modeled on all surfaces of the coated model. On the other hand, the intermediate bond layer, , has not been modeled since it has no significant effect on heat transfer.

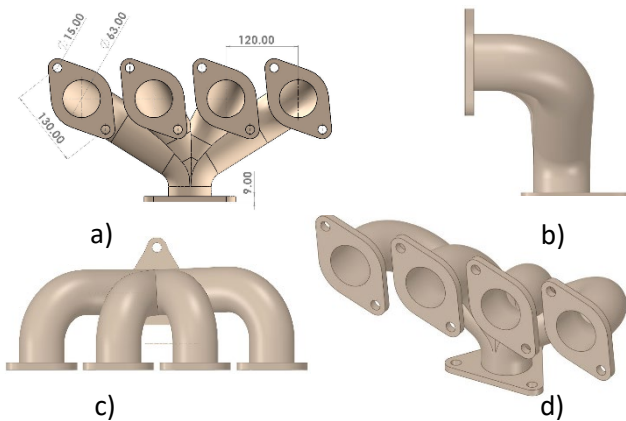


Fig. 1. Exhaust manifold a) front, b) side, c) top, d) perspective view

A. Grid Independence

To determine the sensitivity of the number of elements of the created mesh to the numerical solution, the mesh was tested with three different element numbers. In this study, the coated model is considered. The mesh bodies with the element numbers 9248957, 1769083, and 406161 elements represent fine, medium, and coarse mesh, respectively. A comparison was made with the average temperature values obtained from the lower and upper surfaces of the manifold, and due to sufficient computational sources, the results were similar, and fine mesh was used. The results from this study are shown in Table 1:

Table I. Grid Independence Study

Element number	Manifold top surface mean temperature (K)	Manifold bottom surface mean temperature (K)
9248957	602.885	716.867

1769083	602.689	715.341
406161	601.584	716.934

B. Boundary conditions

In the study, thermal analysis of two different exhaust manifolds, ceramic coated and uncoated, was carried out under convection loads. Ansys-Fluent software was used for the numerical solution. The convergence criterion was determined as 10^{-15} .

Spheroidal graphite cast iron was used as the manifold material and the thermal conductivity coefficient was assumed as 36.2 W/mK in the calculations. 500μ $ZrO_2-Y_2O_3$ with a thermal conductivity coefficient of 0.9 W/mK was used as ceramic coating material.

The thermal loads affecting on the manifold are defined as the convection boundary condition. Surfaces which have convection boundary conditions are shown in Fig. 2 in different colors. For the convection boundary condition on the inner surface shown in yellow, the heat transfer coefficient is $500 \text{ W/m}^2\text{K}$, and the ambient temperature is 600°C . On the outer surface shown in orange, the heat transfer coefficient is $200 \text{ W/m}^2\text{K}$, and the ambient temperature is 35°C . The remaining surfaces are considered adiabatic.

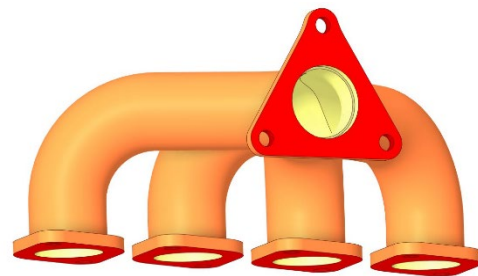


Fig. 2. Surfaces with different colors, where the thermal loads are defined.

III. RESULTS

In this study, the temperature distribution of a coated exhaust manifold under thermal loads was investigated. $ZrO_2-Y_2O_3$ was used as the coating material and the results were compared with an uncoated manifold.

Fig. 3 shows the temperature distributions of the inner surface of the coated and uncoated manifolds. In order for the comparison to be consistent, the results are presented in the same color scale in the images. As can be seen from these results, the temperature values increased on the coated inner surface. The maximum temperature on the ceramic coated inner surface is 841.894 K , and the minimum temperature is 608.205 K . In the uncoated manifold case, the maximum temperature on the inner surface is 756.962 K , and the minimum temperature is 569.869 K . It has been observed that there is a difference of $84,932^\circ\text{C}$ at the maximum temperature and $38,336^\circ\text{C}$ at the minimum temperature values.

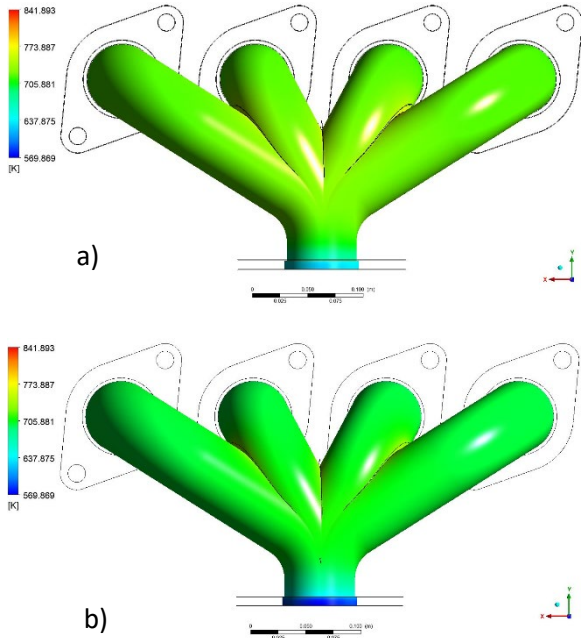


Fig. 3. Temperature distributions on the inner surface of a) ceramic ($ZrO_2-Y_2O_3$) coated and b) uncoated manifolds

The temperature distributions on the outer surface of the ceramic-coated and uncoated manifolds are shown in Fig. 4. In Fig. 4, the results obtained in both manifolds are given in the same color scale. In contrast to the temperature distribution relation on the inner surface, the temperature values on the outer surface of the coated manifold are much lower than on the uncoated manifold. Also, the maximum temperature on the outer surface of the ceramic coated manifold is 676,445 K and the minimum temperature is 384,367 K. In the uncoated manifold, the maximum temperature on the outer surface is 726,992 K, and the minimum temperature is 407,731 K. It was observed that there was a difference of 50,547 °C at the maximum temperature and 23.364 °C at the minimum temperature values.

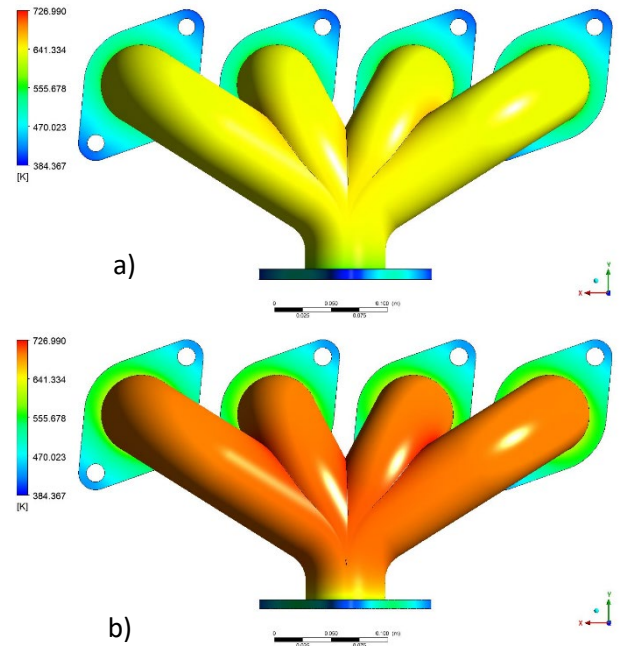


Fig. 4. Temperature distributions on the outer surface of a) ceramic ($ZrO_2-Y_2O_3$) coated and b) uncoated manifolds.

The average temperature values on the inner and outer surfaces of the manifolds are compared in Fig. 5. The average temperature on the inner surface of the ceramic coated manifold is 443,717°C and 329,735°C on the outer surface. In the uncoated manifold, the average temperature on the inner surface is 420.807 °C and on the outer surface, it is 382.415 °C. The average temperature difference between the inner and outer surfaces of the ceramic-coated manifold is 113,982°C. In the uncoated manifold, it is 38,392°C.

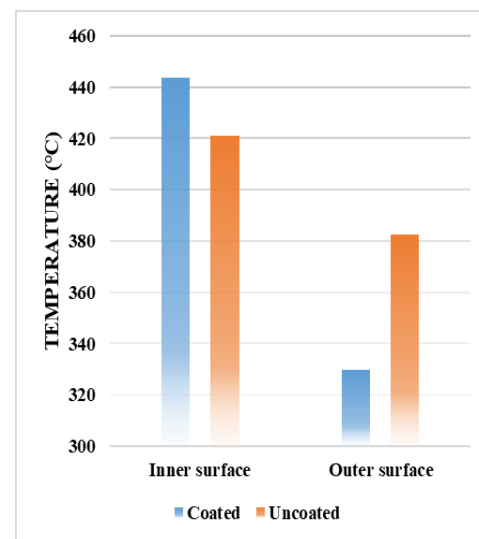


Fig. 5. Average temperature values on the inner and outer surfaces of the ceramic coated and uncoated manifold



IV. CONCLUSIONS

In this study, the thermal behavior of an exhaust manifold covered with a 500 μ ceramic material (ZrO₂-Y₂O₃) under convective thermal loads was numerically investigated. A comparison was made with the temperature distribution of an uncoated manifold under the same thermal loads.

The results showed that the ceramic coating significantly reduces the heat transfer from the inner surface of the manifold to the outer surface which is exposed to the hot exhaust gases. It was observed that the temperature difference between the hot manifold inner surface and the lower temperature outer surface after the ceramic coating increased from 38.892°C to 113.982°C. The ceramic coating formed a thermal barrier between the hot exhaust gases and the manifold, reducing the manifold mean outer surface temperature from 382,415°C to 329,735°C. It was observed that the difference in the values of the maximum temperature that occurred on the outer surface of the manifolds was 50,547 °C.

As a result, the ceramic coating process was successful in reducing the thermal stress on the manifold and it significantly reduced the temperature values on the manifold.

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Biogas product simulation using ADM1 and feasibility study of using biogas in a power generation unit with Aspen plus

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Abstract

Anaerobic digestion could be a renewable energy that produces biogas from organic waste. The little compatibility of anaerobic digestion efficiency with simulation is because of the dearth of a basic model, occurs from the complexity of the processes that include thousands of reactions and many microorganisms promoting anaerobic reactions; Therefore, closing simulation using the biogas production process model to seek out the foremost important factors involved in anaerobic digestion and selecting the foremost effective ones to extend the efficiency of the method, and methane production. The requirement of simulating anaerobic digestion becomes significant when it's difficult to form balanced conditions within the system and therefore the costs of conducting experimental and practical tests are very high and time-consuming. On the opposite hand, selecting thousands of microorganisms of various substrates and many biochemical reactions involved within the process is practically difficult and even impossible. During this research, the ADM1 model was used as a simulation model. The effect of pH changes on methane production rate and methane production processes were investigated. The aim of this research was to supply an integrated modelling platform during which an anaerobic digester might be linked to the opposite unit operations which serve it, both in maintaining the physical—chemical conditions within the digester and in transforming the digestion products to useful fuel and nutrient sources. A simulation of Biogas Digestion process has been

meted out through Aspen Plus. The anaerobic metabolism, its inhibitions and its parameters are studied. Then a model of digestion has been performed using the knowledge found in IWA Anaerobic Digestion Model No. 1 and Angelidaki et al. 1998 model of anaerobic digestion where Acidogenic, Acetogenic and Methanogenic step has been implemented following the reactions shown in both models, also amino-acid degradation reactions are implemented. The research developed an energy model which linked ADM1 to the mechanical processes for biogas upgrading, Combined Heat and Power (CHP) production. This integration of the method components allows accurate sizing of the CHP and direct heating units required for an anaerobic digestion plant designed for fuel grade methane production.

Keywords: Combined Heat and Power (CHP) production, Anaerobic digestion, Renewable energy

I. INTRODUCTION

Nowadays, the use of renewable energy is increasing every year as many countries have decided to reduce greenhouse gas (GHG) emissions in favor of more clean and sustainable energy sources. This is promising as it will address the environmental issues



and energy shortage more efficiently for future generations. Renewable energy options have great advantages, such as less contamination, being greener, and lower cost than traditional fossil fuels, and at the same time could meet the energy demands of many polluting industries and small cities. For instance, hydropower plants contribute close to 17% of the world electricity demand, where the dam-toe scheme is considered eco-friendlier [1]. On the other hand, solar-photovoltaic (PV) and solarthermal systems are non-fossil fuel energy sources that contribute to higher environmental-friendly performance when hazardous materials and processes are minimized during the life cycle of the system [2]. Likewise, Mahmud et al. [3] concluded that biomass plants have little impact on global warming and uses the minimum amount of fossil fuels compared to other renewable energy plants during their life cycle.

Biogas consists of methane (55-75 % vol) and carbon dioxide (25-45 % vol) and other traces of hydrogen released due to anaerobic digestion of biodegradable materials [4]. The methane produced due to its high calorific value (~39.4 MJ m⁻³) can be used for heating, upgrading to natural gas quality or for electricity generation [5]. In anaerobic digestion (AD), several microorganisms work in coaction to form methane and carbon dioxide. The fermentation in AD results in the breakdown of complex biodegradable materials due to a four stage process including hydrolysis, acidogenesis, acetogenesis, and methanogenesis [6]. In the hydrolysis stage, large protein macromolecules, fats and carbohydrates polymers are broken down to amino acids, long chain fatty acids and sugars. The acidogenesis stage involves the fermentation of the products of hydrolysis to form volatile fatty acids (VFA) mainly lactic, propionic, butyric and valeric acid. The acidogenesis stage involves the conversion of VFA's to acetic acid, hydrogen and carbon dioxide. Finally, methanogens

convert acetogenesis products into methane and carbon dioxide [6]–[7].

Recently, the authors investigated factors and found modelling studies by using the dynamic model for high-efficient AD performance. Some research were focused on the improvisation of biogas production quantity and quality from other co-digestion wastes with their mixtures. They found the best kinetic model for all the employed co-digestion wastes with maximum fitting accuracy [8-9-10-11-12]. (Komemoto et al. 2009) examined the effect of temperature on the solubilization and acidogenesis of food waste [13]. (Fedailaine et al. 2015) developed a mathematical model based on biomass mass balances to simulate anaerobic digestion. Some authors investigated the anaerobic digester's performance by utilizing computational fluid dynamics (CFD) to study the mixing behaviour of the fluid flow, energy, and chemical reactions and its effect on anaerobic digestion [14].

Process simulations are well appreciated by industries and researchers, as these can forecast the real scenario accurately, and the costs to perform simulations are much cheaper. Several process simulators are available of which Aspen Plus_ has rigorous property methods and meticulous thermodynamic calculations. In this work, a ADM1 was developed using Aspen Plus_V 12. This model is a library model for AD, which includes intermediary reactions, inhibitions, and kinetics. The model was examined for biogas reactors operating at thermophilic conditions (55 _C).

II. METHODS AND MODEL DETAILS

The component models needed to describe the different unit operations considered in the simulation, i.e. anaerobic reactor (digester) using a mathematical model (ADM1), ancillary equipment, including the biogas upgrading unit, CHP unit, Boiler unit, with Aspen Plus were selected. This was followed by selection of suitable programming languages/tools to allow seamless



communication between the component parts of the simulation. Different model components were calibrated separately for each part of the system. The simulation was verified and validated from laboratory data taken from digesters running under a variety of different conditions within the defined system boundaries.

Digester : Biochemical pathways leading to methane production; type of reactor configuration, mode of mixing and temperature control.

Operational parameters affecting the efficiency of biochemical conversion process from food waste to methane such as pH, COD concentration, temperature, etc.

CHP unit : Efficiency of the engine and its components e.g. compressors, turbines, heat recovery units, etc.

III. QUALITY OF AIR FED TO THE COMBUSTION VESSEL

Aspen Plus acts as a platform connecting the essential unit processes i.e. digester, CHP unit, biogas upgrading unit, boiler unit and ammonia removal unit. The digester as an Aspen plus unit can exchange data with ADM1. Subsequently, this information is used for simulation of the energy requirements of the system and the energy output. The energy model can use one of two stoichiometric—based digester models written for Aspen plus, or take the input data from ADM1, depending upon the accuracy required, and the availability of input waste characterisation data.

The process simulation model divides the digestion or fermentation reactions into two groups of reaction-sets: (a) The reactions of hydrolysis operating based on the extent of reaction, which is the fractional conversion of reactants into products on a scale of 0.0–1.0. Hydrolysis is one of the rate-limiting steps in AD, and henceforth a separate reaction-set was added. With a separate

reactions set for hydrolysis, the effect of pretreatment, which improves the hydrolysis efficiency on different substrates, could be studied in PSM. The other reaction-set (b) constitutes reactions of other phases (acidogenic, acetogenic, and methanogenic reactions) in AD functioning on a kinetic basis.

The iterative solutions were obtained by passing the output of the reaction-set (a) to reaction-set (b) functioning on kinetic reactions. The results generated, are a stream table with mass and energy balance, where the amount of biogas production can be calculated. In each calculator block, the inhibitions in the form of pH, temperature, and ammonia were embedded as logic loops. For every input (fresh or recycled), the calculator blocks calculate the rate of each reaction, thus, rendering the simulation close to reality. Furthermore, process parameters such as OLR, the volume of the reactor, and HRT were entrenched in the model covering the important parameters in the biogas production.

The process simulation model is developed mainly based on the four different stages of biogas production such as hydrolysis, acidogenesis, acetogenesis and methanogenesis. These four stages explain the intermediary metabolisms, how the complex substrates such as carbohydrates, proteins and fats are broke down to monomeric forms and finally to methane and carbon dioxide. For this purpose, the reactions involved in these four stages were collected from previous works [15 – 18]. The equations which were not solved for stoichiometry were solved using MATLAB_ software. In this section, the step-by-step procedure for model development is explained. Firstly, all the compounds required for the simulation was obtained from the equations were added to Aspen Plus and its physical properties were simulated. Some of the complex compounds missing physical properties were obtained from Wooley and Putsche (1996) [19]. NRTL (Non-



Random Two-Liquid model) was chosen as the property method as it correlates and calculates the mole fractions and activity coefficients of different compounds and also to facilitate the liquid and the gas phase in the biogas production. Once, the property check is over, the reactors were included for the simulation. From the reactor models available in Aspen Plus_v, stoichiometric reactor was used for the hydrolysis phase of the reactions, and the continuously stirred tank reactor (CSTR) was used for the other phases in digestion reactions.

List of compounds that have to be filled in aspen plus, thus following the models some components have been selected:

- VFA (volatile fatty acids) represented by acetic ac, propionic ac, butyric ac and valeric ac.
- Long chain fatty acids represented by oleic acid
- Glycerol
- Carbon hydrates represented by dextrose
- All of the main 20 amino-acids without two exceptions Asparagine and Glutamine, for which Stickland reactions are not found. Therefore, their degradations are not known. So their concentration will be supposed to be of the other amino-acids proportionally. [Arginine, Histidine, Lysine, Tyrosine, Tryptophan, Phenylalanine, Cysteine, Methionine, Threonine, Serine, Leucine, Isoleucine, Valine, Glutamic acid, Aspartic acid, Glycine, Alanine and Proline].

However, most of these amino-acids are not well implemented in Aspen Plus databank because a lot of their thermodynamic data is missing.

The solution is explained in the property method needed parameters section. These compounds can be found in Aspen Plus databanks.

IV. RESULTS

This section initially describes how the Aspen Plus model was validated against experimental results as reported in the literature that used food waste as the substrate, and which were conducted under similar concentration (CH₄ %) of 55.66% which was achieved at a 20 C subestra inlet Tempreature and HRT of 60 day. Likewise, the highest average methane concentration (CH₄ %) of 60% was achieved after upgrading in the simulation.

Using two semi-continuous reactors (CSTR and IBR), an HRT of between 20 and 30 days and a temperature of 55 °C, the mean methane content achieved was around 60%. Nevertheless, at an OLR of 3.6 kg VS/m³-day and HRT of 25 days, the highest methane content achieved was 66.04%.

Likewise, Parra-Orobio et al. [20] achieved a methane content above 60% on the anaerobic digestion of food waste using a two-stage digester, HRT of 30 days and OLR of 3, 4.5, 9 and 15 kg VS/m³-day, however, the experiment was conducted at mesophilic temperature (35 °C) and higher methane content and biogas yield and lower HRT could potentially be achieved if thermophilic.

The main components of the platform are shown in Figure 1, and the Aspen Plus simulation window is shown. As can be seen from Figure 1, manure is initially fed into a digester for the digestion. Raw biogas produced after upgrading be fed to a CHP unit and/or boiler for generating electricity and/or heat.

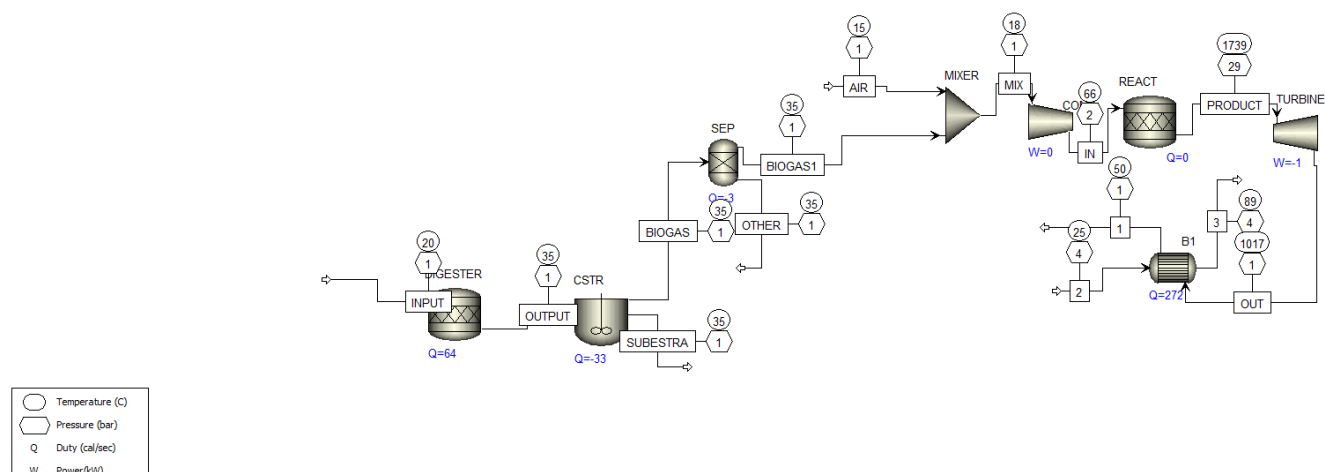


Fig.1. Aspen plus simulation

V. CONCLUSION AND FUTURE WORKS

The paper presents the simulation of various cases of feedstocks through process simulation. The cases are based on the feedstocks cow manure. High biogas potential is realised in 55 C simulation followed by cow dung. High biogas potential creates high electrical energy potential in the simulation case followed by cow manure waste. While this work involves mass compositions from literature review, enhanced accuracy can be achieved by carrying out laboratory experiments on local food waste and cow dung. The stoichiometry only addresses equations that produce methane and carbon dioxide; this can be improved by including rate kinetics, pH and temperature effects and inhibitions.

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Energy Efficient Solutions for Grid-Connected Smart Buildings

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Abstract

Today, in the technological field, innovations are made and developed day by day in line with the increasing population and needs. With the technological activities that have developed in the last 20 years, environmentally friendly, sustainable buildings that provide optimum comfort to users and minimize the use of energy from external sources have begun to be developed. Demand for smart buildings has increased due to the fact that they respond to the needs and requirements of users, have a long life and are low cost. A smart building is an independent structure with air conditioning, ventilation, lighting and security systems that can manage itself. It should be integrated with renewable energy sources, which have become a necessity to use, and turn them into green, sustainable and environmentally friendly buildings. There are many parameters required for buildings to be smart. In this study, the requirements and usage areas of smart buildings according to different standards have been determined. The building efficiency of the devices used in the construction of smart buildings and the solutions required for the use of smart buildings to be environmentally friendly and energy efficient have been researched.

Keywords—Smart Grid, Smart Buildings, Renewable Integration.

I. INTRODUCTION

One of the most crucial scientific ideas is energy, which can be defined as an object's capacity to perform tasks or have an impact on the environment. Energy is another name for the packet of stored work. Energy can exist in potential, kinetic, thermal, electrical, chemical, nuclear, or a variety of other forms, as was previously mentioned. Work that is taken and given changes the energy of a system. The form in which energy is found in nature determines it regardless of how it is conveyed. Heat is transformed into thermal energy and work into mechanical energy towards the end of the operation, as can be seen. Energy cannot be generated or destroyed; instead, only its form may be altered. The law of conservation of energy is relevant here [1-3]. Since energy is an abstract idea, it is thought of as a commodity that cannot be felt but can be quantified by the amount of work completed. It can be found in everyday life in a

form that serves a purpose in every element of living, including heating, using electrical appliances, and public transportation. Energy technology has grown to be a significant factor in social, economic, and cultural development as a result of its broad application. Energy production and consumption have also been used to gauge a nation's degree of progress. Since the beginning of time, when people learned to handle fire, energy use has been a significant concern in the growth of our society. The need for energy has grown in step with the world's expanding population.

II. SMART BUILDINGS

Reasons such as increase in population, decrease in natural resources, international competition, increase in energy costs, environmental pollution and improvement of comfort conditions

necessitated the inclusion of new dimensions in the building design approach. It is necessary to obtain the highest performance by keeping the energy consumption at the lowest point in buildings [4]. Since the first ages, human beings have been trying to build structures that protect their privacy, are safe, comfortable to live in, and adapt to climatic and cultural conditions. One of the most important features that distinguish smart buildings from other buildings is energy efficiency.

In Figure 1, the energy management system application applied in matlab is shown. In the smart building designed in the system, it has been tested using the battery management system and remotely controlled building applications.

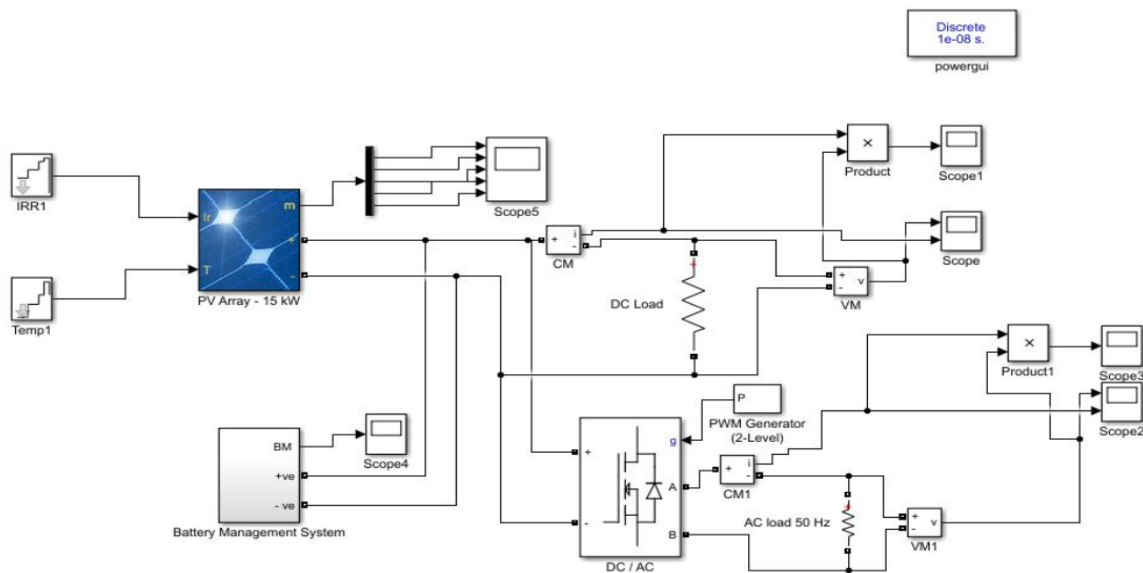


Fig. 1. Smart Energy Management System Matlab Model.



Smart buildings should not only be viewed as the convenience and comfort of being able to remotely control the devices, operating air conditioning or heating systems before coming home. With the usage regulation to be developed in smart homes, it is possible to postpone the use of non-essential devices to cheap hours by distributing the intensity of use of electrical energy. In this, the most appropriate use of smart home systems and smart devices must be programmed. It is shown in Figure 1 as DC Loads are controlled with Matlab. The results are dc loads turning off the lighting that will not be used, programming according to time, Again, an efficient energy consumption will be achieved by postponing the use of devices such as washing machines and dishwashers to more affordable hours. Thus, it is seen that energy management can be achieved [5-7].

III. RESULTS AND DISCUSSION

Building energy management systems are basically a control structure consisting of algorithms that enable to control the electrical energy use of a building by taking into account the preferences of the consumer. These systems also provide communication between the network side and the residences, which are the end consumers.

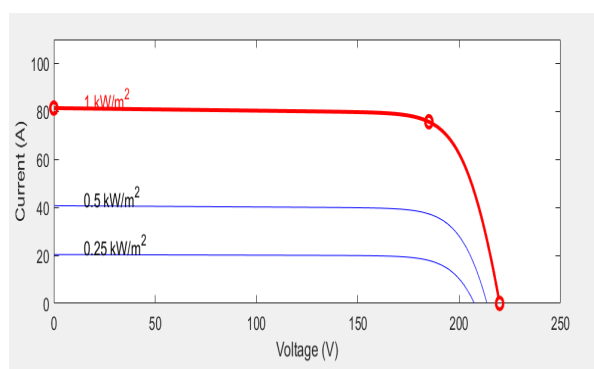


Fig. 2. Current - Voltage (I-V) Characteristics of Buildings Pv Array Matlab Model.

One of the most important criteria in defining a building as smart is that it has an energy management system. Figure 2 illustrates current characteristics of designing building. For this reason, an intelligent energy management that includes different methods or control algorithms in different structures is the basic requirement.

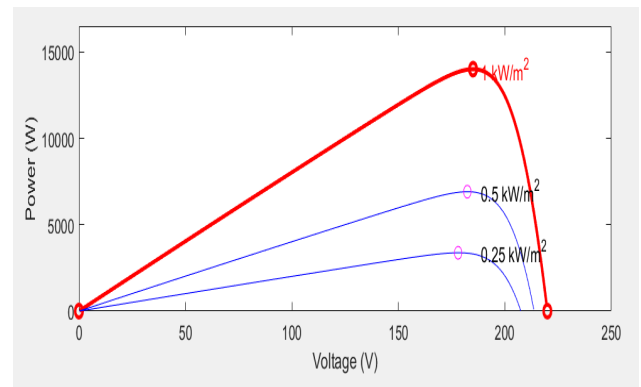


Fig. 3. Power - Voltage (I-V) Characteristics of Buildings Pv Array Matlab Model.

Figure 3 shows power characteristics of building. Considering the dynamic pricing practices that will become widespread in the near future, the energy management system will emerge as an important tool in order for the consumer to consume in accordance with the ever-changing pricing [8].

The most important purpose of smart buildings is to provide energy efficiency at the maximum level. Due to the ever-evolving technology and the increasing need for energy, it is getting harder and harder to provide users with reliable, clean and sustainable energy. The reason for this is the limited resources available in our nature and the increasing damage to the environment. Most of the energy consumed in the world includes the energy used in buildings. Therefore, the place of smart buildings in energy consumption is quite large. Thanks to the use of smart buildings, energy efficiency will also be maximized. Reducing the energy used in buildings will significantly eliminate environmental pollution [9].



IV. CONCLUSION

Smart buildings are the most important building units that use energy effectively and at the same time reduce the use of fossil resources by using the required amount of renewable energy sources [40]. In our country, on December 5, 2009, the “Energy Performance Regulation in Buildings” came into force in order to increase energy efficiency in buildings and to reduce the use of fossil fuels. The most important aims of the regulation [10-11] are:

- Reducing energy consumption with efficiency measures,
- Reducing carbon footprint,
- Preserving environmental and ecological conditions,
- Reducing the ratio of energy consumption and energy on cost by following the energy strategy and policy,

Directing energy savings in buildings by preparing an Energy Performance Certificate and helping people creating an energy culture [39].

It can be achieved with this matlab model on better energy efficiency with energy management. It can be controlled with the reasoning feature of fuzzy logic controllers. In line with the measures taken to improve energy use on the consumption side, demand-side management can also be achieved by determining the times when the demand is high and the price is high, and shifting it to the time periods where the demand and price are low or the production of renewable energy sources [12].

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Estimating The Net Capacities Of Reactors with Artificial Neural Networks

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Abstract

The electricity consumption needed in all countries is increasing with the developing industry. Energy production is obtained from different sources as well as from Nuclear Power Plants. Recently, the decrease in fossil fuels and climate changes due to harmful gases released to the environment have increased the interest in Nuclear Power Plants. For this reason, newly developing countries want to meet their electricity needs with nuclear energy. The aim of this study is to determine the net capacity that can be obtained from a reactor according to the type of reactor needed by the countries by using artificial neural networks. Thus, it will be possible to predict whether the energy production capacities requested by the countries can be met with the reactors built. According to the data received from the IAEA (International Atomic Energy Agency), the artificial neural network model is used to predict whether the reactor to be built will meet the electricity demand in the country. It is seen that the determination of the net capacity of the reactors to be built according to the obtained data can be estimated safely by using this method.

Keywords— Artificial neural network, nuclear reactors, electricity need, net capacity

I. INTRODUCTION

With the developing technology, the electrical power needed is increasing year by year. Energy need is expected to be 60% more in 2030 compared to the present [1]. Countries have had to change their energy policies due to reasons such as the depletion of electricity production resources (coal, oil, natural gas, wind, solar, etc.) in the world, their insufficiency, and the damage of their wastes to the world, changing climate changes and increasing foreign dependency of countries. Nuclear energy in electricity generating energy systems. In addition to being a sustainable, clean, safe, and economical choice, it has once again taken its place on the agenda of the world energy sector in terms of efficiency, performance and environment with the developing technologies. Nuclear energy is the large amount of energy that comes out because of the splitting of the atomic nucleus. Nuclear energy is produced in nuclear power plants. They are systems in which the heat energy released as a result of the splitting of the

atomic nucleus is first converted into mechanical energy and then into electrical energy, similar to thermal power plants. Among the most environmentally friendly and realistic energy strategies for the future, nuclear electricity generation is defended with the thesis of "indispensable" and is considered as "Nuclear Renaissance" in the West, "new environmentalist approaches" and "rising nuclear power" in Asia [2].

Recently, ANN have been used in many fields of nuclear physics such as construction of consistent physical formula for the detector counts in neutron exit channel selection [3], determination of one and two proton separation energies [4], developing nuclear mass systematics [5], determination of ground state energies of the nuclei [6], identification of impact parameters in heavy-ion collisions [7–9], determination of beta-decay energies [10], estimating nuclear rms charge radius [11], estimation of the radiation yields for electrons [12], and consistent empirical physical formula construction for gamma ray angular distribution [13]. In this study, the artificial neural network (ANN) model is used in the estimation and modeling of the net capacity to be produced according to the reactor types, to predict whether the reactor to be built will meet the electricity demand in the country. Six types of reactors that are frequently used in the world were selected and the data for ANN estimates were taken from the International Atomic Energy Agency (IAEA) reports. ANN consists of artificial neurons that can perform mathematical operations in the determined layers. It creates its own outputs by calculating with the interconnected weights of the input neuron. For this reason, ANN becomes an estimator of a function without the need to establish a relationship between input and output. With the developing computer technology, ANN has become a frequently used method in nuclear energy recently. Examples of these are sensor security in nuclear power reactors [14], determination of unmeasurable physical quantities in nuclear reactors [15], systematic studies of control rods, electricity demand forecasts.

II. MATERIALS AND METHOD

Artificial neural network (ANN) method is a mathematical model in which basic functions such as generating new data from the data collected by the brain by learning, remembering,



and generalizing by imitating the learning path of the human brain are performed [16]. Artificial neural networks: Inspired by the human brain, it emerged because of the mathematical modelling of the learning process. In feedforward neural networks, information is transmitted from the input layer to the output layer via an intermediate layer. The function of the middleware is to process the information coming from the input layer. The middle layer can also be referred to as the hidden layer. Because the number of cells in the intermediate layer cannot be known precisely. In feedforward neural networks, the processor elements are arranged in layers and the outputs of the processor elements in one layer are given as inputs to the next layer over weights. The input layer transmits the information it receives from the external environment to the processor elements in the middle layer without making any changes. The output of the network is determined by processing the information in the middle layer and the output layer. Each processor element in the layers has a connection with all the processor elements in the next layer. However, there is no connection between the processor elements in the same layer. Therefore, in feed forward artificial neural networks, the connections between the processor elements do not form a loop and these networks can generally produce outputs very quickly in response to input information. Feedforward neural networks generally use the back propagation learning algorithm and are also called back propagation networks.

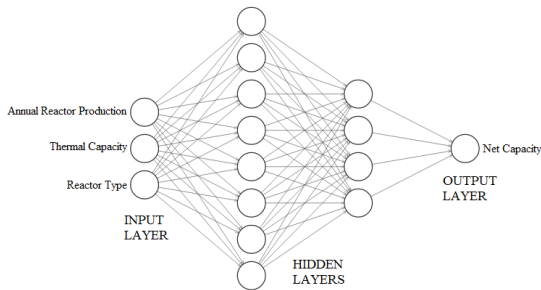


Fig.1 One of the used structures of the ANN (3-8-4-1) for the estimation of the net capacity of the reactors

III. RESULTS AND DISCUSSION

In this study, we have used annual reactor production (TW.h), thermal capacity (MW) and reactor type as the inputs of the ANN (Fig.1). The reactor types used are PHWR (Pressurized Heavy-Water Reactor), PWR (Pressurized Water Reactor), FBR (Fast Breeder Reactor), BWR (Boiling Water Reactor), LWGR (Light Water Graphite Reactor), GCR (Gas Cooled Reactor), respectively. It is assigned as 1, 2, 3, 4, 5, 6, respectively. The output was the net capacity of the reactor in megawatt. Input data for six types of reactors that are frequently used in the world, nuclear production and thermal capacities of reactors are taken from International Atomic Energy Agency (IAEA) 2021 reports [19-24]. After

many trials for the problem, the hidden layer and neurons were considered, in which results close to the desired value were obtained. For the single layer hidden neuron structure, $h=6$ and $h=10$ neuron numbers were used. For the two hidden neuron layer structure, 8 and 4 neurons were used in the first and second layers ($h=8-4$). The number of the data points was 437. In the training stage 80% of the data was used. The rest was used in the test stage of the ANN. The main purpose in the training is to determine the weight values of the connections between each neuron in different layers. Levenberg-Marquard algorithm [17,18] was used in the training phase of this study.

IV. RESULTS AND DISCUSSION

In the study carried out to estimate the net capacities of the reactors, statistical values of the use of different hidden layer neuron numbers (h) are given (see Table 1). As can be understood from the values, it is seen that the root mean square error (RMSE) values on the training data decreases as the number of hidden layers and neurons increase. However, the RMSE values in the estimations of the test data increase with the increasing number of neurons. However, the RMSE values in the estimations of the test data increase with the increasing number of neurons. As can be seen, the best predictions on the training data were obtained with the ANN in the $h=8-4$ structure, while the best predictions on the test data were obtained with the ANN in the $h=6$ structure. As can be seen from the table, the RMSE values on the test data in structures with $h=6$ and $h=10$ neuron numbers are quite close to each other. On the other hand, in the estimations of the training data, the results of the ANN in the $h=10$ structure are approximately 3 times better than the results in the $h=6$ structure.

Table 1. RMSE and r Values of training and test datasets

ANN Type	Net Capacity [MW]			
	RMSE		r	
	Train	Test	Train	Test
$h=6$	92.0	53.8	0.96	0.98
$h=10$	30.8	54.9	0.99	0.98
$h=8-4$	23.7	77.7	0.99	0.97

ANN estimates for $h=6$, $h=10$ and $h=8-4$ ANN structure on the training data was given in Fig. 2. When compared with the values taken from the IAEA 2021 reports, it is seen that the predictions in the single layer $h=6$, $h=10$ and $h=8-4$ ANN structure are not far from each other. However, in the ANN model with the $h=8-4$ structure, the deviations from the data of IAEA 2021 reports were found to be less and at more acceptable levels for the training data. It is seen that the $h=8-4$ ANN model can be used to estimate the net capacity that the reactors can produce.

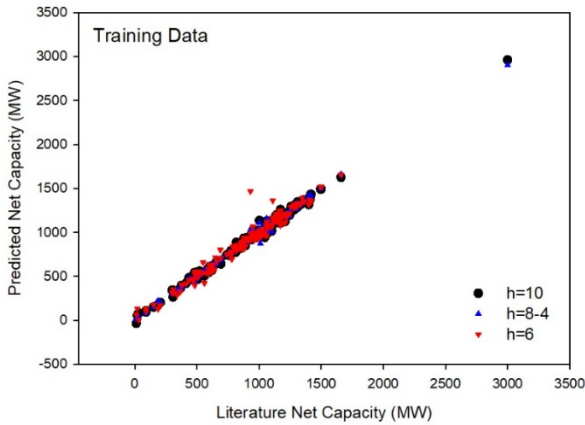


Fig. 2 Comparison between literature values and ANN predictions with h=6, h=10 and h=8-4 ANN structure on the training data

However, the predictions on the test data also need to be examined in order to make the final decision on which ANN structure is the better structure at net capacity. In Figs. 3, 4 and 5, the results of the ANN models with the structure h=6, h=10 and h=8-4, respectively, are shown on the test data. When all 3 figures are examined, it is clearly seen that the ANN estimates give results that are quite compatible with the literature data. When the RMSE values of the results were examined, it was seen that the ANN with h=6 hidden neuron number had the best performance.

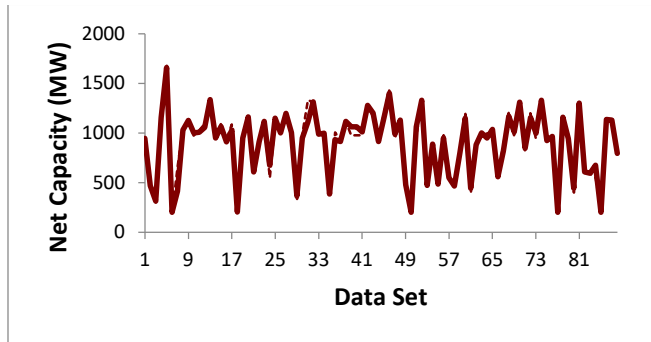


Fig. 3 Comparison between literature values and ANN predictions with h=6 for reactor net capacity (solid line: literature values, dashed line: ANN outputs)

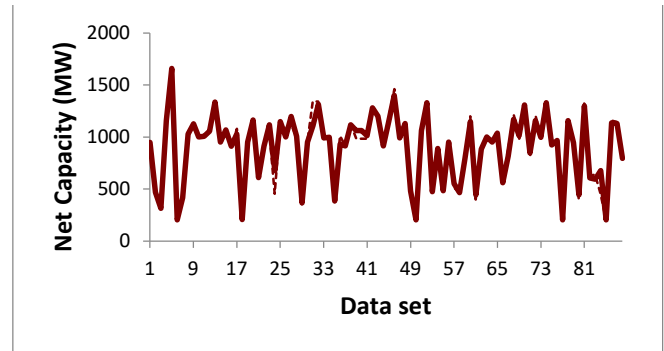


Fig. 4 Comparison between literature values and ANN predictions with h=10 for reactor net capacity (solid line: literature values, dashed line: ANN outputs)

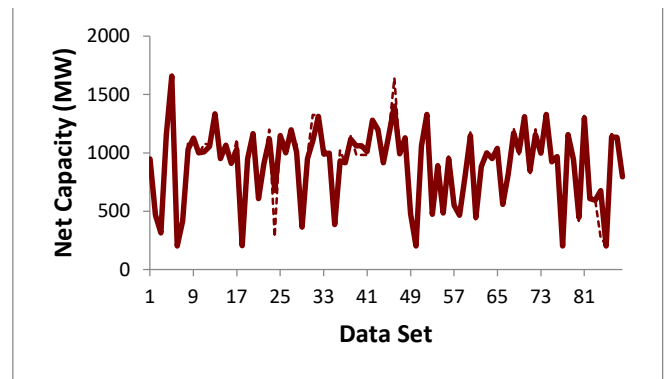


Fig. 5 Comparison between literature values and ANN predictions with h=8-4 for reactor net capacity (solid line: literature values, dashed line: ANN outputs)

V. CONCLUSIONS

In this study, we determined the net capacity that can be obtained from a reactor according to the type of reactor needed by the countries by using artificial neural networks. We tried to reach this goal by using artificial neural network models with different structures. We have seen that the artificial neural network method is a very suitable method for us to reach the goal we want to achieve. When we examine the results on the training and test data, if we consider that both the training and test data are within acceptable error limits, it is concluded that the artificial neural network method in the h=10 structure is the most appropriate structure. It has been concluded that the ANN method is a method that can be used safely in the estimation of the net capacities of the reactors.

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The Impact of Energy Researches on Current Interdisciplinary Sciences

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Abstract

While energy research has been continuing at an increasing pace in recent years, the use of renewable energy resources, which is of great importance in our country and around the world, is progressing with the aim of finding a solution to the energy resource shortage that humanity will face in the future. It seems wise to use self-renewing resources such as the sun and wind, which are provided to us as energy sources in our world, to sustain life. However, although there has not been much research on the cultural reflections of these studies in our country, it is clearly seen that they contain interrogations that will be associated with interdisciplinary sciences in the international arena. One of the main purposes of this study is to explain the concepts of "sustainability" and "energy" and serve as a guide for their use in studies related between to social and natural sciences.

Keywords: Renewable Energy, Interdisciplinary Studies, Energy Effect.

I. INTRODUCTION

Accepting the scientific conclusion that energy is not eternal, but rather created after the fact, should be the basis for future research. The term of "energy" studied in this study does not refer to the energy of bioenergy or

matter; rather, it refers to the energy demand that humans place on the world in order to survive.

Humanity's current engagement with the problem of climate change has necessitated a fundamental shift in our understanding of energy, climate, and human life. All civilizations throughout human history have utilised energy, and the influence of energy consumption on the environment has always been related [1]. However, the harm caused by energy usage to the environment and humanity has reached an unprecedented degree, necessitating an examination across all disciplines. When the level of carbon dioxide in the atmosphere exceeded 400 ppm for the first time in 2013, 100 ppm over the level reached in the previous one million years, all disciplines realised they needed to bring attention to the energy problem.

As for the current generation, the following can be said: since we are not the first generation of humans to face such a challenge, but we are also the only generation in a position to prevent irreversible damage to our planet and ourselves, work should be continued with the understanding that research in this area should be accelerated.

II. ENERGY EFFICIENCY AND SAVING STUDIES IN TURKEY

In contemporary multidisciplinary studies, several investigations are conducted to bring attention to energy



efficiency research. There are two primary strategies to save energy or increase energy efficiency in general [2]:

First, reducing the total electrical load of high energy-demanding electronic elements by replacing them with more energy-efficient equipment, such as drivers, air conditioners, refrigerators, and other electrical equipment; and second, adopting habits that contribute to daylight savings and energy savings. 'Energy Conservation Day' and 'Earth Day' etc. light saving, moving human activity from midnight to early morning with a window of around 3-5 hours each day, so decreasing the overall electrical demand by 20%. It is to save a substantial quantity of energy by reducing the lighting load. In Turkey, summer and winter time practises are an illustration of this phenomenon. In addition to this, the Turkish Ministry of Energy and Natural Resources conducts several research on applications of energy efficiency and energy conservation. The goal is to minimise by at least 20% relative to 2011.

In addition, the first energy efficiency action plan for Turkey, the National Energy Efficiency Action Plan (2017-2023), went into effect on January 2, 2018. It is anticipated that 9 million tonnes of oil equivalent (MTEP) energy will be saved by the implementation of 55 measures in 6 different sectors, a total of 23 with an investment of 10.9 billion USD until 2023. This amounts to a 14% decrease in primary energy usage for Turkey in 2023. The anticipated savings through 2033 amount to 30,2 billion dollars.

With the aim of increasing efficiency in the use of energy resources and energy by aiming to contribute to the protection of the environment;

- Trainings designed to increase the efficiency of the use of energy resources and energy in an effort to contribute to environmental protection (energy manager trainings, study project trainings and international trainings)
- Studies (industrial facilities, commercial and service buildings, public buildings, residences)
- Authentications (Energy Efficiency Consulting Companies, Universities and Professional Chambers)
- Energy Efficiency Supports (Efficiency Enhancing Project (VAP) and Voluntary Agreements)
- Measurement, Monitoring, and Evaluation
- Audit, Promotion and Sensitisation
- Energy Efficiency Conference and Expo
- National and International Project Development

- Planning and Coordination of Efficiency-Related Activities

Efficiency, Activity and Training Studies on Greenhouse Gas Emission and Monitoring Shaped ranked activities Energy and Of course resources by the Ministry is being carried out.

In addition to The Ministry of Energy and Natural Resources MENR(ETKB) research, the report issued by the Ministry of Foreign Affairs summarises the international components of the energy studies in Turkey as follows and also illustrated in Table 1 [3]:

Table 1. Energy Savings in Turkey for 2020 [3].

Sector Name, Action Code and Name	Savings [ktoe]	Cumulative Savings [ktoe]
HORIZONTAL ISSUES	11.25	29.80
Y9-Energy Efficiency Audits	11.25	29.80
BUILDINGS AND SERVICES SECTOR	231.41	1,082.046
B3- Set energy saving targets for public buildings	12.88	12.88
B4- Improving Energy Efficiency in Municipal Services	2.70	8.10
B5-Rehabilitate existing buildings and improve energy efficiency	45.15	259.75
B9-Promote Energy Efficiency in New Buildings	141.13	682.33
B11-Scale up the use of renewable energy and cogeneration systems in buildings	29.54	127.56
B12-Allocate funds to buildings of SME category for energy efficiency audit programmes and audits	0.01	0.03
INDUSTRY AND TECHNOLOGY SECTOR	85.00	1,418.80
S3- Improve efficiency in industry (calculated by ODEX methodology)*	85.00	1,418.80
ENERGY SECTOR	22.85	114.07
E8-Improving Efficiency Increases in Electricity Transmission and Distribution Activities	22.85	114.07
TRANSPORT SECTOR	96.40	460.70
Transport Sector (calculated by ODEX methodology)	96.40	460.70
AGRICULTURAL SECTOR	3.60	84.41
T1- Promote the replacement of tractors and harvesters with energy-efficient ones	3.60	3.60
T2- Switch to energy-efficient irrigation methods	0.00	80.52
T3- Support energy efficiency projects in agriculture sector	0.00	0.15
T4- Promote use of renewable energy resources in agricultural production	0.00	0.14
TOTAL	450.51	3,190.23

*The data will be updated following the publication of the 2020 Energy Balance Sheet.

“Recent events have once again demonstrated the significance of energy supply security. With the initiatives we have undertaken and the actions we have taken in the energy sector, we are diversifying routes and resources, therefore contributing to the energy supply security of our nation. The TANAP natural gas pipeline running through Turkey is the backbone of the Southern Gas Corridor, Europe's fourth biggest natural gas artery. Azerbaijan's natural gas has begun to reach Europe with the completion of the Trans Adriatic Pipeline-TAP, which is the continuation of TANAP. Many European nations, including Bulgaria, Serbia, and Hungary, now have access to natural gas as a result of the TurkStream-2 pipeline, a portion of which traverses our country. In the past sixteen years, the Baku-Tbilisi-Ceyhan Crude Oil Pipeline has delivered 3,9 billion barrels of oil from

the Caspian Basin to worldwide markets. Strengthening our role as an energy hub in the Middle East and Mediterranean basin will result in significant concrete contributions to regional energy security. We highlight that our nation is the most cost-effective and secure path for developing energy resources in the Eastern Mediterranean and the Middle East, using these resources, and transporting them to Europe. We view energy as a sphere of collaboration and encourage other nations in the region to embrace similar perspective.”

III. SMART COMPONENTS

Electricity is produced in enormous power plants and transferred through linked high voltage transmission lines in today's electrical grid systems. However, the lines lack an effective control mechanism. Due to the absence of efficient transmission, a potential power outage on high voltage transmission lines might significantly impact other systems. Figure 1 shows these components.

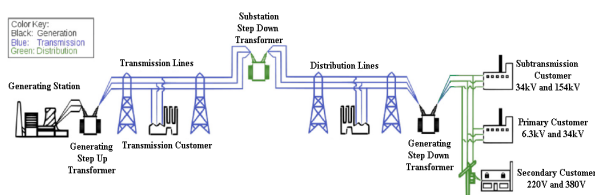


Fig. 1. Power Grid System Components.

On the contrary hand, losses constitute a second major issue. Sadly, the rate of electrical distribution and transmission system losses remains so high. In addition to losses, unauthorized power consumption is unregulated. Illegal use of power may have severe and hazardous consequences. This condition, which leads generating units to become overloaded, may also result in partial power outages and system failures. It is believed that electrical firms throughout the globe lose 25 billion dollars annually due to unauthorized power consumption.

Using a smart electrical meter helps resolve issues such as losses and unauthorized power use on the current system.

IV. ENERGY EFFICIENCY STUDIES IN THE WORLD

Recent interdisciplinary worldwide scientific investigations give proof of the results of energy research. Gündogdu and Diallo reviewed the use of energy from a social viewpoint, emphasized the necessity for nations of the Islamic Union to engage in the energy sector, and evaluated the social value equivalents of the concept of sustainability [4].

There are also inter-disciplinary studies that evaluate the influence of sustainability advancements and energy use on future generations. [4], [5].

Asian nations were assessed in [6]. To ignore the connection between Islamic culture and green energy sustainability measures would be irresponsible. Moreover, research in this sector demonstrates that the fundamental tenets of Islam, such as respecting human beings and avoiding waste, predate the notion of sustainability, which humanity is just now learning [2], [7]–[9].

However, it is feasible to assert that the strategy to alter the self-indulgent lifestyle of mankind in the 21st century is beyond their reach, as it is in opposition to capitalist value systems [6].

The findings of the study on energy efficiency, which were described in detail in the preceding section, indicate that research in the fields of energy and the environment is proceeding swiftly in our nation. In addition to these studies, the Organization of the Islamic Union conducts cooperation studies in Turkey from an different viewpoint of energy. [10].

V. DISCUSSION AND CONCLUSION

Since 1987, when the United Nations World Commission's report titled 'Environment and Development' was published, the idea of 'sustainability' has received substantial attention as a consequence of global concern over the impact of human activities on the environment. This research is often referred to as the Brundtland Commission Report [11]. The research introduced the now-familiar notion of sustainable development: development that meets the requirements of the present without jeopardizing the capacity of future generations to meet their own needs. [12]. The International Union for Conservation of Nature (IUCN) defines sustainable development more generally as "improving the quality of life within the carrying capacity of ecosystems." [12].



Diverse contemporary approaches for sustainable development may be summed up in three points:

(1) Intergenerational sustainability: ensuring that the development efforts of the present generation do not compromise the capacity of future generations to satisfy their own needs.

(3) Social sustainability: the need for fair income distribution and the eradication of severe poverty. Adopted by the United Nations (UN) General Assembly in 2016, the new global Sustainable Development Goals (SDGs) framework, "Transforming our World: The 2030 Agenda for Sustainable Development," highlights these concerns extensively.

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An Analysis of Synthesis with Renewable Chemicals from Lignocellulosic Biomass

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Abstract

The primary reliable and cost-effective energy source that now ensures the production of required product quality is fossil fuels. According to statistics from the last ten years, the transportation sector uses more than 25% of the global energy, primarily diesel and gasoline. Recent years have seen a rise in interest worldwide in the use of renewable resources to displace petroleum as the principal feedstock for liquid fuels, chemicals, and materials. The rising price of oil and the harm that petroleum causes to the environment, and the benefits of renewable resources, such as their quantity and sustainability, make it attractive. The potential for bio-based compounds made from renewable resources is examined in this article. Since they make up around 95% of the biomass produced each year, carbohydrates are the most widely used feedstock for both commodities and specialized chemicals. Direct extraction, chemical and biological conversion pathways, as well as a few recent technological developments are covered. Examples of specific bio-chemicals are given, along with their conversion processes from biomass, derivatives, and prospective applications.

Keywords: Renewable, Chemicals, Lignocellulosic and Biomass.

I. INTRODUCTION

Today, there is a lot of concern about the growing usage of non-renewable resources and their ongoing depletion. It is sustainable and practical to produce renewable fuels from agricultural lignocellulose waste (Khaire et al., 2021). Cellulose, hemicellulose, and lignin are the primary components of lignocellulose and are present in various ratios

(Fortunati et al., 2019). The most plentiful, renewable, and sustainable bio resource is this essential component of plant biomass that results from photosynthesis (Dai et al., 2020). For the anticipated lignocellulosic bio refinery industry, biomasses from agricultural crop residues, grasses, wood, forest trash, and municipal solid waste are abundant, cost-effective, and renewable supplies. The use of lignocellulosic biofuel in place of existing fossil fuels might significantly cut greenhouse gas emissions and slow global warming (Girio et al., 2010).

Another benefit of lignocellulosic energy is its CO₂ neutrality, zero carbon emission, environmental friendliness, inability to disrupt the food chain, ability to diversify agriculture, and many other benefits. The cellulose conversion and sugar extraction technology that could support a cost-effective and efficient biorefinery process is the bottleneck of the lignocellulosic bioenergy industry. The two main types of lignocellulosic materials are wood and agricultural wastes like bagasse from sugar cane and other types of straw. Gymnosperms (softwoods) and angiosperms (hardwoods) have lignin contents that range from 20-25% to 28-32%, respectively (Eriksson & Bermek, 2009) Figure 1 show an image lignocellulosic biomass. For cell adhesion as well as to strengthen the cell walls of the xylem tissues, lignin are often dispersed with hemicelluloses in the space between cellulose microfibrils in both primary and secondary cell walls and in

the middle lamellae. As in the instance of the mosses (phylum Bryophyta), when the plant is just millimetres tall, the absence of lignin renders the plant incapable of standing upright. Plants that live in water float, thus they do not require lignin reinforcement. The lignin also serve the well-known purposes of assisting sap conduction through vascular components and protecting the plant from intruders like insects and microbes. The structure of the hemicelluloses found in hardwoods and softwoods differs significantly. Hardwoods have a high glucuronoxylan concentration, while softwoods have galactoglucomannan as their predominant hemicellulose (Dai et al., 2020). However, there is a lot of variety in the chemical make-up of various types of tree cells as well as the chemical make-up of different types of wood. The cinnamate process is a complex biochemical reaction pathway that uses glucose, shikimic acid, L-phenylalanine, and cinnamic acid to produce lignin monomer. This process has been clarified using ¹⁴C-labeled precursors; however, it seems to be quite energy-intensive. The enzymes peroxidases and laccases convert the phenolic monomers to their corresponding phenoxy radicals to produce the lignin polymers (Chen, 2015a). As far as is known, these radicals spontaneously polymerize without any help from an enzyme. Initiation locations and a full complement of cell wall-localized enzymes are needed for the process of lignin deposition within the cell wall during xylem formation, which suggests that it is a tightly controlled process. It is thought that the procedure is an illustration of template polymerization. There is some uncertainty regarding the nature, function, and roles of the starting sites and the enzymes. Additionally, there is still debate concerning the relative contributions of laccases and peroxidases to the lignification process. However, there is general agreement that the three distinct phenylpropanoid structures are polymerized by free radicals to form lignins. Lignins found in softwoods are virtually totally used for energy generation. Research in labs all around

the world has focused mostly on finding ways to release the solar energy that has been stored in diverse lignocellulosic materials. A substantial literature has been produced as a result of the enormous efforts made to understand the mechanisms involved in the degradation of wood and plant materials, especially by fungi and their enzymes which are crucial for the successful usage of these resources. (Adav & Sze, 2014).



Fig.1: Lignocellulosic Biomass.



II. BIOMASS COMPOSITION AND STRUCTURE

Lignocellulose biomass is a complex matrix of mainly three components: cellulose (20%–50%), hemicellulose (15%–35%), and lignin (5%–30%); (Adav & Sze, 2014). The composition of some common lignocellulosic feedstocks is summarized in Table 1 (Dotan, 2014). Cellulose, the building block and main component of interest, is a high molecular weight polymer of D-anhydro-glucopyranose units joined together by b-1,4 linkages. Depending upon the origin of cellulose, the DP (number of glucose molecules in one chain) in cellulose can vary from 100 to more than 10,000 (Chen, 2015; Kumar et al., 2015) Figure 2 and 3 show the structure and fractions of lignocellulosic biomass. Cellobiose, a dimer containing two glucose units rotated by 180 degrees relative to each other, is the repeating unit in long cellulose chains and provides conformational stability to the cellulose structure. Due to the presence of three free hydroxyl groups, the anhydroglucose units in cellulose form numerous inter- and intra-chain hydrogen bonds and result in a crystalline structure which is insoluble in water and highly resistant to degradation. Under natural conditions and in the absence of enzymes, half-life of cellulose would be of several hundred million years (Lynd et al., 2002). Cellulose contains both amorphous and crystalline regions with degree of crystallinity varying from 50% to 90%, depending upon the origin of cellulose. Unlike cellulose, hemicellulose is a heterogeneous polymer of sugars (mainly five carbon sugars, xylan being predominant) and uronic acids (4-O-methyl-glucuronic, galacturonic acids). Hemicellulose is a short chain polymer, amorphous in nature, and acts as a linkage between cellulose and lignin (Adav & Sze, 2014; Chundawat et al., 2011; Eriksson & Bermek, 2009). Lignin, the most complex component of lignocellulosic materials, is an amorphous three-dimensional polyphenolics and branched polymer of

phenolic alcohols (coniferyl alcohol, sinapyl alcohol, and p-coumaryl alcohol). During the lignin structure formation, these monolignols further give rise to phenylpropanoid monomeric units and are identified as p-hydroxyphenyl (H), guaiacyl (G), and syringyl (S) units, respectively. Amount and composition of lignin (ratio of different phenyl-propane monomers) vary among different feedstocks. In general, lignin from softwoods has higher guaiacyl content, and hardwoods lignin contains both guaiacyl and syringyl units. Lignin forms a complex three-dimensional irregular network with cellulose and hemicellulose. It provides structural stability by acting as glue that binds together the polysaccharides and makes biomass highly resistant to degradation (Chundawat et al., 2011) (Adav & Sze, 2014; Chundawat et al., 2011; Eriksson & Bermek, 2009).

Table 1: Types and Chemical Composition of Some Lignocellulosic Materials (Dotan, 2014; Kumar et al., 2015).

Biomass Type	Biomass (%)	Cellulose (%)	Hemicellulose (%)	Lignin (%)
Agricultural	corn Stover	38-40	24-26	7-19
Residue				
	Sugarcane bagasse	25-48	19-32	15-42
	Rice straw	28-36	23-28	12-19
	Wheat straw	33-39	23-32	12-19
	Barley straw	31-45	24-38	6-19
	Sweet sorghum bagasse	34-45	18-27	14-21
	Tall fescue straw	31	20	14
Hardwood	Poplar	51-53	26-29	16-17
	Oak	40.4	35.9	24.1
Softwood	Pine	42-50	24-27	20
Grasses	Switchgrass	35-40	25-30	15-20
	Miscanthus	38-40	18-24	24-25

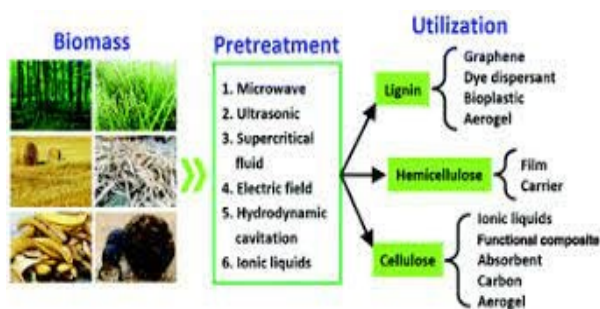


Fig. 2: Lignocellulose Biomass Fragmentation

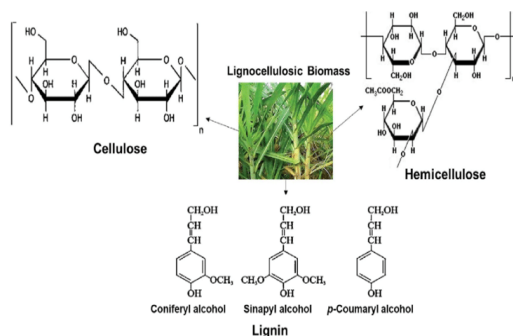


Fig. 3: Structure of lignin, cellulose and hemicellulose

III. REACTION PATHWAYS OF LIGNOCELLULOSIC MATERIALS TO GREEN CHEMICALS

A green chemical is one that provides higher performance and functionality while being more environmentally benign throughout its entire life-cycle. This approach has been codified in the Twelve Principles of Green Chemistry that provide a framework for innovation and design (Jiang et al., 2015).

3.1 Chemical Conversions

Chemical conversions refer to processes which directly convert biomass to chemicals at high temperature and pressure and in the presence of a catalyst. Some bulk chemicals, including levulinic acid and furfural, can be produced by treating biomass at high temperature for specific times in the presence of conventional mineral acid catalysts, such as hydro sulfuric, hydrochloric, and phosphoric acids (Adams et al., 2018). However, low yield and significant volumes of side products, together with the use of corrosive

chemicals, are challenging commercialization and environmental issues. A thermochemical process, generally referred to as gasification, partially oxidizes biomass into syngas, a fuel gas mixture consisting of hydrogen, carbon dioxide, nitrogen and carbon monoxide (Mohammed et al., 2019). The syngas can be converted to important chemical intermediates, including methanol, ammonia and oxy-alcohols. However, this route is relatively slow and typically requires large, complicated and expensive equipment. Many efforts have been made to design innovative alternative pathways to effectively convert biomass to chemicals. One area of research has focused on improving the efficiency of catalysts. A novel aqueous phase catalysis process uses robust catalysts and modified carbon supported catalysts developed to convert sugar and organic acids to industrial chemicals at the Pacific Northwest National Laboratory. Besides research on catalysts, advancement of efficient conversion processes has been reported. A cost-effective two-phase route for the selective dehydration of fructose to remove excess functional groups, and thereby produce hydroxymethylfurfura (Román-Leshkov et al., 2006). In addition, chemical conversions have been used to convert the chemical intermediates, which were produced from biological conversion, to final chemical products, including tetrahydrofuran and gamma-butyrolactone from 1, 4-diacids (succinic, fumaric, and malic), and 1,3-propanediol from 3- hydroxypropionic acid (Xu et al., 2008).

3.2 Biological Conversions

Biological conversions involve the utilization of biological enzymes or living organisms to catalyze the conversion of biomass into specialty and commodity chemicals. Overall, it is considered to be the most flexible method for conversion of biomass into industrial products (Xu et al., 2018). Compared to



chemical conversions, where high temperatures and pressures are involved, operating conditions for biological conversions are relatively mild. Actually, biological conversions are not a new topic, but rather some commercial bulk chemicals, such as ethanol, lactic acid, citric acid and acetone-butanol, have been produced via yeast and bacterial fermentation processes (Román-Leshkov et al., 2006). Recently, there has been growing interest in utilization of biocatalysts to convert renewable resources into chemicals, due to high yield and selectivity, and fewer byproducts. However, because of the metabolic restriction in microorganisms, only a few bulk products currently are produced via fermentation. Therefore, development of new technologies to broaden the product spectrum is necessary. Genetic engineering has emerged as a powerful tool for genetic manipulation of multistep catalytic systems involved in cell metabolism. Recombinant DNA technology is used to clone and manipulate gene encoding enzymes in organisms. Recombinant microorganisms, with altered sugar metabolism, are able to ferment sugar to some specialty chemicals, which cannot be produced by the corresponding original strain. For example, catechol and adipic acid were produced from glucose using genetically modified *Escherichia coli*. Both glucose and xylose, in cellulosic biomass, have been converted into ethanol by recombinant *Saccharomyces* yeast. In addition, immobilized enzyme and whole cells have been used to produce biomass-derived chemicals. Currently, efforts are continuing to identify, characterize, and even modify enzymes and living organisms and processes so they can better utilize renewable resources to produce structurally diverse and complex chemicals. High yield and selectivity, as well as minimum waste streams, favor biological conversions as pathways to transform biomass to higher-value chemicals. However, there are still problems with current biological conversions technologies.

Sterilization, fermentation stirring, and separation of target products from aqueous systems with low production concentration entail high energy requirements. Further, considerable investment is required to make processes highly efficient and continuous. Therefore, there are research opportunities in the development of new low cost biological conversions technologies to effectively transform biomass into chemicals.

3.3 Direct Extraction

Some commodity and fine chemicals can be extracted directly from biomass. Ferulic acid, a precursor for vanillin, occurs in a relatively high concentration in the form of xylan polysaccharide ester in corn fibre. Vanillin, used in the flavour and fragrance industries, can be recovered by alkaline oxidation of lignin in the presence of a copper catalyst. Compared to traditional solvents, the advantages of using gas-expanded liquids include low operating cost, ease of separation and reduction of the amount of solvent needed. Direct extraction is a promising pathway for utilizing renewable resources, irrespective of scale. From an economic point of view, the extraction of high-value added chemicals from biomass can be the most profitable, but the availability and variety of chemicals are limited (Xu et al., 2008).

IV. RENEWABLE CHEMICALS SYNTHESIZED FROM BIOMASS

4.1 Chemicals from Lignin

Aromatic products from lignin include some high-value products that can be derived from lignin depolymerisation which are; benzene, toluene, xylene (BTX), phenol, adipic acid and vanillin (Eriksson & Bermek, 2009; Schutyser et al., 2018).



4.2 Chemical Synthesis from Cellulose and Hemicellulose

Chemicals synthesized from cellulose and hemicellulose are; Glucose, Polyols 3 Ethylene Glycol (EG), 4 5-Hydroxymethylfurfural (5-HMF), and Levulinic Acid (LA). Ethanol, Xylitol, 2,3-Butanediol, Methyl ethyl ketone, and 2-Butanol and lastly Organic Acids.

V. CONCLUSIONS

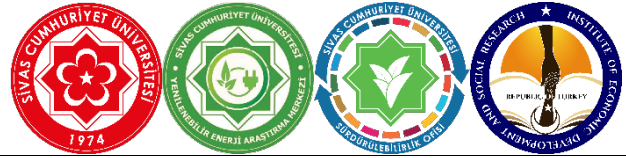
- It's a promising and intriguing idea to consider using biomass instead of fossil fuels to make crucial chemical products.
- The creation of novel catalysts is crucial to the success of biomass conversion into chemical compounds.
- The goal of catalysis research will have to change from creating functional structures out of basic building blocks to re-functionalizing complicated molecular arrangements since the original molecular structure of lignocellulosic biomass components should be conserved.
- High-performance alternatives such as enzymes or whole-cell biocatalysts frequently result in increased selectivity and yield.
- Lignocellulosic pretreatment has adverse effect on the products.
- The raw materials also have their different percentage composition of chemicals.
- Different methods favor different products.

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Electromagnetic Field Levels Analysis for Grid Connected Smart Devices

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Abstract

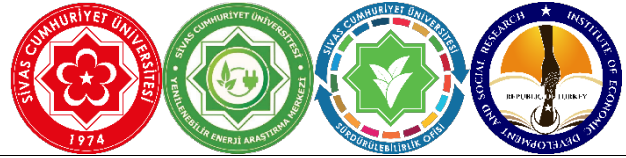
Electromagnetic pollution will be examined under two different headings: natural electromagnetic field sources and artificial electromagnetic field sources. Artificial electromagnetic field or radiation sources, which are generally included in our lives with the use of technology, such as smart electronic devices transmission lines, are much stronger than natural electromagnetic field sources. In the world we live in, everyone is exposed to electromagnetic field pollution at various levels from the electronic devices they use at home, the generation, transmission and distribution of electricity, industrial equipment, telecommunications and broadcasting. In this study, the compatibility of smart grid technologies with the electromagnetic field has been examined and it has been revealed whether they comply with the standards given in the World Health Organization reports. As a result, solution proposals on electromagnetic field pollution were presented. Electromagnetic field sources were simulated in the Magnet program and the results were interpreted. It is exposed to various levels of electromagnetic field pollution from industrial equipment, telecommunications and broadcasting. In this study, the compatibility of smart grid technologies with the electromagnetic field has been examined and it has been revealed whether they comply with the standards given in the World Health Organization reports. As a result, solution proposals on electromagnetic field pollution were presented. Electromagnetic field sources were simulated in the Magnet program and the results were interpreted.

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Keywords: Smart Grid, Electromagnetic Effects, Electromagnetic Fields.

I. INTRODUCTION

Electrical energy usage which brought by the developing technology continues to increase day by day. Along with the increasing electrical energy, electromagnetic field pollution surrounding our environment is also increasing. National and



international scientific organizations have established limit values and standards in order to reduce the exposure of this pollution. The entry of smart grid systems into our lives plays an important role for devices that cause electromagnetic field pollution to work more in line with standards and limit values. Electromagnetic field pollution caused by rapidly increasing wireless communication systems has attracted the attention of people. Increasing radio frequency (RF) in the environment provides an increase in research on electromagnetic radiation. As a society, it should be known by people that we are exposed to many different electromagnetic field sources, not only the microwaves and radio frequencies emitted by mobile phones and base stations, but also by researching and learning more about electromagnetic fields. The most important biological effect of high frequency electromagnetic fields is the heating effect. For example, we use microwave ovens to heat food. The strength of the natural electromagnetic fields and radio frequency that people are exposed to is much lower to provide this warming. High-frequency waves have a high heating effect and recommendations are for this. Another important issue is the research subject of the effects of electromagnetic waves at a level that will not increase body temperature. To date, the effects of long-term exposure to low-level electromagnetic fields on human health have not been confirmed, but studies on this subject continue actively. In this study, first of all, a comprehensive literature review was made and general information about the contribution of smart systems to electromagnetic field pollution was given.

II. ELECTROMAGNETIC FIELDS

Wherever an electric current flows, there is an electric field. Charges create an electric field around the current, which repels or attracts any charge that enters

its range. The field in which electric charges exhibit this characteristic is defined as the electric field. The electrical force exerted by this field on the charge at a point within the range of action expresses the magnitude of the strength of this electric field. If an electrical force acts on a load standing at any point, it can be said that that point is in an electric field. The electric field is denoted by E . If two objects are electrically charged, the pushing or pulling force they exert on each other is inversely proportional to the square of the distance between them. Therefore, as the distance increases, the magnitude of the electric field will decrease. This decrease, which lasts for eternity, decreases immeasurably. As the input voltage (V) of any device increases, the electric field value also increases. The electric field is a vector quantity and its unit is V/m [3].

A magnetic field is created as a result of the movement of electric charges. If there is an electric field in any environment, it means that a magnetic field is also formed. Its direction and time are definite, that is, it is a vector quantity. The number of magnetic field lines passing through a surface is called the magnetic flux. The higher the current strength, the higher the magnetic field strength. The magnetic field loses its intensity as the distance increases. We can give magnets as an example. Magnetic field lines are always closed. These lines can be thought of as lines that come out of one end with N poles and move to the other end with S poles. Magnetic fields are represented by the letter (B). The unit of magnetic field is Newtons per coulomb-meter/second. One ampere in coulombs per second is called $T=N(Am)-1$. Usually, Gauss(g) is used, since Tesla is such a large unit for everyday events. $1\text{ Tesla}=10^4\text{ Gauss turn}$ [3], [4].

Electromagnetic fields are invisible to humans. But everyone knows the terms electricity and magnetism. For example, the earth's magnetic field causes the compass needle to point to the North pole, which is a very long range electromagnetic effect. If a

strong horseshoe magnet is brought near any compass, this magnet suppresses the movement of the compass needle and dominates it. Electromagnetic fields propagate at almost the speed of light in vacuum and in mediums such as air and therefore instantly fill the entire space. But they are densely concentrated around the source. In some cases it is possible to screen and limit the area. Similar long-distance action events are known from electricity. For example, those near a storm cloud or static electricity from friction with a comb can cause our hair to stand on end. In the case of electrical or magnetic fields occurring in nature, the effects of these fields at long distances are generally weak. The area can be expressed as the region that contains the electrical force created by the negative or positive charge in its immediate vicinity. The measured area varies according to the movement and amount of the load. It is assumed that positive charges form an electric field outward from the center, and negative charges form an electric field towards the centre. Neutral objects, on the other hand, do not create any field. It is assumed that positive charges form an electric field outward from the center, and negative charges form an electric field towards the centre. Neutral objects, on the other hand, do not create any field. It is assumed that positive charges form an electric field outward from the center, and negative charges form an electric field towards the centre. Neutral objects, on the other hand, do not create any field.

III. ELECTROMAGNETIC FIELD APPLICATIONS

Electric current creates an electric field in the environment it passes through. If there is an electric field in any medium, it definitely creates a magnetic field. Since the electric field moves perpendicular to the magnetic field, it can be said that the electric and magnetic fields move perpendicular to each other. While the electric field is defined as the force

acting on a unit electric charge; magnetic field is defined as the force acting on a unit charge in motion [2], [9].

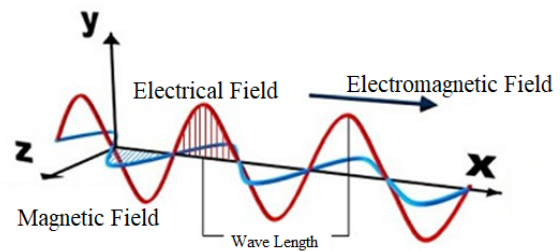


Fig.1 Electromagnetic Field Levels.

Figure 1 shows basic principles of electromagnetic field levels analysis. Applications done in MagNet v7 software. It gives better performance on the computational techniques for solving, post-processing, meshing, and other software features will undergo a significant overhaul. The methods are parallelized to enable simultaneous execution on many cores and multithreaded operations.

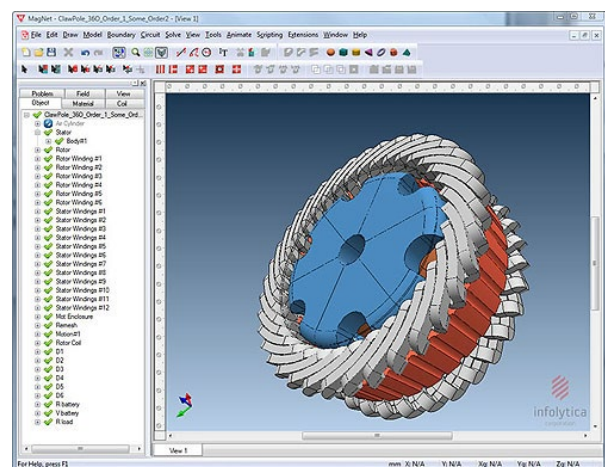


Fig.2 Electromagnetic Field Levels Analysis.

The outcome is considerable program speed increases. To show the boost in performance, a transient 3D simulation of a clawpole alternator was done on a quadcore CPU utilizing an internally developed MagNet v7. Using a mix of system enhancements and multi-threaded techniques, a 2.8x speed up factor was obtained with two threads, while a 3.8x speed up factor was reached with four threads. MagNet v7 provides further

enhancements, such as a revamped and restructured graphical user interface with expanded CAD capability and sharper post-processing visualizations.

Electric fields occur independently of the movement of electric charges; An electric charge at any point creates an electric field in all directions. For example, in cables such as high voltage lines, an electric field is formed while carrying electric charges, and this electric field moves around the cable in a cylindrical fashion. The shape of the electric field at any point changes depending on the charge distribution and the surrounding objects. The existence of a magnetic field wherever there is an electric current requires the subject to be handled with different dimensions. At this point, it is inevitable that these two physical factors, which differ in their characteristics, will have different effects on living things, which are 'biological systems'.

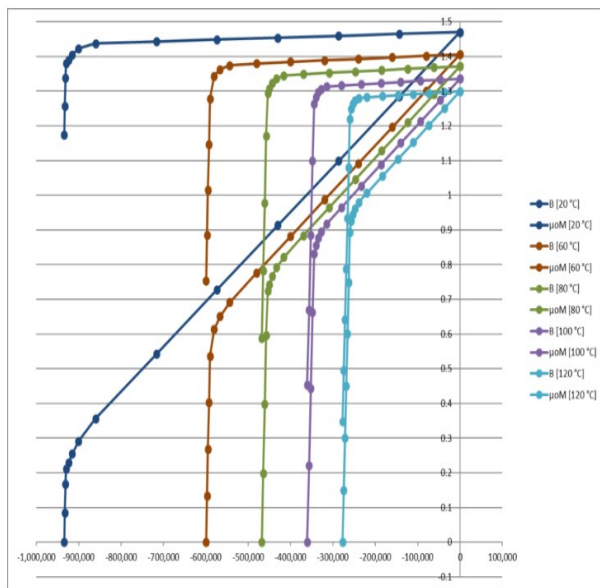


Fig.3 Plotting different levels of electromagnetic fields.

As we mentioned earlier, magnetic fields are caused by the movement of electric charges. Therefore, there is a direct proportionality between these fields and electric currents. In other words, the increase in the electric current will cause the magnetic field to be formed in the

environment to increase. In addition, the increase in frequency causes the formation of more intense electric and magnetic fields [5]. Graphical results shown at different temperature results of electromagnetic fields on Figure 3.

IV. CONCLUSION

Especially the increase in urbanization has made it almost impossible for people to escape from electromagnetic fields. Although the effects of these fields are still not fully revealed, there are many studies showing that magnetic fields negatively affect our lives. This situation should be approached with unity by giving priority to human health. Although individual measures are taken, these measures alone are not sufficient. There are numerous sources of electromagnetic fields in common areas where power lines pass, devices in public institutions, influences on the streets and in our homes. Therefore, countries should create policies and legislate on electromagnetic field measures. Some recommendations for protection from electromagnetic fields; Turn off the electrical appliances you are not using by pulling the plug from the socket. LCD, Prefer LED or plasma screens and keep the distance between you and the screen at least 1 meter. Prefer economy type lamps such as halogen and fluorescent. Do not keep devices such as televisions and computers in the bedroom to increase sleep efficiency. Unplug the electric blanket before going to bed. Prefer devices such as radios and alarm clocks that work with batteries. Use devices with high magnetic fields such as hair dryers for a short time. Prefer wireless headphones when talking on a mobile phone. If there is no earphone, the speaker feature should be used or keep a distance of 1-2 cm from our ears. When using microwave ovens, keep a minimum distance of 1 meter and leave that area if possible. Tube screens should not be used as much as possible, and the minimum distance from the screen should not be less than 2 meters. As much as possible,



devices such as shavers should prefer battery-operated models. The distance with the photocopiers should be kept at a minimum of 50 cm. (High magnetic field). When talking on the phone, wired and payphone models should be used, if any. Care should be taken to use mobile phones in places where the shooting power is high. Care should be taken not to use the mobile phone in places where the gravity power is low, such as the basement of the elevator. It is recommended that pregnant women, children and the elderly do not use mobile phones unless they have to. The World Health Organization states that children and young people are more affected by electromagnetic field pollution because the nervous system and brain continue to develop, so it recommends that the phone should not be used. Positioning the bed away from sources of electromagnetic fields will reduce exposure. The hood is a strong electromagnetic field source, so care should be taken not to stand near it while working. Wireless access (Wi-Fi) generates strong radio frequency waves. Therefore, cable modem was not preferred while working on your computer. Since the device acts as an antenna on computers with Wi-Fi feature turned on, it collects all the radio frequency waves around, so the computer's wi-fi feature should be turned off when you are not using the internet. When purchasing a mobile phone, we should choose phones with a SAR value of less than 1 W/kg or closest to zero.

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Protection of Microgrids with Renewable Integration

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Abstract

Smart grids aim to control electricity generation, transmission and distribution systems by using electronic communication for reliable and efficient energy supply. In today's world, where the availability of renewable energy sources is increasing, the transition to renewable energy at the macro level with its integration into smart grids is of great importance. The reliability of a smart grid is based on the reliability of its control and communication systems. As communication systems become more complex to provide better control and high reliability, smart grids require a higher degree of connectivity to external networks to support new features. However, dependence on these external networks also brings with it cyber security vulnerabilities and breaches. Therefore, these connections must meet the requirements of various standards developed within the scope of cyber security requirements. In this study, the proposals for providing cyber security in renewable energy sources in smart grids and resolving attacks that threaten this security are discussed. By mentioning the importance of cyber security today, the types of attacks that threaten this security, the solutions produced for these attacks and the problems that may arise in these solutions, the importance of cyber security in energy systems is emphasized.

Keywords—Smart Grid, Micro Grid, Cyber Security, Renewable Integration.

Özet

Akıllı şebekeler, güvenilir ve verimli enerji temini için elektrik üretim-iletim-dağıtım sistemlerini elektronik haberleşmeyi kullanarak kontrol etmeyi amaçlar. Yenilenebilir enerji kaynaklarının bulunabilirliğinin arttığı günümüz dünyasında, akıllı şebekelere entegrasyonu ile makro düzeyde yenilenebilir enerjiye geçiş büyük önem taşımaktadır. Bir akıllı şebekenin güvenilirliği, kontrol ve iletişim sistemlerinin güvenilirliğine bağlıdır. İletişim sistemleri daha iyi kontrol ve yüksek güvenilirlik sağlamak için daha karmaşık hale geldikçe, akıllı şebekeler yeni özellikleri desteklemek için harici ağlara daha yüksek derecede bağlantı gerektirir. Ancak bu dış ağlara bağımlılık, siber güvenlik açıklarını ve ihlallerini de beraberinde getiriyor. Öyleyse, bu bağlantılar siber güvenlik gereksinimleri kapsamında geliştirilen çeşitli standartların gereksinimlerini karşılamalıdır. Bu çalışmada akıllı şebekelerde yenilenebilir enerji kaynaklarında siber güvenliğin sağlanması ve bu güvenliği tehdit eden saldırıların çözümlenmesine yönelik öneriler ele alınmıştır. Siber güvenliğin günümüzdeki önemine, bu güvenliği tehdit eden saldırı türlerine, bu saldırılara yönelik üretilen çözümlere ve bu çözümlerde ortaya çıkabilecek sorunlara değinilerek enerji sistemlerinde siber güvenliğin önemi vurgulanmaktadır.

Anahtar Sözcükler—Akıllı Şebeke, Mikro Şebeke, Siber Güvenlik, Yenilenebilir Entegrasyon.



I. AKILLI ŞEBEKE NEDİR?

Akıllı şebekeler, güvenilirlik ve verimlilik amacıyla güç şebekesindeki işleyişi gelişmiş iletişim ve algılama işlevlerini birbirine bağlamaktadır. Bu şebekeler; üretim, iletim, dağıtım sistemlerinden oluşmaktadır. Akıllı şebekelerin sorunsuz bir şekilde çalışmaları için iletişim esnekliği, kontrol sisteminin esnekliği ve dağıtımın akıllılığı koşulları gerekmektedir. Akıllı şebekeler, gerilim kaynağı dönüştürücülerinin içine girmesiyle basit bir biçimde saldırıya uğrayabilmektedir. Bu saldırı türleri arasında arayan kimliği saldırısı, web sitesi saldırısı, e-posta saldırısı, IP saldırısı, GPS saldırısı ve metin mesajı saldırısı bulunmaktadır [1]. Bu saldırılar, saldırgan tarafından veriler taklit edilerek başka bir kişinin veya programın adına hareket ettiğinde ortaya çıkmaktadır. Saldırgan başka bir kişi, başka bir bilgisayar, başka bir cihaz vb. gibi davranabilmektedir.

Akıllı şebekeler, geniş alanlara yayılan bir iletişim ağına sahiptirler. Bu nedenle, akıllı şebekelerin her bileşeni, saldırılarda aktif hale gelebilmektedir. Saldırıları tespit etmek, tanımak, kontrol etmek, değerlendirmek için ağ trafiği durumu düzenli olarak izlenmelidir. Bununla birlikte, saldırılar karşısında ağı kendi kendini iyileştirme potansiyeline de sahip olması gerekmektedir.

Akıllı şebekelerin yerleştirilmesinde çeşitli sorunlar ortaya çıkmaktadır. Bu sorunlar güç dalgalanmaları, voltaj dengesizliği, frekans uyumsuzluğu, geçiş yönetimi olarak değerlendirilmektedir [2]. Güç dalgalanmaları, yenilenebilir enerji kaynaklarının düzensiz hareketliliğinden ortaya çıkmaktadır. Voltaj dengesizliği, küçük voltaj düşüşlerine ağır yüklenme yapılmasıyla meydana gelmektedir. Kesintili, kontrol edilemeyen, yerel şebekede üretim ve tüketim dengesizliği, dağıtım sistemleri için bir sorun olmaktadır.

Yenilenebilir enerjiyi elektrik şebekelerine entegre etmek için ağlar, akıllı şebeke teknolojisiyle birlikte çok daha dikkatli bir şekilde yönetilmelidir [3]. Akıllı şebekeler, gözlemlenebilir, öngörülebilir, yönlendirilebilir ve çok yönlü özelliklerine sahip olduklarında kontrolün sağlanması başarılı olacaktır.

Tablo 1. Dünyadan bazı akıllı şebeke projeleri.

Ülke	Proje	Kapasite
Avustralya	Berrimal Wind Farm	72000 KW
Avustralya	Mortlake South Wind Firm	157500 KW
Çin	Fujian Electric Power Company	6000000000 KW
Çin	Hebei Electric Power Company	4590000 KW
ABD	CCET	8500000 KW
ABD	Detroit Edison's	11084000 KW

II. AKILLI ŞEBEKELERDE SİBER GÜVENLİK

Siber güvenlik, operasyonları yetkisiz erişim veya saldırılara karşı güvence altına almak amacıyla teknoloji, insan, bilgi ve süreçleri içeren bilgisayar tabanlı bir disiplin olarak tanımlanmaktadır. Siber suçlar, insanlarda korku yaratmak, mülklere zarar vermek veya yok etmek için çeşitli haberleşme araçları kullanılarak gerçekleştirilen çeşitli suçlar olarak tanımlanmaktadır [4]. Suçlular, siber saldırıları başlatmak için kötü amaçlı yazılımlar kullanılmaktadırlar. Bilgisayarlar, akıllı telefonlar, bilgisayar ağları vb. gibi elektronikler kötü amaçlı yazılımları çalıştırırlar.

Teknolojinin ilk yıllarında kötü amaçlı yazılımlar basit amaçlar için yazılmaktaydı. Bu nedenle tespit edilmesi daha kolaydı. Bu tür kötü amaçlı yazılımları, geleneksel kötü amaçlı yazılımlar olarak tanımlamaktayız. Günümüzde ise geleneksel kötü amaçlı yazılımlara göre daha yıkıcı ve güçlü olan kötü amaçlı yazılımlara, yeni nesil kötü amaçlı yazılımlar denmektedir. Bu tür kötü amaçlı yazılımlar, güvenlik



duvarları gibi koruma yazılımlarını kolayca atlayabilmektedir. Yeni nesil kötü amaçlı yazılımlar; aynı anda, birden fazla, farklı işlemi kullanır ve kendini gizleyip sistemde kalıcı olmak için çeşitli teknikler kullanırlar. Bu kötü amaçlı yazılımları algılama teknikleri bulunmaktadır. Bunlar; imza tabanlı, davranış tabanlı, sezgisel tabanlı, model kontrolüne dayalı, derin öğrenmeye dayalı, bulut tabanlı, mobil cihaz tabanlı, IoT tabanlı algılama teknikleridir [5].

III. SİBER SİSTEMLERDEKİ GÜVENLİK AÇIKLARI

Siber saldırıların tetiklediği yardımcı programlar hazırda bulunmadıkları için talep azalabilmektedir. Akıllı şebeke ağı, mevcutta bulunan güç ağını geliştirerek, daha rahat ve farklı tehdit çeşitlerine karşı savunmasız hale getirebilmektedir.

Tüketicilerin bilinci; tehditleri belirleyip takip etmek için gereken tüm temel özelliklere sahip olan akıllı şebekeler için kapsamlı ve kolay bir savunma mekanizması, sadece hizmet ile elde edilemeyecek detaylı bir araştırmayı içermektedir. Geliştirilen yardım, hizmet, koruma ihtiyacı sebebiyle, tüketicilerin bu yardım, hizmet ve korumaların tehlikeleri, maliyetleri ve avantajları hakkında tam olarak bilgi sahibi olmaları gerekmektedir.

Çok fazla erişim noktası; çok fazla sayıda bilgisayarın kontrol altına alınması demektir. Bu da oldukça zor bir iştir [6]. Akıllı şebekeler, elektrik akışıyla bir ağ ihtiyacını takip etmek için kullanılan araçlardan oluşmaktadırlar. Bu tür araçlar, saldırganlara geniş erişim sağlamaktadırlar.

Bilinmeyen ve yeni teknolojiler; güvenlik duvarları ve sınırlandırılmaları bilinmediğinden, sadece saldırganların görebildiği birçok yeniliklere sahiptir. Bu nedenle, hataları atlamak için boşluklar bulmak kolay olmaktadır.

Standartlar ve yönetmelikler; akıllı şebekenin birlikte çalışabildiği çeşitli sistemlerin, bilgisayarları ve verileri paylaşmasını, bir sistemi yürütmek için uyumlu bir bileşen kullanmasını sağlayabilmektedir. Standartlar ve yönetmelikler, beraber çalışabilirliği sağlamak için akıllı şebekenin her bölümünü korumaktadır. Yeni alınan kararların uygulandığı yönetmelikler de, güvenlik eksikliğine katkıda bulunmaktadır.

Takımlar; farklı alanlarda akıllı şebekelerde çalışırlar. Takımlar arasındaki hatalar ve koordinasyon eksikliği bilgisayarların korunmasında da hatalar ve eksiklikler oluşturur.

IP donanımı; bilgisayarda uyumlu yazılımlarla ilgilendir. Fakat DoS, FDI gibi siber tehditlere karşı savunmasız olabilmektedir.

Siber Sistemdeki Güvenlik Açıklarının Çözümleri

Gizlilik; kullanıcı verilerindeki ölçümlerin incelenmesiyle ortaya çıkabilmektedir. Tüketicilerin eylemleri ve satın alma verileri üzerinde analiz yapılabilmektedir. Akıllı şebekelerdeki koruma, tüketicilerin haklarının dikkate alınmasını sağlamaktadır.

Erişim yönetimi; saldırganların ağa girmesini engellemektedir. Erişim yönetimi, yasal kullanıcıları yetkisiz kullanıcılardan ayırmaktadır. Ancak lisans ihlali durumunda güvenlik sorunları ortaya çıkmaktadır.

Üçüncü şahıs koruması; bir koruma yöntemidir. Zayıflamış bir akıllı şebeke ağı sahibinin üçüncü şahıs kayıpları için sivil sorumlulukları bulunmaktadır. Yetkilendirme, üçüncü şahıslar için tesis otomasyon ağına yapılan saldırılardan kaynaklanan potansiyel tesis ağındaki güvenlik açıklarıyla ilgilendirilmektedir.

Kaydedip izleyerek; sinyal işleme alanında kapsamlı bir çalışma gerçekleştirilmektedir. Saldırıların tespiti durumunda kanıt sağlamaktadır.

Akıllı şebekeler, Wifi, TCP, IP ve diğer işletim sistemlerini kullanmaktadır ve altyapıyı saldırılara karşı



daha savunmasız hale getirmektedir. Bu nedenle, akıllı şebekelerin altyapısı risklere ve saldırılara karşı güvenli olmalıdır. Güç şebekesi, siber saldırılardan kaynaklanan tehlikeleri önlemektedir, savunmayı planlayıp ve ortadan kaldırmaktadır.

A. Akıllı Şebeke İletişim Güvenlik Açıkları

Akıllı şebekelerin altyapı bilgileri, şebekeye yönelik saldırıların başlatılmasında kullanılan güvenlik açıklarına sahip internet protokollerine dayanmaktadır. TCP/IP, internete genel amaçlı bağlantı için kullanılmaktadır ve kontrol merkezlerine bağlanmak için kullanılmamaktadır. İnternet ağları, diğer ağların yanlış yapılandırması nedeniyle doğrudan veya dolaylı olarak akıllı şebekeye bağlanmaktadır. Kontrol merkezleri arasındaki veri alışverişi, ICCP protokolü ile güvenlik açıklarına sahip olmaktadır.

B. Akıllı Şebeke Yazılım Güvenlik Açıkları

Akıllı şebekeler, akıllı sayaçlar ile uzaktan arttırılabildiği için kolayca saldırıya uğrayabilmektedir. Saldırganlar, sayaçları tek tek veya kontrol merkezinden kontrol ederek karartma yapabilmektedir. Bu güvenlik açıklarından, yazılım hataları yoluyla yararlanılabilmektedir. Şebeke bileşenleri erişilebilir olurlarsa, saldırı için potansiyel bir erişim noktası sağlayabilirler.

C. Akıllı Şebeke Gizlilik Açıkları

Bu güvenlik açıkları, müşterilerin evlerine yerleştirilen akıllı sayaçlar ile kamu hizmeti şirketleri arasındaki iki yönlü iletişimin bir sonucu olarak ortaya çıkmaktadır. Saldırganlar, müşteriler hakkında gizli bilgiler elde edebilmektedir.

D. Akıllı Şebeke Fiziksel Güvenlik Açıkları

Akıllı şebekelerde gerçek varlıkların fiziksel korunmasını sağlamak yeterince mümkün olmamaktadır. Evlere, binalara ve uzak alanlara takılan akıllı sayaçlar, onları sayısız fiziksel saldırı için kolay bir hedef haline getirebilmektedir. Bu nedenle, inhibisyon solüsyonları ile birlikte algılama tekniklerini geliştirmek gerekmektedir.

IV. SİBER SALDIRI ÖNLEME YÖNTEMLERİ

Malware, False Data Injection Attack, DDoS ve DoS, Phishing, SQL Injection, Man in the Middle, Cryptojacking, Zero Day Exploit, Passwords Attack, Eavesdropping Attack, Supply Chain Attack, Ransomware, Credential Stuffing, Internet of Things, Cross-Site Scripting; siber saldırı türlerinin en bilindikleridir. Bu saldırılardan en sık karşılaşılan DoS Attacks ve False Data Injection Attacks saldırıları bu çalışmada incelenmiştir.

A. DoS Attacks

DoS saldırıları, hizmet reddi saldırıdır. Saldırganın hizmetlerin kullanılabilirliğini ele geçirebildiği tehlikeli bir saldırı çeşididir. DoS, İnternet Kontrol İletim Protokolü (ICMP) gibi çok sayıda güvenliği ihlal edilmiş sistemleri ele geçirecek, sistemlerin çalışmasının engeline neden olabilmektedir [9]. Bu saldırılarla, kayıtlı kullanıcıların sahip oldukları önemli kaynaklara erişilebilmektedir. Sistemdeki kararsızlık noktası anlaşıldığında, iletişim kanallarına saldırılarak, saldırı gerçekleştirilebilir.

DoS saldırıları, elektronik sistemleri ve protokolleri hedef alarak tüm kanalları tıkamaktadır. Bir DoS saldırısı, iletişim ağını çok fazla yoğun hale getirerek, kullanıcılara erişimi sınırlayabilmektedir.

DDoS saldırılarında, saldırılar önceden planlanmaktadır. DoS saldırıları, akıllı şebekelerdeki iletişimi sıfıra indirebilmektedir [10].

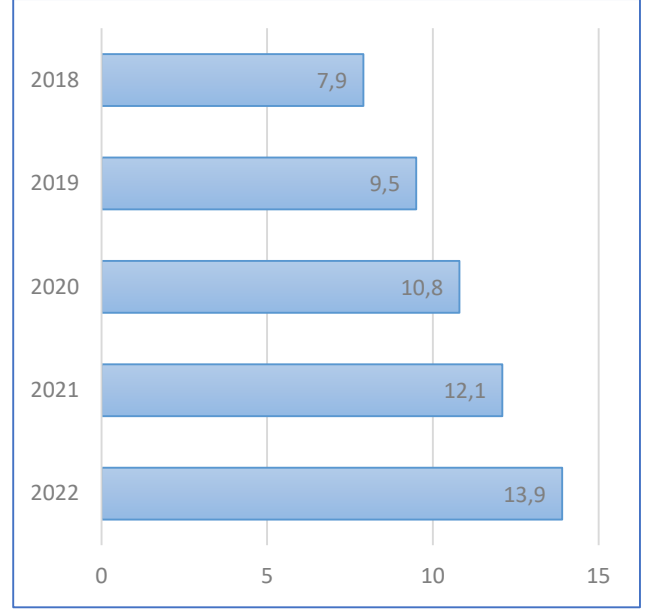
Saldırmanın bir ağdaki birçok kanala erişimi olması ve her an başka bir sisteme saldırı için hazırlıklı bulunması, dağıtılmış hizmet reddi (DDoS) saldırısı olarak adlandırılmaktadır. Dağıtılmış DoS (DDoS) saldırılarında, çok sayıda bilgisayar aynı anda bir sisteme saldırarak, saldırıyı gerçekleştirmektedir.

DDoS saldırıları çeşitli şekillerde uygulanabilmektedir.

Hacim Tabanlı DDoS: Hacim tabanlı DDoS saldırıları, tüm merkezleri yoğun bir trafikle doldurma amacı olan saldırılardır. Bu tür DDoS saldırıları, tüm merkezdeki ağların bant genişliğini tüketmektedir. İnternet Kontrol Mesajı Protokolü (ICMP) taşması, Kullanıcı Datagram Protokolü (UDP) taşması, IP/ICMP Parçalama, IPsec taşması, bu saldırılardan birkaçı olarak bilinmektedir.

Protokol DDoS: Protokol DDoS saldırılarında, internet iletişim protokollerindeki tüm açıklardan tam olarak yararlanılmaktadır. Bu açıkların bulunup değiştirilmesi zor olup zaman almaktadır.

Uygulama Katmanı DDoS: Katman 7 (L7) DDoS saldırıları olarak da bilinmektedir. HTTP GET gibi birçok popüler internet ağlarının en üst katmanına sızmayı amaçlayan bir saldırı türü olarak bilinmektedir. Diğer ağ katmanlarına kıyasla sunuculara da zarar vermektedir.



Şekil 1. DDoS Saldırıları Yıllık Değişim Grafiği.

B. False Data Injection Attacks (Kötü amaçlı enjeksiyon saldırıları)

Kötü amaçlı enjeksiyon saldırılarında (FDIA) saldırgan, durum tahmin süreçlerine müdahale edebilmektedir ve ağ operatörünü aldatabilmektedir. Akıllı şebeke ağları boyunca aşamalı olarak kötü karar vermeye yol açtığı için en tehlikeli siber saldırı olarak da kabul edilebilmektedir ve ciddi saldırılara yol açmaktadır.

FDIA, izinsiz giriş yapan kişinin amacına bağlı olarak, enerji hırsızlığı ve ağ üzerinden fiziksel yıkım gibi birçok benzer çeşitli sonuçlara sahip olabilmektedir [11].

Fiziksel Tabanlı FDIA: Bu tür saldırılar kontrol ve güvenlik cihazlarını tipik olarak izlemeyi hedeflemektedir. FDIA, donanım yazılımı değiştirilerek herhangi bir işlemci tabanlı cihazda uygulanabilmektedir. Bu tür savunmasız cihazların sayısı sınırlı olmaktadır.

Siber Tabanlı FDIA: Bu tür saldırılar, düşmanın kontrol sistemine ve önemli uygulamalarına girdiği saldırılardır. Hedefleri, sistemin çalışması ve hizmet etmesidir.



V. SONUÇ VE ÖNERİLER

A. DoS Saldırılarını Önleme için Şifreleme Yöntemleri

DoS saldırıları, sistemin ana içeriğiyle değil, sisteme gönderilen içeriklerin toplamıyla ilgilenmektedir. Veri doğrulamanın güçlendirilmesi, ağ kaynaklarının çeşitli hizmetlerle ilgilenmesi, ağ altyapılarının iyileştirilmesi, düzenli izleme ağı gibi çözümlerle bu tür saldırılardan hasarsız çıkılabilmektedir. Aynı zamanda, kimlik doğrulama ve şifreleme yöntemleri de çeşitli çözümlerdendir. Ancak bu saldırıları önlemek için, kullanılan bazı çözümler hizmet kalitesini düşürebilir, hatta saldırı için boş bir alan bile açabilmektedir. Bunun için, mekanizmayı başarılı bir şekilde kurmak gerekmektedir.

B. FDIA Önleme Yöntemleri

Bu tür yöntemlerde, yük hesaplaması çok önemlidir. Bu nedenle, enerji tüketimini azaltmak, hesaplama maliyetini azaltmak, algoritmanın etkinliğini arttırmak, algoritma doğruluğunu arttırmak ve hesaplama hızını arttırmak için düzenli olarak araştırma yapılması gerekmektedir.

B. 1. Atlamalı Kimlik Doğrulama

Bu yöntemin FDIA önleme için uygulanabilir olduğu kanıtlanmıştır. Ancak DoS saldırılarını önlemek için kanıtlanmamıştır [12]. Sebebi, veri sıkışıklığıdır.

B. 2. Açık Anahtar Şifreleme

Bu yöntem, akıllı güç sistemlerinde siber saldırıları tespit etmek için kullanılan bir diğer yöntemdir. Akıllı ölçüm cihazlarının ve akıllı

eviricilerin, ICT özelliklerine sahip entegrasyonu ile bu tür yaklaşımlar uygulanabilir olabilmektedir. FDIA için şifreleme yöntemleri; Rivest-Shamir-Adleman (RSA), Eliptik Eğri Şifreleme (ECC), açık anahtar şifrelemesi, veri doğrulama şifrelemesi olarak bilinmektedir [13]. Özel anahtarı tanımlamak için bilinen, güçlü bir şifre çözme yöntemine ve hataları düzeltme yöntemine sahip bir kod seçilmektedir. Bu sisteme McEliece Sistemi denmektedir.

B. 3. Güvene Dayalı Yaklaşımlar

Akıllı şebekeler için bir diğer önleme yöntemi, güven değeri mekanizmasıdır. Bu yaklaşımda, kötü niyetli düğümleri belirlemek için güven seviyesini değerlendiren bir model kullanılmaktadır. Bu Hash algoritmasıdır [14].

Kötü niyetli düğüm belirlendikten sonra, yönetim merkezine bildirilir ve kötü niyetli düğüm ortadan kaldırılır. Bir algılayıcı düğüm, başka bir gruba gittiğinde, güven değeri yönetim merkezine geri gönderilir. Sonuç olarak, güven değeri araştırılan kümedeki düğümlerin ilk güven değeri olarak kabul edilmektedir. Bu yöntem FDIA önleme için bir çözüm olmaktadır.

FDIA ve Ddos saldırılarında farklı çözüm yöntemleri önerilse de akıllı şebekelerde siber güvenliğinin çalışma aşamaları uygulandığında, siber saldırılar gerçekleşmeyip, akıllı şebekelerin siber saldırılardan korunması da bu şekilde sağlanacaktır.

Siber saldırılardaki güvenlik açıkları dikkate alınıp üzerinde çalışıldığında, farklı güvenlik açıklarına farklı çözümler üretilmesi gerekmektedir. Bu güvenlik çözümleriyle akıllı şebekelere yapılan siber saldırılar engellenmektedir ve sistemler başarılı bir şekilde çalışmaktadır. Siber saldırıların çeşitleri detaylıca incelendiğinde, bu saldırı çeşitleri iyice tanınmış olup, erken teşhis ile birlikte erken önlem alınabilmektedir.



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