MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
KYIV NATIONAL ECONOMIC UNIVERSITY
NAMED AFTER VADYM HETMAN
Faculty of International Economics and Management
Department of International Economics

BACHELOR DEGREE PROGRAM	**«INTERNATIONAL ECONOMICS»**
FIELD OF KNOWLEDGE	**05 Social and behavioral sciences**
SPECIALTY	**051 «Economy»**

Form of education full-time

BACHELOR THESIS

Title «State energy policy in the context of country's economic development (on the example of a particular country)»

By **Valeri Khaimanot**
(Student's name, surname) (Signature)

Academic Supervisor PhD, Associate Professor
(Scientific degree, academic status)
Liudmyla Tsymbal
(Signature) (Name, Surname)

Bachelor Thesis has been approved for defense at Attestation Examination Commission (EC)

Head of the Department of International Economics Dr.of Science, Professor
Y. Stoliarchuk
(Signature)

KYIV 2024

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AGREED
Head of the project group (guarantor) of
The educational-professional program
__________________ Y. Stoliarchuk
(Signature)

__________________ 2023

APPROVED
Head of the Department
______________ Y. Stoliarchuk
(Signature)

______________ 2023

INDIVIDUAL TASK
higher education applicant Valeri Khaimanot
Name, Surname
full-time form of education

Bachelor Thesis

Title: **«State energy policy in the context of country's economic development (on the example of a particular country)»**

The title of the Bachelor’s thesis has been approved by the Rector’s Order
«07» 12. 2023 №2231-ст

Plan of Bachelor Thesis and the terms of its submission to the Academic Supervisor

Object of research: State energy policy in the context of Ukrainian economic development.
Subject of research: impact and effectiveness of energy policy decisions on the Ukrainian economy, especially under the unique challenges.
The purpose of the thesis: Identify the main features of energy policy and to create a framework for evaluating its effects on the economy, particularly focusing on Ukraine.

Chapter 1. Theoretical basis for energy policy analysis

Applicant has to conduct a comprehensive literature review on energy policy and the various types of policy instruments. She will explore the historical development of energy policy frameworks, analyze different theoretical models and frameworks used in the study of energy policies, and discuss the implications of energy policy decisions on economic growth and sustainability.

In Chapter 2. Analysis of energy policy frameworks

Applicant has to identify the determinants of the Ukrainian energy sector. She will examine the current state of Ukraine's energy policy and its alignment with European standards, assess the effectiveness of various energy policy instruments used in Ukraine, and analyze case studies of energy policy decisions in Ukraine and other countries to draw comparative insights. The chapter will culminate in the development of a framework for evaluating the impact of energy policy decisions on the Ukrainian economy.

The task has been set by the academic supervisor	_______ (signature)	Liudmyla Tsymbal (Name, Surname)
The tas has been given to Applicant	_______ (signature)	Valeri Khaimanot (Name, Surname)

ABSTRACT

The qualifying bachelor thesis contains 82 pages, 2 tables, 28 figures, a list of used sources with 73 items, and appendices.

The *object* of the research is state energy policy in the context of Ukrainian economic development.

The *subject* of the study is the impact and effectiveness of energy policy decisions on the Ukrainian economy, especially under the unique challenges posed by geopolitical tensions and technological advancements.

The *purpose* of this qualifying bachelor thesis is to identify the main features of energy policy and to create a framework for evaluating its effects on the economy, particularly focusing on Ukraine. To achieve this goal, the following tasks have been defined:

- To analyze current trends in global energy policy and their relevance to Ukraine.
- To identify key factors influencing the effectiveness of energy policies.
- To study various scenarios of energy policy implementation and their potential economic consequences.
- To assess the impact of innovative technologies and renewable energy sources on Ukraine's energy sector.
- To analyze geopolitical aspects and their influence on Ukraine's energy policy.

The *theoretical significance* lies in expanding knowledge and generalizations in the field of energy policy and its economic implications. The thesis examines key aspects of energy policy during war, identifies factors influencing its effectiveness, and predicts future scenarios. The results contribute to the theoretical base and encourage further research in energy policy and economic development.

The *methodological significance* lies in the development of a framework and analytical methods to assess the impact of energy policy on economic development. The research involves analyzing statistical data, economic models, and prognostic techniques.

These methods can be used for educational and research purposes in studying energy policies and their impacts.

The *practical significance* lies in applying the obtained results to real-world energy policy and economic development. The study provides insights and recommendations that can be used in energy policy decision-making, development projects, and strategic planning. The findings help understand and adapt to changes in the energy sector, improving the efficiency and sustainability of energy systems in Ukraine.

The research employs dynamic modeling, stock-flow modeling, and feedback loops modeling using Vensim. These methods involve constructing detailed models that simulate the behavior of energy systems over time, capturing the interdependencies and feedback mechanisms inherent in complex energy systems. Dynamic modeling allows for the analysis of how energy policies affect various economic and environmental variables over time. Stock-flow modeling helps visualize the accumulations and changes in energy resources, infrastructure, and economic factors. Feedback loops modeling captures the cyclical interactions within the energy system, providing insights into how changes in one part of the system can influence other parts. Using Vensim, these modeling techniques enable the evaluation of various policy scenarios and their potential impacts on the economy, helping to develop strategies that enhance energy security, support economic growth, and build resilience against external shocks.

The year of defense: 2024.

Key words: energy policy, Ukrainian economic development, energy security, renewable energy, geopolitical tensions, economic impact, policy effectiveness, sustainability, energy infrastructure, innovative technologies.

Academic supervisor's review
on the bachelor thesis
by the applicant of Kyiv National Economic University
named after Vadym Hetman
bachelor degree program "International economics"

Valeri Khaimanot

Title **Energy policy of the state in the context of economic security (on the example of a particular country)**

1. Relevance of the research topic is related to the importance of energy policy for the country's economic independence, its weight in maintaining macroeconomic stability. This issue is especially relevant during the war and energy crisis in Ukraine. It is also relevant to determine the weight of influence of various factors on the formation of the country's energy policy

2. Positive aspects of the thesis: the paper analyzes the energy policy and in the work defines the peculiarities of energy policy formation in the developed countries of the world. The paper also analyzes the determinants of the formation of the energy policy of Ukraine.

3. The author's independent ideas and conclusions, scientific novelty. The author identified the determinants of the formation of energy policy of Ukraine, carried out economic and mathematical modeling to determine the impact of energy policy on the economic development of Ukraine.

4. Practicality of the conclusions and recommendations. conclusions and recommendations can be used in the formation of a strategy for the development of the energy sector of Ukraine.

5. Negative aspects of the paper: the work could be improved by calculating the efficiency of implementation of the proposed measures, taking into account possible losses in the energy sector.

6. Total result of the master Thesis and its approval for defense at Attestation Examination Commission: The work is performed at a high theoretical level, in accordance with the requirements for qualifying bachelor theses and can be admitted to the defense before the examination board with a total score of 46 points.

Academic Supervisor Doctor of economic sciences, professor

________________ Liudmyla Tsymbal
(Signature)
"___"______________ 20____

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INTRODUCTION

Energy policy decisions have profound implications for a country's economy, environment, and national security. In Ukraine, the significance of energy policy is amplified by the ongoing geopolitical tensions, particularly with Russia, which have exposed the vulnerabilities of the country's energy infrastructure. Effective energy policy is essential not only for ensuring a stable and secure energy supply but also for fostering economic development and achieving environmental sustainability.

The consequences of energy policy decisions on the economy are far-reaching. These decisions influence energy prices, the stability of energy supplies, and the overall economic growth. For instance, investments in renewable energy can lead to job creation, technological innovation, and reduced greenhouse gas emissions. On the other hand, reliance on fossil fuels and outdated infrastructure can result in economic inefficiencies and increased vulnerability to external shocks.

Learning from the experiences of other countries provides valuable insights into making better energy policy decisions. Developed countries like Japan, Germany, France, and Canada have implemented diverse strategies to address their energy challenges.

A critical aspect of this thesis is the creation of a framework to determine the effect of energy policy decisions on the economy. This framework will help policymakers understand the potential outcomes of their decisions and develop strategies that enhance energy security, support economic growth, and build resilience against external shocks. By simulating different scenarios, the framework provides a strategic tool for evaluating the impacts of various energy policies under varying conditions.

This thesis aims to explore the essence and concept of energy policy, examine the types and forms of state regulations, and analyze the lessons learned from developed countries. By applying these insights to Ukraine, the thesis seeks to develop a comprehensive framework that can guide policymakers in making informed energy policy decisions. The goal is to ensure that Ukraine's energy policy not only addresses immediate challenges but also aligns with broader objectives of economic development, national security, and environmental stewardship.

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CHAPTER 1.
THEORETICAL BASIS FOR ENERGY POLICY ANALYSIS

1.1 Energy policy essence and concept

Before delving into the definition of energy policy, it is crucial to first explore the fundamental concept of policy itself. Merriam-Webster defines policy as: “A high-level overall plan embracing the general goals and acceptable procedures especially of a governmental body”. Charles L. Cochran and Eloise F. Malone offer a more specific definition: “Public policy consists of political decisions for implementing programs to achieve societal goals.”

Generally, policy is the response of government to the present conditions in a particular sphere of activity in a society. Governments have a choice to either maintain the conditions to meet certain social objectives or change those conditions to ensure that certain social objectives will be met. Thus, policy may consist of positive actions by the government or simply the maintenance of the status quo [1].

Energy policy is a specific type of policy designed to address the circumstances within the energy industry. According to the Oxford Research Encyclopedia, energy policy comprises rules concerning energy sources, energy efficiency, energy prices, energy infrastructure, and climate and environmental aspects of energy production, utilization, and transit. The main theme in this policy domain, especially in the European context, concerns the trade-offs between affordable, secure, and clean energy. Energy policy is a cross-sectoral—or boundary-spanning—policy domain, and as such, it is affected by decisions taken in other policy domains as well as affecting what is decided there. The cross-sectoral character of energy policy is reflected in how it is proposed, adopted, implemented, and evaluated [2].

Merve Suna Ozel Ozcan defines energy policy as the set of rules and strategies that determine the energy resources, production, consumption, distribution, and pricing of a country or a region [3]. According to The Canadian Encyclopedia, energy policy comprises government measures concerned with the production, transportation, and use of energy commodities. Governments may adopt energy policies to meet goals such as economic growth, the distribution of income, industrial diversification, and the protection of the environment. Since the large jump in energy prices in the early 1970s, governments around the world have played an increasingly active role in energy policy [4].

I find the definition in the Oxford Encyclopedia most fitting, providing a thorough and solid explanation for the term. Hereinafter, I will use the term 'energy policy' referencing this definition. The necessity of separately defining 'energy policy' from 'policy' arises due to a significant distinction. Unlike other types of policy, the outcome in the energy sector is not solely determined by economic factors; these factors play a crucial role in shaping the policy agenda.

Governments take on the responsibility of ensuring that the outcomes in the energy sector are consistent with a range of social objectives. If the only objective was economic efficiency in the energy sector, it could be argued that the only role for government is the maintenance of competition or the regulation of natural monopoly. The energy sector, however, does not sit isolated from other spheres of activity in a modern society. In addition, within the energy sector itself, competition is not sufficient to produce efficiency outcomes where problems of externalities are involved. Thus, energy policy has to be concerned with not only efficiency but also concerns associated with social equity, environmental impacts of energy use, and the long-term sustainability of the energy resources available to society. Furthermore, energy policy has to be made consistent with policy in other areas such as transportation, the built environment, industry policy, and taxation policies [1].

This makes energy policy cross-sectoral and inherently more complex. Managing and solving problems becomes challenging when implementing diverse approaches. The fundamental questions of energy policy encompass considerations such as what sources of energy should be used, who should own energy resources, how these resources should be utilized, how to make energy production more efficient, and how to meet society's needs.

These central questions define the goals of energy policy around the world. According to the Energy Union (2015), the five main aims of the EU's energy policy are to:

1. Diversify Europe's sources of energy, ensuring energy security through solidarity and cooperation between EU countries;
2. Ensure the functioning of a fully integrated internal energy market, enabling the free flow of energy through the EU through adequate infrastructure and without technical or regulatory barriers;
3. Improve energy efficiency and reduce dependence on energy imports, cut emissions, and drive jobs and growth;
4. Decarbonize the economy and move towards a low-carbon economy in line with the Paris Agreement;
5. Promote research in low-carbon and clean energy technologies, and prioritize research and innovation to drive the energy transition and improve competitiveness [5].

To achieve these goals, energy policy should be efficient and responsive to rapid changes in technology and shifts in market dynamics.

As Figure 1.1 illustrates, an effective energy policy has five key elements: thrust, commitment, applicability, implementation, and review.

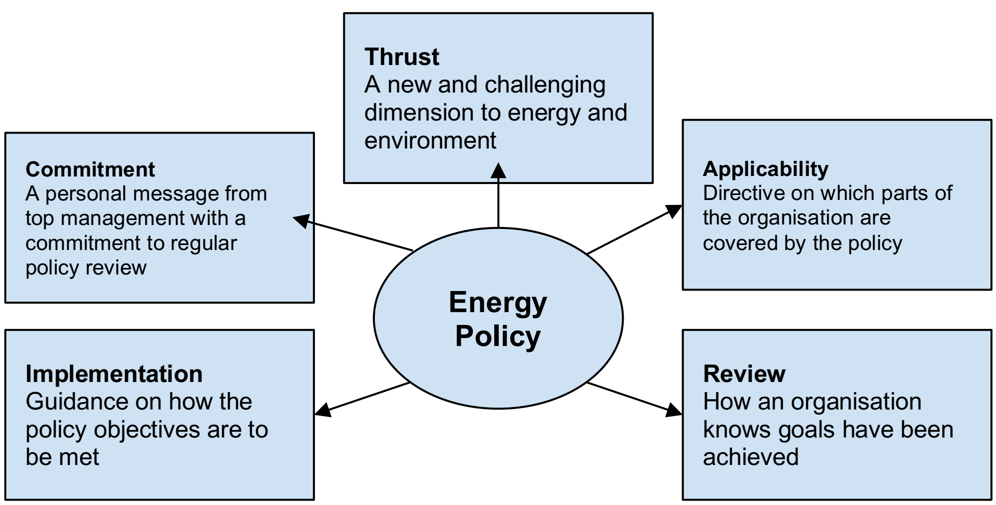


Figure 1.1 – Key Elements of the Energy Policy [6]

The first feature is highly important because a policy should be challenging and motivating—an ideal or challenge that we hope to attain. This feature is directly related to the contents of the energy policy and is stated in what is referred to herein as the Energy Agenda. It is particularly linked to the strategic vision and the higher-order or general objectives.

The last two features are parts of the cyclical process described above. The second feature—Commitment—is directly related to the institutional dimension. Its starting point is the commitment shown at the highest institutional levels of government agencies, particularly the body governing the energy policy, which creates the necessary confidence and assurance that the policy will be followed through or that its action plans will be executed. This is why the institutional dimension, discussed below in this chapter, is so important. The next feature—Applicability—puts the technical dimension into perspective and has to do with the feasibility of implementing the policy by creating and maintaining sufficiently favorable conditions to address and overcome any risks and achieve the objectives [7].

In conclusion, understanding energy policy requires a comprehensive approach that considers various economic, social, and environmental factors. The cross-sectoral nature of energy policy highlights the complexity and interdependence of different policy domains, emphasizing the need for coordinated and adaptive strategies to meet evolving challenges and goals. A well-formulated energy policy not only addresses the immediate needs of energy production and distribution but also aligns with broader societal objectives such as sustainability, equity, and environmental protection. Thus, the importance of a meticulously crafted energy policy cannot be overstated in the context of modern economic development and environmental stewardship.

1.2 Types and Forms of Energy Policy State Regulations

Countries have reported more than 7,000 energy policies to the International Energy Agency, which represents only a fraction of the energy policies implemented by provincial and municipal governments. Energy policies are shaped by pressures from stakeholders with diverse interests, including economic development, geopolitical security, climate action, and the deployment of new technology. The influence of each stakeholder group on decision-makers varies, and political science helps explain how these differences affect policy. For instance, in the US, traditional energy interests have historically outspent clean energy advocates tenfold in lobbying efforts. However, recent increases in spending by clean energy proponents have led to significant US policies promoting electric vehicles and renewable energy.

Some policies utilize financial incentives to alter the relative prices of energy products or end-uses. Fossil fuel subsidies, which reached a record high of $7 trillion according to the International Monetary Fund, remain a critical international policy issue amidst the catastrophic effects of climate change. Other financial incentives include tax credits, direct spending, and research support, which collectively cost the US $30 billion in 2022. Additionally, at least 40 countries use carbon pricing to shift some costs of climate change to fossil fuel producers and consumers.

Regulation is another major category of energy policies influencing the decisions of energy producers and consumers. For example, regulations on air pollution from cars and power plants drive transitions to electric mobility and renewable energy. Building energy codes and appliance standards have also contributed to making energy efficiency a key component of clean energy transitions. Furthermore, regulations in areas seemingly unrelated to energy, such as wildlife protection or waste management, can impact decisions about energy, including the siting of renewable energy projects and coal ash treatment [8].

In terms of scope and outreach, policies can be classified as cross-cutting or sectoral. In terms of the time horizon for implementation, they can be short, medium or long-term policies. Long-term policies usually involve structural aspects of the socio-environmental system and can be categorized as development policies, because they seek to meet the structural needs of the socio-environmental system in order to boost economic growth and social progress.

Governments at all levels have developed policies to surmount specific barriers to more rational use of energy.

In general, five main distinct types of energy policy types can be identified:

- Pricing mechanisms
- Regulatory and control mechanisms
- Fiscal measures and tax incentives
- Promotional and market transformation mechanisms
- Financial remediation [9]

Table 1.1 – Types of energy policy with examples

Policy	Example
Pricing mechanisms	Variable tariffs where higher consumption levels invoke higher unit prices.
Regulatory and control mechanisms	Compulsory activities, such as energy audits and energy management. Minimum energy performance standards (MEPS). Energy consumption reduction targets. EE investment obligations on private companies.
Fiscal measures and tax incentives	Grants, subsidies and tax incentives for energy efficiency investments. Direct procurement of EE goods and services.
Promotional and market transformation mechanisms	Public information campaigns and promotions. Inclusion of energy efficiency in school curricula. Appliance labelling and building certification.
Technology development	Development and demonstration of EE technologies.
Commercial development and capacity building	Creation of energy service companies (ESCOs). Training programmes. Development of EE industry.
Financial remediation	Revolving funds for EE investments. Project preparation facilities. Contingent financing facilities.

Source: International Energy Agency OECD/IEA, January 2010

We will now explore each policy type in detail.

Pricing mechanisms. Peer-to-Peer energy trading pricing mechanisms can be separated into two sections: energy pricing and network service pricing. The pricing mechanism is a rule for determining the value of goods or services exchanged. Energy pricing establishes the price of energy to align with market objectives, while network service pricing sets the cost for using network infrastructure and ancillary services to facilitate energy trading. The energy price can be assessed by the trading strategy adopted in P2P energy trading, which is regulated by various factors such as energy production and consumption. The trading strategy can vary depending on the energy pricing method used, for example, in a pool-based market, market participants only consider energy production and consumption while in bilateral contracts the trading strategy can be based on the counterparty. Figure 1.2 represents the strategy for classifying pricing mechanisms, including methodologies for implementation of these pricing mechanisms.

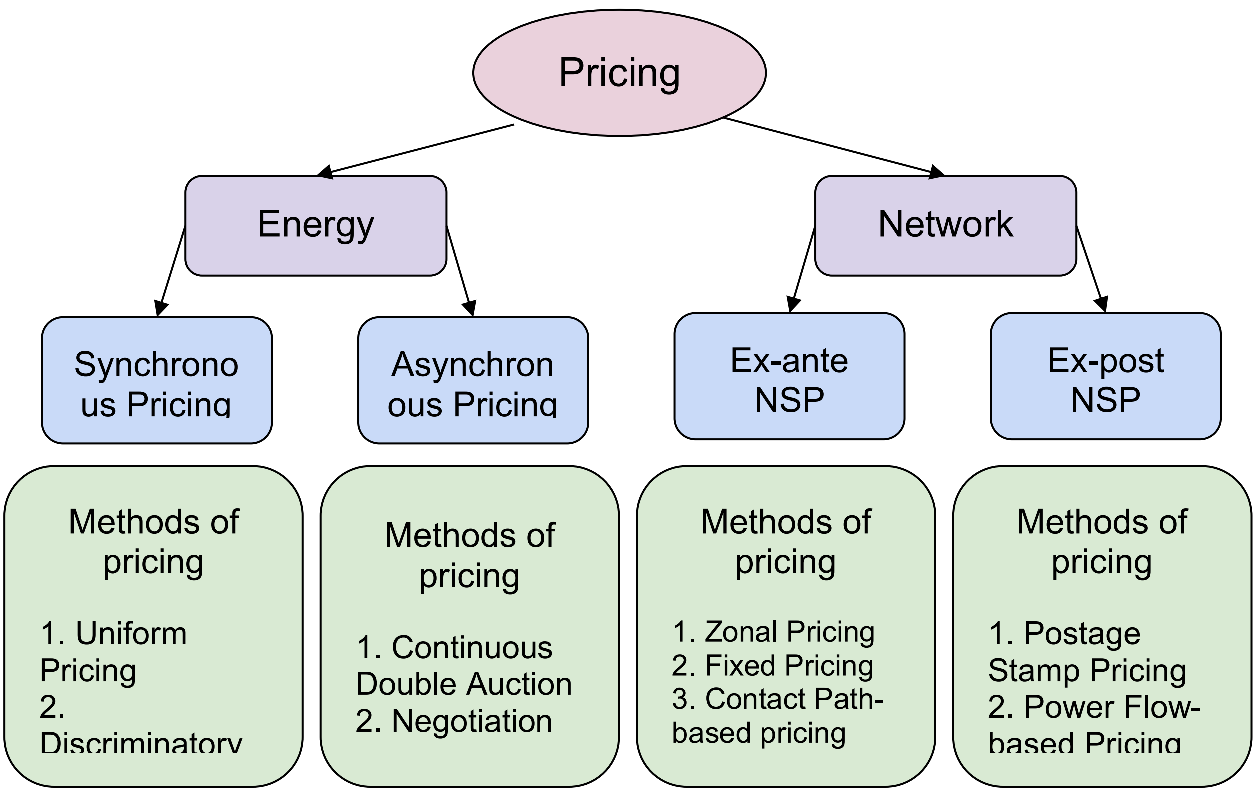


Figure 1.2 – Pricing Mechanism types [73]

The cost of network services can have a significant impact on the utility of the consumer and can account for nearly 25% of the energy bill. However, unlike energy pricing, network service pricing is only determined by the SO, and market participants must conform to it when conducting energy trading, thus it must be considered when developing a trading strategy [10]. Regulatory and control mechanisms constitute a pivotal component of energy policy. These mechanisms encompass a spectrum of governmental regulations, directives, and oversight strategies designed to supervise and influence the activities of energy producers, distributors, and consumers. Within this framework, regulatory bodies are entrusted with the responsibility of establishing and enforcing guidelines that govern the entire energy supply chain. This includes setting standards for environmental sustainability, safety protocols, and operational practices. The aim is not only to guarantee the reliability and stability of energy production and distribution but also to align these processes with broader societal and environmental objectives.

Moreover, regulatory and control mechanisms play a crucial role in fostering competition and preventing monopolistic practices within the energy market. By implementing fair market regulations, governments can encourage innovation, promote efficiency, and ensure that energy resources are allocated equitably. These mechanisms also extend to monitoring and managing compliance with established policies and addressing deviations [11].

Fiscal measures and tax incentives form a vital aspect of energy policy, aiming to influence and incentivize activities within the energy sector. These measures involve the strategic use of taxation and financial tools to encourage specific behaviors and investment in sustainable energy practices. Governments employ fiscal policies to shape the economic landscape of the energy sector, offering tax incentives and subsidies to entities engaged in environmentally friendly practices. These incentives may include tax credits for renewable energy projects, accelerated depreciation for energy-efficient technologies, or reduced tax rates for clean energy producers.

Promotional and market transformation mechanisms constitute essential components of energy policy, focusing on shaping market dynamics and encouraging the adoption of sustainable practices. This category encompasses a variety of strategies aimed at promoting environmentally friendly technologies and transforming the energy market towards greater efficiency and sustainability. Promotional mechanisms strategies involve targeted campaigns, public awareness initiatives, and educational programs to promote the adoption of energy-efficient technologies and practices. Governments and regulatory bodies often collaborate with industry stakeholders to disseminate information, raise awareness, and incentivize consumers and businesses to embrace sustainable energy solutions.

Market transformation strategies seek to alter the fundamental dynamics of the energy market. This may involve the implementation of standards and certifications that prioritize environmentally friendly products and practices. Additionally, financial incentives such as grants, low-interest loans, or subsidies may be employed to encourage businesses to invest in cleaner technologies and practices. Together, promotional and market transformation mechanisms within energy policy aim to create a supportive environment for sustainable practices, fostering innovation, and steering the market towards greater energy efficiency and reduced environmental impact [12].

Financial remediation within the context of energy policy pertains to the strategic use of financial tools and interventions to address economic challenges and instabilities within the energy sector. This category encompasses various measures aimed at rectifying financial imbalances, mitigating risks, and promoting stability in energy-related financial transactions. As of debt relief and restructuring financial remediation may involve the restructuring of debts incurred by energy projects or companies, particularly in cases where economic challenges jeopardize their financial viability. Governments or financial institutions may intervene to alleviate financial burdens through debt relief or restructuring programs.

In some instances, financial remediation may include the provision of financial incentives or subsidies to support struggling energy initiatives. These incentives could range from tax credits to direct financial support, aiming to stimulate economic recovery within the energy sector. Financial remediation strategies also encompass the development and implementation of risk mitigation measures. This could involve creating financial instruments or insurance mechanisms to safeguard energy projects against unforeseen economic challenges or market fluctuations [5].

In conclusion, energy policies are multifaceted tools that shape the energy landscape through financial incentives, regulatory controls, promotional efforts, and financial remediation. These policies, influenced by diverse stakeholders, aim to balance economic development, environmental sustainability, and technological advancement. By integrating various policy mechanisms, governments can effectively drive the transition to clean energy, enhance market efficiency, and ensure the stability of the energy sector, ultimately contributing to global sustainability goals.

1.3. Energy landscape of Ukraine

In September 1962, Ukraine established the Ministry of Energy and Electrification, consolidating all energy systems and the majority of energy enterprises and organizations within the republic. This specialized ministry was instrumental in advancing Ukraine's energy industry, marked by the construction of substantial thermal power plants with high-capacity steam power units (150-200-300-800 thousand kW), the establishment of a series of hydroelectric power stations on the Dnieper, and, in the 1970s, the commissioning of nuclear power units with RBMK and VVER reactors (Chornobyl, South-Ukrainian, Zaporizhzhya, Rivne, Khmelnytsky NPPs). The progressive development of power grids across voltage classes from 0.4 to 750 kV enabled the integration of all power systems into a unified, robust power system.

Eventually, the United Energy System of Ukraine was linked to the energy systems of Hungary, Czechoslovakia, Poland, Romania, and Bulgaria via 220-400 kV power lines, becoming part of the MIR2 energy association created by the REV countries. The Dnieper cascade of hydroelectric power stations was constructed rapidly between 1950 and 1980, including the Kakhovsk, Kremenchutsk, Dniprodzerzhinsk, Kanivsk HPP, and Dniprovsk HPP-2. A unique hydropower complex was built near Kyiv, featuring the first horizontal capsule hydro units with a total capacity of 352 MW and the USSR's first hydroelectric power plant (HAPP) with a 225 MW capacity in generator mode. Hydroelectric power plants became essential for peak load coverage and frequency regulation within the UES. In 1963, 300 MW power units were operational at Prydniprovska and subsequently at Kryvorizka, Zaporizka, Zmiivska, Vuglegirska, and Zuivska DRES. The expansion of electrical networks facilitated the inclusion of new Ukrainian regions into the general network [46].

Before the 2014 invasion, during Viktor Yanukovych's presidency, his administration feigned European integration-oriented reforms. Ukraine joined the European Energy Community in 2011, committing to adopting European energy regulations. However, tangible progress was minimal and weakly supported. Genuine reform implementation would have entailed significant changes, such as market pricing for households. Yanukovych's administration preferred to superficially endorse reforms to bolster the president's image rather than implement substantial changes, which would have threatened the oligarchs' and Yanukovych's inner circle's control over the energy sector, including his son's attempts to dominate it [47].

Ukraine's energy security faced severe challenges in 2014 due to extended gas price negotiations with Russia, military actions in the eastern regions, and the loss of control over Crimea. These events led to potential shortages in natural gas, coal, and electricity supplies, highlighting the urgent need for sound energy policies and measures. Coal production in the Donbass basin was significantly reduced due to military damage to coal mining and energy-intensive industries, causing logistical issues and nearly halting coal supplies to central Ukraine and thermal power plants by mid-2014 and early 2015 due to disrupted rail operations and damaged infrastructure. This destruction has had major, irreversible impacts on the coal and industry sectors, affecting the country's energy and economic outlook [48].

Compounding the crisis, Russia attempted to blackmail Ukraine over gas supplies. Under the take-or-pay clause of the then-existing contract, Ukraine would have owed significant payments to Russia's Naftogaz through 2019, regardless of gas deliveries. Additionally, Russia revoked the 30% discount from the Kharkiv Accords and began demanding some of the highest prices in Europe. This dual strategy would have bankrupted

Naftogaz, but Ukraine later won the case at the Swedish International Court of Arbitration [49].

The 2014 energy crisis and societal hesitancy about EU integration delayed necessary reforms in Ukraine's energy sector. Nevertheless, between 2014 and 2017, essential laws were enacted to align Ukraine's energy legislation with European standards, enhance energy security, and make the energy sector more financially sustainable. During this period, Russia continued its threats to Ukraine's energy sector, shifting tactics to cyber-attacks on Ukrainian energy facilities, leading to occasional blackouts, such as in late 2016 [47].

Amid new challenges, Ukraine developed policies and programs to facilitate financing for energy infrastructure projects through foreign and domestic capital investors, private banks, development entities, and financial institutions. Public-private partnerships and concessions were key mechanisms, enabling the country to increase its renewable energy sources (RES) from 5% to 12.4% by the end of 2020, aiming for 25% by 2035. The "Infrastructure Transparency Initiative" (CoST), supported by the government and the World Bank, was launched to address corruption in the infrastructure sector, focusing on disclosure, assurance, multi-stakeholder engagement, and social accountability [50].

Despite the 2014 invasion, Ukraine remained heavily dependent on imported oil and gas. Fluctuations in the UAH–USD exchange rate, export market access, the closure of the Russian market, construction activities in Asia and the Middle East, agriculture, and energy supply and price trends significantly impacted its domestic economy. Yet, nearly 65% of Ukraine's total energy demand was met by domestic production, primarily due to nuclear energy, with Ukraine being the world's seventh-largest producer (83 TWh in 2019). Over half of the country's electricity is nuclear-generated, and Ukraine, along with Armenia, are the only EU4Energy countries producing nuclear energy.

Ukraine's energy mix is relatively diversified, with no single fuel exceeding 30%. In 2018, coal was the primary fuel (30%), followed by natural gas (28%) and nuclear energy (24%). Ukraine depended on imports for approximately 83% of its oil, 33% of its natural gas, and 50% of its coal. In 2018, Ukraine imported 8.5 Mtoe (10.6 bcm) of natural gas, 13.8

Mtoe of coal, and 10.4 Mtoe of oil products, with Belarus being the main supplier of refined products.

Ukraine has a long history of oil and gas production, with substantial conventional and unconventional hydrocarbon reserves estimated at 9 billion tonnes of oil equivalent (Btoe). Natural gas reserves are estimated at 5.4 trillion cubic meters (tcm), with proven reserves of 1.1 tcm, over 400 million tonnes of gas condensate, and 850 Mt of oil reserves. However, the loss of Crimea’s offshore gas resources necessitated a downward revision of natural gas reserve estimates.

Hydrocarbon resources in Ukraine are concentrated in three regions: the Carpathian region (west), the Dnieper-Donetsk region (east), and the Black Sea-Sea of Azov region (south). The Dnieper-Donetsk region holds 80% of proven reserves and produces about 90% of gas, while the Carpathian region has 13% of proven reserves and 6% of production. The southern region accounts for 6% of proven reserves and 5% of production. Ukraine also has significant unconventional gas potential, such as coalbed methane in eastern Ukraine and two shale gas basins: the Lublin Basin (extending into Poland) and the Dnieper-Donetsk Basin. Coalbed methane resources are estimated at around 3 tcm, and technically recoverable shale gas resources at 1.2 tcm [48].

Ukraine's extensive coal reserves comprise over 90% of its fossil fuel reserves, ranging from anthracite to lignite, including thermal and coking coal. Currently, the energy sector is a primary target of Russia’s military aggression. The full-scale invasion began four hours after Ukraine's energy system was disconnected from the Russian and Belarusian energy systems in preparation for future synchronization with the European unified energy system. Despite active hostilities, the Ukrainian energy system operated in isolation for three weeks and demonstrated its stability. On March 16, a year ahead of schedule, the UES of Ukraine was synchronized with the European energy system ENTSO-E.

However, Russia continues to deliberately target and destroy Ukraine's energy infrastructure. The Ukrainian energy industry has lost significant capacities: more than 50% of thermal, 30% of solar, and 90% of wind generation have been disabled or occupied, and several state-owned mines have been shut down. The Zaporizhzhia nuclear power plant has been under occupation since March, and the Chernobyl NPP was occupied and looted for over a month. Power grids, substations, and gas distribution networks are heavily damaged, leaving hundreds of thousands without electricity and gas.

Despite these challenges, Ukrainian energy workers are making tremendous efforts to restore energy supplies daily, often at great personal risk. Energy companies from less affected regions are aiding their colleagues by transferring equipment to areas severely impacted by the conflict. International partners have also provided equipment and materials since the war began. Countries like Poland, Italy, Great Britain, Sweden, Norway, Latvia, Switzerland, Spain, Denmark, Belgium, Germany, and the Czech Republic have sent necessary equipment and spare parts. The Secretariat of the Energy Community coordinates humanitarian aid from European companies and countries [51].

As the invasion continues, Ukraine is focused on tracking large-scale energy supply disruptions and actively working to restore power and heating for civilians. It is also preparing an ambitious recovery and reconstruction plan with a strong emphasis on energy security. In the medium term, Ukraine's energy strategy remains centered on European integration and aims for an energy system ready for a Net Zero future [52].

Ukraine's aging grid was challenging to maintain even before the war's targeted attacks. Before the invasion, NREL supported the USAID Ukraine mission and Ukrainian officials in modernization plans to transition to greater renewable energy penetration. Renewable energy can build a more resilient energy system by diversifying energy sources away from fuels like diesel and enabling the construction of decentralized energy systems, making the grid more resilient to disruptions. However, as researcher Eliza Hotchkiss notes, renewables must be designed for resilience.

The USAID-NREL Partnership's initial goal in Ukraine was to provide technical support and data analysis for distribution systems siting and project investment decisions, and to help plan for integrating more wind and solar into Ukraine's nuclear-dominant system to meet decarbonization and energy independence targets, aligning with the EU's clean hydrogen-based energy future. Needs quickly changed with the invasion [53].

The mission of the Energy Strategy of Ukraine until 2050 is to create conditions for sustainable national economic development by ensuring access to reliable, sustainable, and modern energy sources. By 2050, the energy sector aims to be as close to climate neutrality as possible, ensuring clean energy availability, overcoming energy poverty, developing an innovative and decentralized energy system, fully functioning national energy markets, and integrating into international markets.

Key principles of Ukraine's Energy Strategy include economic soundness, environmental friendliness, accessibility, social justice, and marketability. The strategy is based on economic development targets outlined in the National Economic Strategy until 2030 and international commitments under the EU Association Agreement and the Paris Climate Agreement. Goals include achieving maximum climate neutrality, reducing coal use, renewing and modernizing energy infrastructure, increasing resource use efficiency, integrating with European markets, and developing alternative energy sources and innovative solutions.

The UK government provides technical assistance for developing Ukraine's Energy Strategy until 2050, with KPMG, experienced in both private and public sector strategies, serving as the project consultant. The strategy development involves experts, the public, and leading energy companies [54].

Positive Adjustments. Despite the odds, Ukraine has made significant positive changes to its energy sector, strengthening energy security. The conflicts initiated in 2014 and the full-scale invasion in 2022 have reduced dependency on Russian energy supplies. Before 2014, Russia was Ukraine's major energy supplier, but now imports from Russia are banned. Despite the ongoing hostilities, Ukraine continues to transit Russian oil and gas to Europe, committed to maintaining these supplies as long as Europe requires them [47].

A recent European Commission report assessed Ukraine's energy reform progress as "a good level of preparation." Despite operating under emergency conditions due to Russian attacks, Ukraine made legislative advancements in wholesale energy market integrity, transparency, renewables, gas transmission, and gas storage certification. However, martial law measures decreased stakeholder transparency and independence.

Ukraine relies mainly on domestic production and limited EU imports for natural gas and has steadily increased electricity import capacity. Although Ukraine has yet to implement the Oil Stocks Directive, significant progress was made with the 2022 gas storage certification law and subsequent certification of Ukrtransgaz.

Ukraine’s gas and electricity transmission system operators (TSOs) have observer status in ENTSO-E and ENTSOG. Ukrenergo, the electricity TSO, is working toward full ENTSO-E membership, and Ukraine participates in Aggregate EU, the EU's joint gas purchase platform. Agreements with Hungary, Poland, and Slovakia ensure firm capacity for gas imports.

In energy efficiency, Ukraine's law aligns with the EU Energy Efficiency Directive, incorporating EU best practices in local energy planning and energy management systems. Energy audits are mandatory for large companies but lack enforcement penalties or incentives.

Ukraine's renewable energy sector, heavily impacted by conflict, prioritizes market-based support for RES to attract private investment. By 2030, Ukraine targets a 27% RES share in gross final energy consumption. In July 2023, legislative amendments allowed renewable producers to sell electricity directly in various markets, with prosumers permitted to install RES facilities up to specific capacities and two compensation options offered.

In nuclear energy, Ukraine adheres to international conventions on nuclear safety and radiation protection, despite the challenges posed by the ongoing conflict and the illegal seizure of the Zaporizhzhia nuclear power plant by Russian forces. As the war continues, Ukraine tracks energy supply disruptions and focuses on recovery and reconstruction, with an ambitious plan emphasizing energy security. The medium-term energy strategy focuses on European integration and preparing the energy system for a Net Zero future [55].

In conclusion, Ukraine's energy landscape has evolved significantly since the establishment of the Ministry of Energy and Electrification in 1962. The development of high-capacity thermal power plants, hydroelectric stations, and nuclear power units has created a robust and integrated power system. However, the geopolitical tensions and conflicts, especially post-2014, have posed severe challenges to energy security, necessitating reforms and adaptations. Despite these adversities, Ukraine has shown impressive resilience. Continued efforts to enhance energy self-sufficiency for households, develop adaptive policy frameworks, and strengthen integration with European energy systems are essential. The unique challenges faced by Ukraine require a responsive and dynamic approach to energy policy, focusing on sustainability, diversification, and resilience to build a secure energy future for the nation.

CHAPTER 2.
ANALYSIS OF ENERGY POLICY FRAMEWORKS

2.1 Peculiarities of the energy policy of the developed countries of the world

The comprehension of the energy policies adopted by developed nations holds paramount significance for the study, as these policies serve as benchmarks influencing global standards. This part focuses on some of the Group of Seven (G-7) countries, namely Japan, Canada, and the EU block (Germany, France, and Italy), in order to assess the distinctive characteristics inherent in their respective energy policies.

The energy policies of developed countries, including Japan, provide valuable insights into diverse approaches aimed at ensuring energy security, reducing environmental impact, and fostering sustainable economic growth. The Japanese experience is particularly relevant to Ukraine due to similar challenges both countries have faced. Like Ukraine, Japan experienced a dramatic nuclear power accident in Fukushima, which significantly influenced public perception and made it difficult to launch new nuclear power plants without societal concerns. Furthermore, both countries have historically relied heavily on nuclear energy as a primary energy source. Therefore, understanding Japan's background, policies, and strategies for addressing these challenges is crucial for this research.

The energy policy of Japan is intricately connected with its geographical, geological, and historical factors. Being a relatively small country Japan faces a scarcity of domestic energy resources, making it dependent on imported resources. Japan, ranked fifth-highest consumer of oil in the world, relied on imports to meet 97% of its demand in 2022 as a result of insufficient domestic resources. (Appendix A, Figure A.1) Because it has no international oil or natural gas pipelines, Japan relies on tanker shipments of liquefied natural gas (LNG) and crude oil to meet demand. [13]. In the fiscal year 2019, Japan’s self-sufficiency ratio was 12.1%, ranking it as the 35th country globally in terms of energy self-sufficiency [14].

Japan is an island nation, and as a result, its electrical grid operates in isolation without connection to any international systems. The grid is organized into four wide-area synchronous grids, maintaining a self-contained energy system within the country's borders. Despite the reliance on energy imports, Japan's energy infrastructure remains self-contained within its borders [14]. Moreover, the geographical location of Japan exposes it to high seismic activity, posing additional challenges to its energy sector. Following the Fukushima nuclear accident in 2011, which led to the release of radioactive contaminants, the Japanese government implemented a temporary shutdown of all nuclear plants. Subsequently, stringent safety standards were established, and thorough examinations were conducted to ensure compliance with these standards.

During the period of nuclear plant shutdowns, the energy deficit was compensated for by increased reliance on fossil fuel energy sources. This shift resulted in a notable surge in greenhouse gas (GHG) emissions, reaching a historic peak in 2013. The Fukushima incident prompted a reassessment of Japan's energy policies and reforms, emphasizing the need for enhanced safety measures and a diversified energy mix to mitigate the environmental impact and ensure a more resilient energy infrastructure. The reforms followed the same three objectives: to enhance the security of supply, to increase competition, and to reduce end-user prices [15].

Since 2013, the Japanese government has shifted its focus towards renewable energy, signaling a commitment to address international concerns and reduce the country's greenhouse gas (GHG) emissions. This transition is part of a broader initiative, as the government has set an ambitious goal to attain net-zero emissions by the year 2050. This target reflects the government's determination to align with global efforts in combating climate change and demonstrates a proactive stance in lowering Japan's contribution to GHG emissions. The gradual restart of nuclear power generation, expansion of renewable energy, and energy efficiency gains have reduced the need for imported fossil fuels and contributed to a continuous decline in greenhouse gas emissions.

IEA report suggests that most of the energy is imported rather than being produced by the country. The little energy that the country produces is predominantly non-renewable Oil, Coal, and natural Gas. (Appendix A, Figure A.1) While the feasibility of this goal may be subject to debate, the Japanese government's emphasis on renewable energy and the pursuit of net-zero emissions highlights a proactive approach to addressing environmental challenges on the international stage. Japan presented its new “Green Growth Strategy in line with Carbon Neutrality in 2050” in December 2020. The strategy is specifically designated as an industrial policy and promotes the creation of a virtuous cycle of economic growth and environmental protection, together with the business community [15].

Key focal points identified to facilitate Japan's transition to net-zero emissions include hydrogen, Carbon Capture, Utilisation and Storage (CCUS), and carbon recycling. By 2030, Japan aims to have 800,000 fuel cell vehicles, and more than 5 million residential fuel cells and to establish an international hydrogen supply chain. It is also experimenting with large-scale power generation based on hydrogen. Nowadays, energy security is the main challenge Japan is facing, and focusing on renewable energy is a possible solution to the energy security problem [15].

In October 2021, Japan's Ministry of Economy, Trade, and Industry (METI) released the 6th Strategic Energy Plan, providing a comprehensive vision and policy framework for the country's energy sector. In contrast to the previous 5th Energy Plan, which set the goal of achieving carbon neutrality by 2050 without specifying the necessary steps, the 6th Energy Plan focuses on outlining a clear path for the energy policy to realize carbon neutrality [16].

The point of the energy policy is to first and foremost ensure stable supply (“Energy Security”), and realize low cost energy supply by enhancing its efficiency (“Economic Efficiency”) on the premise of “Safety.” It is also important to make maximum efforts to pursue environment suitability (“Environment”). The viewpoint of S+3E as the major principle remains important [17].

Since the Fukushima accident, citizen groups have vehemently opposed the use of nuclear power. This opposition manifested through large-scale anti-nuclear protests, with over 80 thousand people participating, and the creation of a petition supported by 5 million individuals calling for the permanent shutdown of all nuclear power plants [18]. In response to the incident, there was a reevaluation of the decision-making process. This led to the partial removal of representation from power utilities in ministerial committees responsible for determining policies. As a result, the influence of power utilities in the policy-making process was reduced [19].

Despite public distrust, the 6th Strategic Energy Plan suggests that nuclear is an important low-carbon base-load power source and a quasi-domestic energy source, contributing to the stability of the energy supply-demand structure in the long term, on the major premise of ensuring its safety. Nuclear is important because of these perspectives; 1) superiority in stability of energy supply and efficiency, 2) low and stable operational cost, and 3) free from GHG emissions during operation [17].

Renewable energy is set to become central in the following years in the energy mix. The increased share of renewable energy is most strongly associated with the introduction of the feed-in tariff (FIT) in 2012 under the short-lived Democratic Party of Japan (DPJ) government. An FIT provides a guaranteed rate of return to investors in renewable energy technologies, and is typically set at a rate higher than the assessed project cost in order to induce investment into the sector, with the rate falling over time to induce innovation and cost reductions, and to reflect falling technology costs. In the case of Japan, the FIT differs on a technology basis, with different rates provided for solar photovoltaics, wind power (onshore and offshore), and geothermal power and biomass [19].

The introduction of the Feed-In Tariff (FIT) in Japan has resulted in a substantial surge in investment in renewable energy, leading to a notable increase in power generation, although the absolute scale remains relatively modest. A key feature of the FIT in Japan is the predominant role of solar photovoltaics (PV) among non-hydro sources of renewable electricity. (Appendix A, Figure A.2)

Larger solar PV facilities have been the primary beneficiaries of the FIT, attracting significant investments. This stands in contrast to households, where the impact of the FIT has influenced purchasing decisions for solar PV systems, albeit to a lesser extent. The FIT has played a crucial role in shaping the renewable energy landscape in Japan, particularly in the dominance of solar PV as a major contributor to the country's non-hydro renewable energy capacity [20]. The government of Japan will steadily make such efforts as ensuring optimal siting while living in harmony with local communities, cost reduction, overcoming power grid constrains, rationalizing regulations, and promoting of technological development, etc. Through these efforts, the government of Japan will expand the renewable energy introduction while managing excessive national burden, securing a stable supply in the entire power system, ensuring project implementation and living in a harmony with local communities [17].

Fossil energy currently dominates the energy supply, and it is anticipated to remain a significant energy source in the future. However, considering the imperative of decarbonization, measures need to be taken to mitigate the environmental impact. The government of Japan is proactively addressing this challenge by focusing on the development and implementation of key technologies such as Carbon Capture, Utilisation and Storage (CCUS), synthetic fuels, and synthetic methane.

The strategic deployment of these technologies is crucial for achieving decarbonization goals. By investing in CCUS technology, the government aims to capture and store carbon emissions, thereby reducing the overall carbon footprint of fossil energy use. Additionally, the promotion of synthetic fuels and synthetic methane contributes to diversifying the energy mix and provides cleaner alternatives.

Furthermore, the government's commitment to utilizing these technologies is not only driven by environmental concerns but also by the goal of cost reduction. The integration of advanced technologies is expected to make the transition to cleaner energy more economically viable [17].

Hydrogen has emerged as a crucial secondary energy source in the pursuit of carbon neutrality. Countries worldwide are intensifying efforts to utilize hydrogen, recognizing its role in enhancing energy security through diversified procurement sources, including the use of domestic resources. The flexibility of hydrogen and ammonia production from various energy sources, including redundant electricity from renewables, contributes to a more robust and resilient energy framework. When combined with Carbon Capture, Utilisation and Storage (CCUS), hydrogen enables the cleaner utilization of fossil fuels, adding to the versatility of its applications.

Beyond serving as a standalone source of heat and electricity, hydrogen acts as a feedstock for ammonia and synthetic fuels. Its multifaceted nature positions hydrogen as a central player in the carbon-neutral era, meeting diverse needs across industries, commerce, residential areas, transportation, and the power sector. Tailored to each user's characteristics, hydrogen viewed is a key element in the transition towards a sustainable and carbon-neutral energy landscape in Japan [17].

Policy on initiatives for ensuring stable supply of critical minerals [21]. This policy aims to realize the critical minerals security goals outlined in the Battery Industry Strategy (2022) by setting specific targets:

1. Establishing a domestic manufacturing base capable of producing 150 GWh of batteries and their materials annually by 2030. The Japanese Battery Association for Supply Chain (BASC) estimates the annual need for approximately 100,000 tons of lithium, 90,000 tons of nickel, 150,000 tons of graphite, and 20,000 tons of manganese to achieve this target.

2. Japanese companies securing a global manufacturing capacity of 600 GWh of batteries annually by 2030. The BASC projects an annual requirement of about 380,000 tons of lithium, 310,000 tons of nickel, 60,000 tons of cobalt, 600,000 tons of graphite, and 50,000 tons of manganese to meet this second goal.

To ensure a stable supply of these critical minerals, the Japanese government offers subsidies under the Economic Security Promotion Act (ESPA). This support encompasses exploration, feasibility studies, mine development, smelting, and research and development activities in the mining and processing of critical minerals.

The latest policies Japanese government has adopted include CCS Long-Term Roadmap [22]. In January 2023, Japan's Ministry of Economy, Trade and Industry (METI) unveiled its CCS Long-Term Roadmap, intending to accelerate the adoption of carbon capture and storage (CCS) technologies with the goal of achieving commercial deployment by 2030. The roadmap outlines specific targets, including reaching a CO2 storage capacity of 6-12 million tonnes of CO2 per year (MtCO2/yr) by 2030 and a more ambitious goal of 120-240 MtCO2/yr by 2050. This initiative reflects Japan's commitment to advancing CCS technologies as a key strategy in mitigating carbon emissions and combating climate change.

Another impotant policy is the Amendment to the Energy Conservation Act in Japan expands the definition of "energy" to include all forms of non-fossil energy. It requires large-scale energy consumers to submit mid-to-long term plans for non-fossil energy transition with a target year of 2030, as well as regular reports on non-fossil energy usage. Incentives, such as evaluating high-performing businesses and providing budgetary support, are being considered to help support the transition. The amendment is in force at the national level from May 13, 2023 [23].

Additionally, Japanese Industry Minister and Indonesian Energy Minister signed a memorandum of cooperation (MoC) at a bilateral meeting held in Jakarta on 10/01/2022. The MoC is aimed at collaborating in the development and deployment of decarbonization technologies such as hydrogen, ammonia and carbon capture utilisation and storage (CCUS) [24]. Japanese policymakers are primarily focused on reshaping the energy market through market instruments to foster the growth of the renewable energy sector. However, certain financial tools employed to incentivize investments in renewables have the potential to increase consumer prices, possibly leading to resistance from citizens. Balancing the dual objectives of reducing Green House Gas emissions and advancing new renewable energy technologies while maintaining reasonable consumer prices is a challenging yet not insurmountable task for the Japanese government.

Addressing energy security is identified as a significant challenge in the 6th Strategic Energy Plan. Despite the difficulties associated with this issue, the government emphasizes its importance and commits to overcoming this challenge. Achieving a balance between environmental sustainability, technological innovation, and economic considerations remains a key focus for Japanese energy policies.

Canada, on the other hand, is very rich in natural energy resources, creating a significant similarity between Canada and Ukraine. Unlike Ukraine, however, the Canadian government has successfully established strong trading agreements and positioned itself as one of the world's leading energy suppliers. As Ukraine undergoes numerous changes to integrate with the European Union, it is crucial to understand the policies that have contributed to Canada's success. This knowledge can provide valuable insights for Ukraine's efforts to enhance its energy sector and achieve similar economic benefits. The Canadian energy policy has a historical foundation rooted in pro-market policies, energy market deregulation, and fostering free trade activities [25]. Canada stands as one of the world's largest energy exporters, with energy companies wielding significant influence in policy-making through robust lobbying efforts. Presently, Canadian energy policy is closely intertwined with the United States, adopting more regulations than in the past to strike a balance between market freedom, deregulation, and the imperative of decarbonizing the industry. Canada, with its meticulous regulations, boasts one of the cleanest electricity supplies globally [25] and is dedicated to reducing GHG emissions.

To comprehend the historical context of Canadian energy policy, a glance back to the 1980s is essential. During this period, there was a prevailing inclination toward market favoritism through deregulation and pro-market policies [25]. However, in October 1980, Finance Minister Allan J. MacEachen announced the National Energy Program (NEP) as part of the federal budget. This move was prompted by a series of energy crises and price spikes, necessitating government intervention and disruption to stabilize the situation.

"...ever since the oil crisis of 1973 industrial countries have had to struggle with the problems of inflation and stubbornly high rates of unemployment. In 1979 the world was shaken by a second major oil shock. For the industrial world this has meant a sharp renewal of inflationary forces and real income losses. For the developing world this second oil shock has been a major tragedy.... They are not just Canadian problems. ...they are world-wide problems. … The new energy policy limits the rise in prices of oil and gas to domestic consumers and thus continues to protect us from the violent shocks of OPEC price increases. It strengthens our specific measures to promote the most economical use of energy and in particular the displacement of oil by other fuels. It provides new impetus to the development of new sources of supply, through direct government programs and through new incentives of particular value to Canadian-owned producers. Energy policy is only the most urgent element of our new strategy. Renewed growth in productivity and lower costs are needed throughout the economy. Within the overall expenditure plan which I will lay before the House, we have assigned clear priority to economic development." Allan J. MacEachen.

The main elements of the NEP program included:

(a) a blended or 'made-in-Canada' price of oil, an average of the costs of imported and domestic oil, which will rise gradually and predictably but will remain well below world prices and will never be more than 85 per cent of the lower of the price of imported oil or of oil in the US, and which will be financed by a Petroleum Compensation Charge levied on refiners...;

(b) natural gas prices which will increase less quickly than oil prices, but which will include a new and rising federal tax on all natural gas and gas liquids;

(c) a petroleum and gas revenue tax of 8 per cent applied to net operating revenues before royalty and other expense deductions on all production of oil and natural gas in Canada...;

(d) the phasing out of the depletion allowances for oil and gas exploration and development, which will be replaced with a new system of direct incentive payments, structured to encourage investment by Canadian companies, with added incentives for exploration on Canada Lands (lands which the federal government held the mineral rights as opposed to private lands and lands which provinces held the mineral rights);

(e) a federal share of petroleum production income at the wellhead which will rise from about 10 per cent in recent years to 24 per cent over the 1980-83 period, with the share of the producing provinces falling from 45 to 43 per cent and that of the industry falling from 45 to 33 per cent over the same period;

(f) added incentives for energy conservation and energy conversion away from oil, particularly applicable to Eastern Canada, including the extension of the natural gas pipeline system to Quebec City and the maritimes, with the additional transport charges being passed back to the producer; and

(g) a Canadian ownership levy to assist in financing the acquisition of the Canadian operations of one or more multinational oil companies, with the objective of achieving at least 50 per cent Canadian ownership of oil and gas production by 1990, Canadian control of a significant number of the major oil and gas corporations, and an early increase in the share of the oil and gas sector owned by the Government of Canada [26].

The National Energy Program (NEP) had the overall effect of making energy more affordable for the average Canadian, instilling trust in the government while preserving a relative degree of freedom in the energy market. However, the NEP faced strong opposition from the energy industry, particularly due to the increased government share in petroleum production and price control. Some energy-producing provinces opposed the NEP, viewing it as detrimental to the industry.

Following the NEP, a series of policies were implemented to counterbalance its impact. These included the Western Accord, an agreement between Ottawa and western producer provinces that deregulated oil and restored continental oil markets, and the Atlantic Accord, an agreement to phase in the deregulation of gas. While these policies contributed to market deregulation, the lasting influence of the NEP policies cannot be underestimated.

Politically, the NEP left a bitter taste, especially regarding relations between central and western Canada. Especially in western Canada, it became the quintessential example of how not to make policy [25].

Subsequently, the Canadian-United States Free Trade Agreement was signed. The U.S.-Canada Free Trade Agreement was signed by President Ronald Reagan and Prime Minister Brian Mulroney on January 2, 1988, with the goal of eliminating all tariffs on trade between the two countries. The FTA is the wellspring of one of the most heated political debates in Canada. This heat is generated by the conflict between those who bore the short-run adjustment costs (displaced workers and stakeholders of closed plants) and those who are garnering the long-run gains (stakeholders of efficient plants, consumers, and purchasers of intermediate inputs). One cannot understand current debates about free trade without understanding this conflict. Unfortunately, much of the academic debate has been fragmented: one set of researchers has focused on the short-run adjustment costs of worker displacement while another has focused on the long-run productivity gains [27].

Simultaneously, environmental issues gained prominence, with growing concerns about greenhouse gas (GHG) emissions. In response to these concerns, the Kyoto Agreement was established (1980), linked to the United Nations Framework Convention on Climate Change. This accord mandated all industrialized nations, including Canada, to reduce their GHG emissions. The escalating environmental concerns prompted the Canadian government to enact more stringent regulations in the energy sector.

Canada committed to lowering its greenhouse gas emissions by 6 percent below the 1990 levels, averaged over the period from 2008 to 2012. However, due to a delay in implementing measures, this commitment escalated to a required 26 percent reduction. In late 2002, Canada completed the process of ratifying the Kyoto Protocol. Unfortunately, due to the country's inability to meet the established targets, in 2011, the Prime Minister announced the repudiation of the Kyoto Protocol [28].

“Unfortunately, the Kyoto targets were set without reference to the cost of meeting them (or of their potential benefits relative to those of following alternative scenarios of emissions reductions and time frames). Considering how far Canada is from reaching its Kyoto target, and how closely the emissions of the principal GHGs (green house gasses) resulting from human activity are linked with the growth and type of economic activity the country has typically enjoyed, a serious attempt at meeting the commitment within a given timetable would likely involve significant changes in the economy and even in Canadian lifestyles" [29].

As previously mentioned, Canada holds a significant role as a major producer and exporter of energy. Energy plays a crucial role in Canada's economy, contributing 10% to the nation's gross domestic product and serving as a major source of capital investments. With substantial reserves and production capacity in oil and natural gas, Canada produces more energy than required for domestic consumption. In 2020, the country exported 44% of its domestic energy production, primarily to the United States.

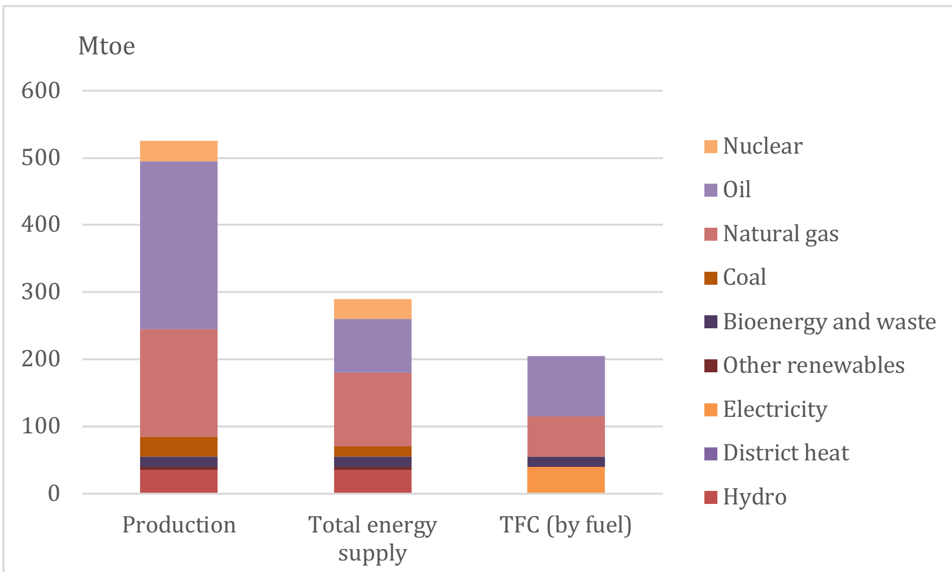


Figure 2.1 – Overview of Canada's energy production, supply and demand, 2020 [25]

As depicted in the table, oil constitutes the largest share in Canadian energy production, followed by natural gas and hydro. This emphasizes the continued significant role of fossil fuels in the country's energy production (fig. 2.2).

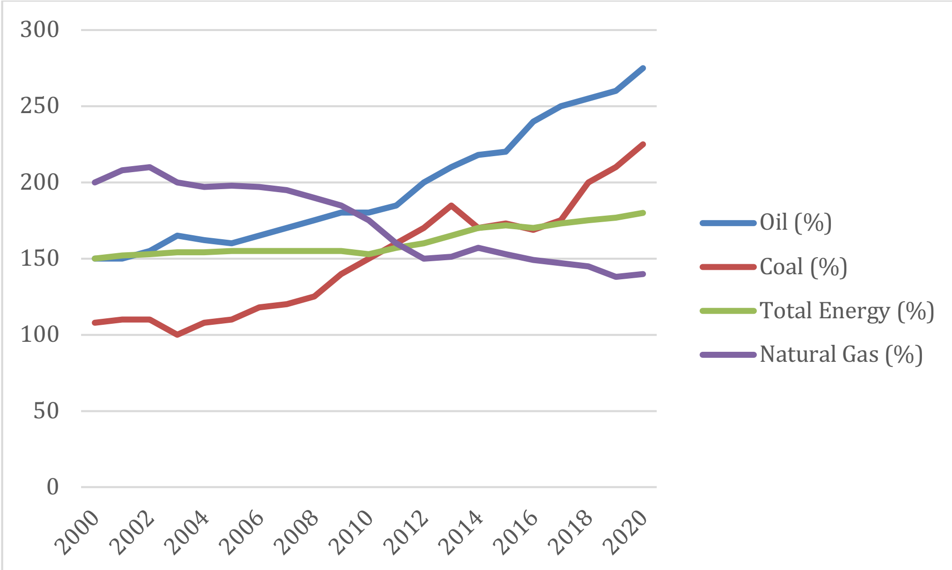


Figure 2.2 – Canada's energy import self-sufficiency, 2000-20 [25]

In 2015, as part of the Paris Agreement commitments, Canada pledged to achieve a greenhouse gas (GHG) emissions reduction target of 30% below 2005 levels by 2030. Additionally, the country is legislatively committed to achieving net-zero emissions by 2050. To meet these targets, the government needs to implement a variety of policies. Nonetheless, it is noteworthy to acknowledge Canada's success in modernizing its electricity system, which is among the cleanest globally, with 83% of it being non-emitting [25].

While Canada faces a significant journey to achieve its emission reduction targets, the country has taken notable steps. In 2019, Canada introduced an ambitious carbon pricing scheme, aiming to provide effective price signals that encourage a shift in consumption towards cleaner fuels. This initiative is complemented by various policies, including the 2016 Pan-Canadian Framework on Clean Growth and Climate Change (PCF), the 2020 Strengthened Climate Plan, the Greenhouse Gas Pollution Pricing Act, Clean Fuel Regulations, a commitment to phasing out unabated coal use by 2030, nuclear plant extensions, upstream methane regulations, stringent vehicle emissions standards, and energy efficiency measures. Together, these policies form a comprehensive approach to address climate change and promote sustainable practices in Canada [25].

To achieve its climate agenda, elected leaders of all provinces and territories and the federal government endorsed the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) in December 2016. The PCF is built on four pillars:

1) pricing carbon pollution;

2) complementary actions to reduce emissions;

3) adaptation and climate resilience; and

4) clean technology, innovation, and jobs.

The PCF includes over 50 concrete actions that cover all sectors of the economy. A central policy tool for achieving emissions targets is carbon pricing [30].

In conclusion, Canada's energy policy reflects a pro-market orientation with a historical emphasis on deregulation. However, recognizing the pressing need to curtail greenhouse gas emissions, the country has undertaken dynamic shifts. The introduction of carbon pricing, comprehensive frameworks like the Pan-Canadian Framework, and increased regulations signify the government's commitment to navigating a sustainable path. This evolution underscores a complex yet responsive approach to aligning economic interests with environmental responsibilities in the ever-changing energy landscape.

Meanwhile, the European Union faces the challenge of navigating an ever-changing energy landscape. The state of European energy policy has been significantly impacted by the war in Ukraine, prompting the EU to reduce its reliance on Russian energy through initiatives like the REPowerEU plan. Historically, the EU's heavy dependence on gas and coal imports has highlighted its vulnerability. Currently, the EU faces challenges similar to those of Ukraine. Their geographical proximity facilitates mutual assistance and collaboration to overcome modern challenges. While the EU's problems are not as severe as those faced by Ukraine, understanding the nature of these challenges and the EU's responses can be valuable for Ukraine.

The EU was highly reliant on gas and coal import. It’s important to sympethize that Russian invaded Ukraine the day Ukrainian energy grid was disconnected from “USSR” block and was supposed to undergo connection to European grid. Showing the importance of energy in the economics and politics as a whole.

The invasion provoked energy crisis in the EU, forcing all problems within the organization of energy sector in EU resurface.

From one hand, the current situation destabilized EU energy market and showed the big problem of energy security in the EU. From another hand, the trouble showed the benefits of renewable energy and as the energy mix will drastically change for a sake of energy security, there is an opportunity to incorporate more renewable energy sources and meet the net zero target even earlier than planed [31].

The main problem energy sector of the EU faces right now is a lack of consolidation. Each country wants to be independent and doesn’t want to rely on other countries in terms of energy. Which makes it harder for the European commission to navigate and sustain the energy development and policy [32].

Until the mid-1990s, energy policy received limited attention within the European integration process. In 1968, the European Commission's “First Guidelines for a Community Energy Policy” outlined a potential energy policy and proposed measures to establish a common energy market. However, the Council of Ministers only agreed on very general principles. The 1980s and early 1990s saw several unsuccessful attempts in the energy policy arena. The European Commission's proposal to include an energy chapter in the Maastricht Treaty was abandoned, as was the introduction of a carbon/energy tax due to strong opposition from member states. The concept of an Internal Energy Market (IEM) was introduced in the late 1980s, with the first electricity and gas market directives (the "First Energy Package") appearing in 1996 and 1998, respectively. Since the mid-1990s, the European Commission has proposed several significant EU initiatives, enhancing supranational influence on energy policy [33].

Since the mid-2000s, efforts towards a common energy policy, including renewable energy sources (RES) policy, have become more intense and politicized. The notion of a common energy policy was endorsed at the informal Hampton Court Summit of the

European Council in October 2005, under the UK's Presidency. The disruption of gas supplies to the EU, resulting from the Russia-Ukraine gas price dispute, highlighted the need for decisive action by the EU. In response to the Council's invitation, the European Commission prepared a Green Paper outlining a comprehensive strategy for achieving "sustainable, competitive, and secure energy". This Green Paper laid the foundation for a policy process that culminated in the prominent 20/20/20 strategy, which set three ambitious goals: a 20 percent reduction in greenhouse gas emissions, a 20 percent increase in the share of renewable energy, and a 20 percent reduction in overall energy use in the EU [33].

Historically EU is concentrated on energy efficiency (EE1 principle) and security. In the light of recent events the energy security is highly compromised. It brings out the always existent problem of EU reliance on the oil. However, it also gives a big push for the EU to make its energy green and more sustainable.

As we can now see the current energy crisis comes from a long standing issue - In its 2013 Report, ACER observed that Member States had national, uncoordinated, and often diverging approaches to security of supply. The lack of cross-border coordination on the issue of security of supply had resulted in a patchwork of capacity mechanisms in Europe to the detriment of the market integration process. This might appear paradoxical given Member States' efforts to complete the internal market through enhanced cooperation. The situation is still very much the same. The provisions introduced in the Electricity Regulation by its recast prescribe that resource adequacy assessment have a regional scope. These provisions impose that capacity mechanisms allow for cross-border participation and might eventually also have an impact in prioritizing market reforms

These measures include: removing regulatory distortions, price caps, and regulated end-user prices; introducing a shortage pricing function for balancing energy; increasing interconnection and internal grid capacity; enabling self-generation, energy storage, demand-side measures, and energy efficiency; and ensuring cost-efficient and market-based procurement of balancing and ancillary services [34].

Furthermore, in light of the full-scale invasion in Ukraine, the REPowerEU plan was launched. Its main goal is to address the energy crisis and energy security concerns by reducing dependence on the Russian fossil fuels. It shapes the energy policy in EU member-states. So let's take a closer look into what are the main objectives of REpowerEU plan.

The plan's main proposed actions are:

- Save energy
- Diversify supplies
- Quickly substitute fossil fuels by accelerating Europe's clean energy transition
- Smartly combine investments and reforms

Save energy: Energy savings are the quickest and most cost-effective way to tackle the current energy crisis. Reducing energy consumption lowers high energy bills for households and companies in both the short and long term, and reduces imports of Russian fossil fuels. Enhancing energy efficiency is a crucial part of the clean energy transition, which strengthens the EU economy's resilience and protects its competitiveness against high fossil fuel prices.

Diversify supplies: For several months, the EU has been working closely with international partners to diversify supplies and mitigate rising energy prices. Following a mandate from the European Council in March, the Commission and Member States established an EU Energy Platform for the voluntary joint purchase of gas, LNG, and hydrogen. On May 5th, the Commission and Bulgaria created the first regional task force as part of the EU's Energy Purchase Platform, in coordination with southeastern European neighbors.

Substitute fossil fuels and accelerate Europe's clean energy transition: A significant increase in renewable energy in power generation, industry, buildings, and transport will hasten the phase-out of Russian fossil fuels. Over time, this will also lower electricity prices and reduce fossil fuel imports.

Smart investment: The Commission's analysis indicates that REPowerEU requires an additional investment of €210 billion by 2027, on top of what is needed to achieve the Fit for 55 proposals' objectives. This investment will pay off, as implementing the Fit for 55 framework and the REPowerEU plan will save the EU €80 billion annually in gas import costs, €12 billion in oil import costs, and €1.7 billion in coal import costs by 2030. During the transition, the rapid decoupling from Russian energy imports may lead to higher and more volatile energy prices. Targeted measures are necessary to minimize volatility, control prices, and protect individuals at risk of energy poverty to ensure a fair transition for all. The Commission urges the European Parliament and the Council to adopt its proposal for a Social Climate Fund to support vulnerable households and small businesses during the transition [35].

Measures related to renewable energy and energy efficiency include:

- Increasing EU’s 2030 target to 45% renewables in the EU mix, up from the current target of 40% (an additional 169GW to the Fitfor55 2030 target of 1067 GW)

- Accelerating the rollout of PV energy, with a dedicated EU Solar Energy Strategy, aiming to deploy over 320 GW of new solar photovoltaic by 2025, and almost 600 GW by 2030

- Introducing the European Solar Rooftop Initiative, which is anchored around a legally binding EU solar rooftop obligation for certain categories of buildings

- Aiming at doubling the current deployment rate of individual heat pumps, to reach 10 million cumulative units over 2023-2027

- Decarbonising the industry by accelerating the switch to electrification and renewable hydrogen and enhancing our low-carbon manufacturing capabilities

- Speeding up renewables' permit to minimize the time for the roll-out of renewable projects and grid infrastructure improvements, through the revising of the Renewable Energy Directive proposal which will designate renewable energy as an overriding public interest and introduce the designation of 'go-to' areas

- Increasing the EU’s 2030 binding energy savings target to 13% (up from 9% in the Energy Efficiency Directive) [36]

To better understand the energy policy of EU countries, we shall investigate their National Energy and Climate plans (NECP) submitted to the European Commission by the top member countries. Here I won't go into details of a decision-making process regarding energy policy in every country, however, I will discuss the energy mix and plans of the key EU countries (France, Italy, Germany) regarding the energy market. Starting with France.

Since the International Energy Agency (IEA) last reviewed France's energy policies in 2015, the French government has made significant strides in climate action aimed at achieving net-zero emissions. The 2019 Energy and Climate Law set the goal of carbon neutrality by 2050 and established a more stringent emissions reduction pathway, targeting an 85% reduction by 2050 compared to 1990 levels. Despite this progress in policy development, France has struggled with implementation. The country missed its 2020 targets for energy efficiency and renewable energy, and its 2030 emissions targets, set in 2015, remain unchanged. In 2020, the second carbon budget was revised upwards, reducing the effort required through 2023.[37]

In energy efficiency, France's final energy consumption was 145.5 million tonnes of oil equivalent (Mtoe) in 2019, well above the 2020 target of 130 Mtoe. Achieving the 2030 target of 120.9 Mtoe will require significant changes in France's economic structure, consumer behavior, and increased digitalization and electrification. Renewable energy generation from wind and solar photovoltaic (PV) has grown over the past decade, increasing the share of renewables in electricity generation from 14% in 2010 to 23.4% in 2020. Hydropower constitutes half of this renewable generation. France aimed for a 23% share of renewables in gross final energy consumption by 2020 but reached only 17.2% in 2019 and 19.1% in 2020. To meet the 2023 targets under the Multiannual Energy Plan (PPE), France needs to add 6.4 gigawatts (GW) of wind capacity and nearly double its solar PV capacity within three years. Administrative inefficiencies and lengthy permitting procedures have hampered progress, though recent reforms aim to streamline these processes.

France's emissions reduction targets for sectors outside the European Union's (EU) Emissions Trading System (ETS) are also off track, particularly in the transport sector where emissions continue to rise. The country did not meet its first carbon budget and its ability to meet the second remains uncertain. The COVID-19 pandemic temporarily reduced CO2 emissions by 12% in 2020, but a rebound is expected as the economy recovers (Figure 2.3).

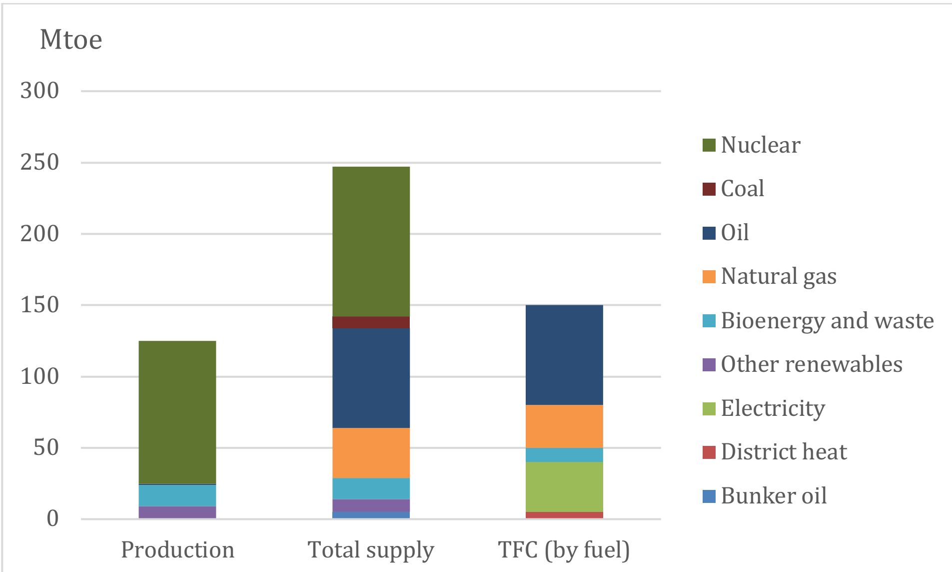


Figure 2.3 – Overview of France's energy production, supply and consumption, 2019 [37]

In 2019, France produced about half of its total energy supply (TES) domestically, primarily from nuclear energy (79%), bioenergy (13%), and other renewables, including hydropower (3.7%). Nuclear energy accounted for 43% of TES in 2019, followed by imported oil (29%), natural gas (15%), and domestically sourced bioenergy (7%). On the demand side, oil represented 44% of total final consumption (TFC) in 2019, with buildings consuming 39%, followed by transport and industry, each at 30%.

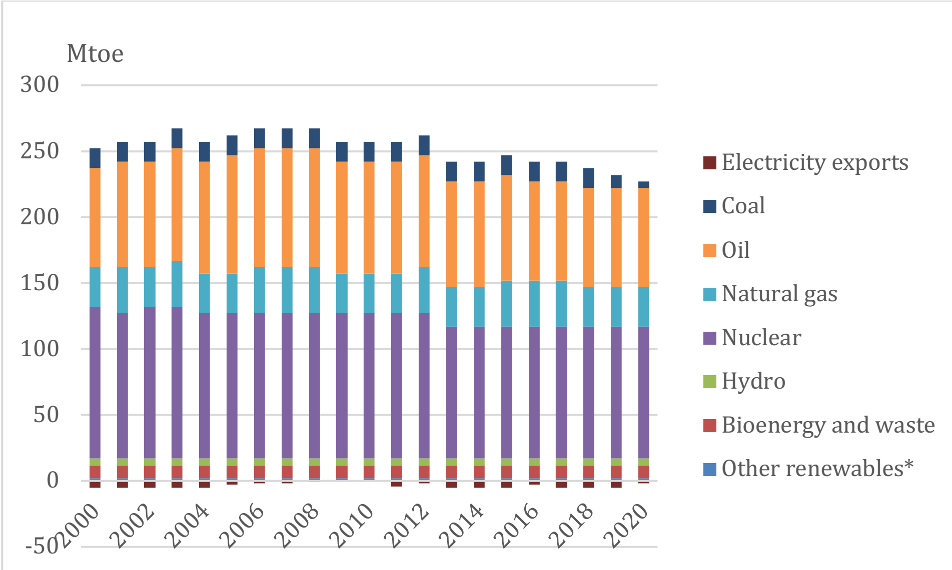


Figure 2.4 – Total energy supply in France by source, 2000-20 [37]

Total energy supply (TES) was 217.8 Mtoe in 2020, decreasing by 8% from 2010 to 2019 and by 10% from 2019 to 2020 due to the pandemic. The share of nuclear energy remained stable over the past decade. Renewables increased by 23% from 2010 to 2020, while coal supply decreased by 55% and natural gas by 18%, reflecting an 81% drop in electricity production from coal during this period. (Figure 2.6)

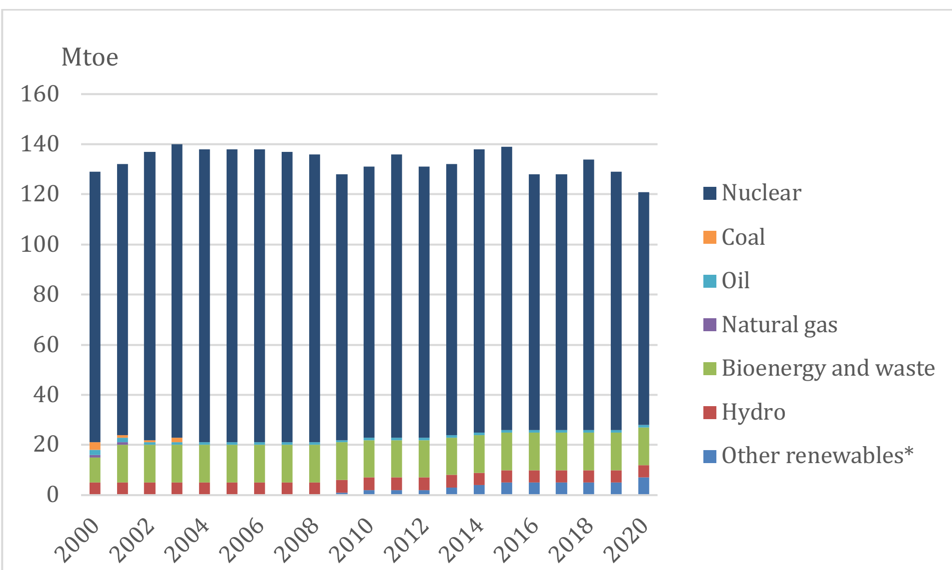


Figure 2.5 – France's energy production by source, 2000-20 [37]

Total energy production (TEP) was 133.6 Mtoe in 2020, showing a decrease of 7% from 2010 to 2019 and a 9% drop from 2019 to 2020, primarily due to the pandemic. The share of nuclear energy in France's energy production remained consistently high over the past two decades. Renewables experienced a significant increase of 25% from 2010 to 2020, while coal production decreased dramatically by 60%, and natural gas production also saw a reduction. This shift highlights a substantial move towards renewable energy sources in France's energy production landscape during this period. (Figure 2.6).

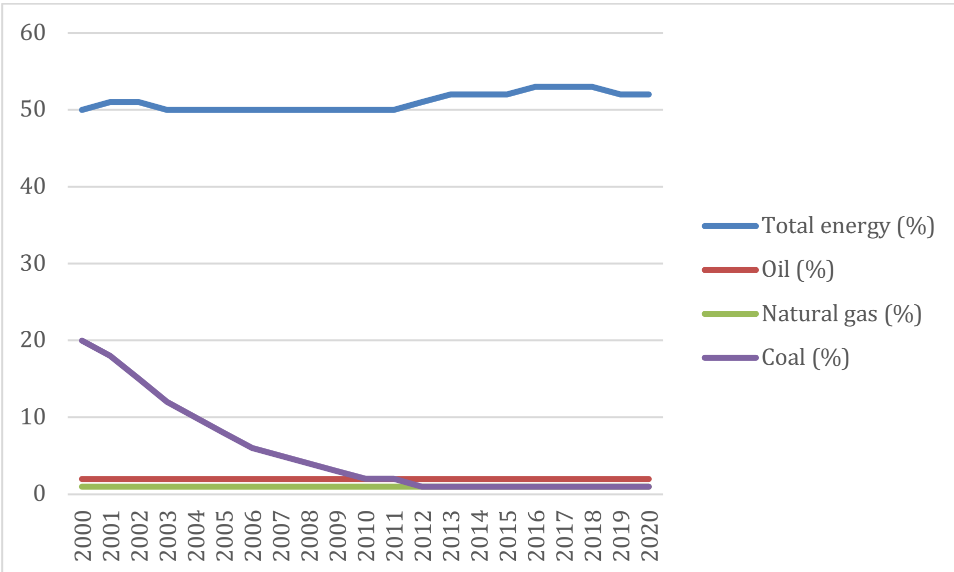


Figure 2.6 – Share of total energy supply produced domestically in France by energy source, 2000-20 [37]

In 2020, nuclear energy covered 77% of domestic production, though it decreased by 17% from 2010 to 2020. Bioenergy and waste accounted for 13%, and hydropower for 4.5%. France imports all its coal and gas needs, with domestic coal production ending in 2004. Only 1% of oil supply was produced domestically in 2020. The ratio between domestically produced energy and total energy supply remained mostly stable from 2010 to 2020 (Figure 2.7).

France has the lowest share of fossil fuels among G20 countries, largely due to its significant nuclear energy shar.

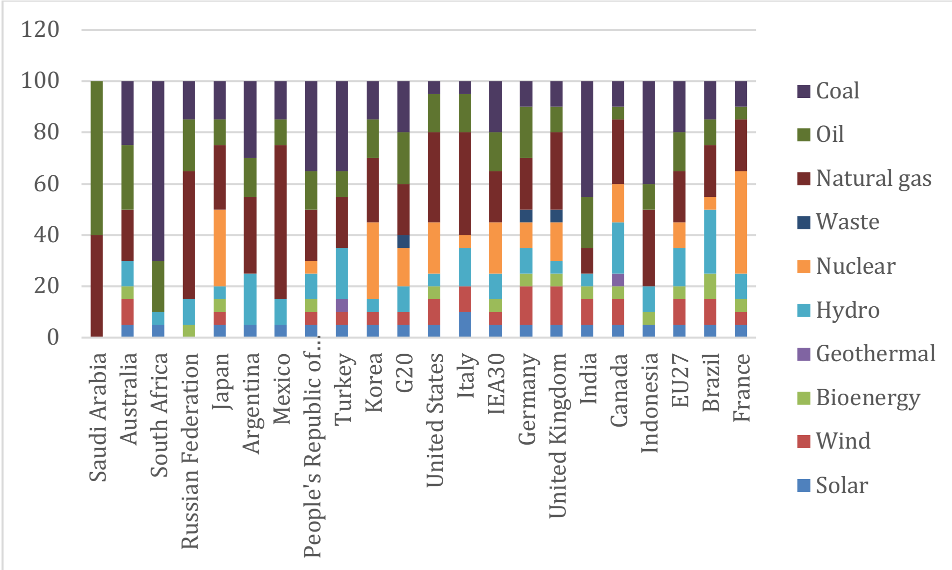


Figure 2.7 – Share of total energy supply by source in G20 countries, 2019 [37]

Total final consumption (TFC) in France decreased from 160 Mtoe in 2010 to 150 Mtoe in 2019, the lowest level since 1994. Despite a 15% GDP increase and a 4% population growth from 2009 to 2019, energy intensity of GDP declined by 16%. In 2019, buildings accounted for 39% of TFC, while industry and transport each represented 30%. Energy demand in buildings fell by 14% from 2010 to 2019, while industrial energy consumption decreased by 4%, and transport energy consumption increased by 4%.

Oil covered 44% of energy demand in 2019, primarily in transport and industry. Electricity accounted for a quarter of TFC, with the highest share in buildings (43%). Natural gas was the second most used energy source in industry and buildings, accounting for over a quarter in both sectors. Bioenergy and waste accounted for 8%, particularly in the buildings sector (12%).

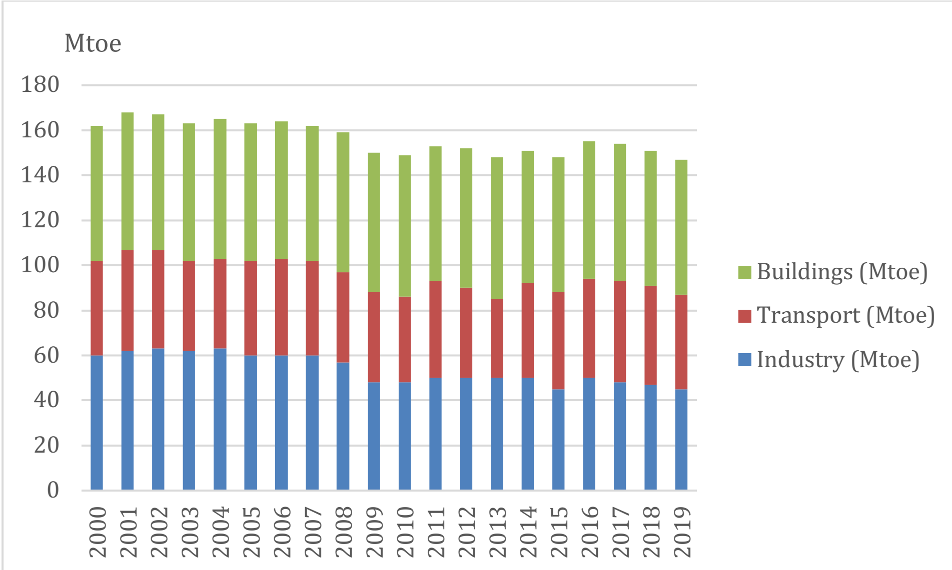


Figure 2.8 – Total final consumption in France by sector, 2000-19 [37]

Total final consumption (TFC) in France was 150 Mtoe in 2019, showing a relatively stable trend over the period from 2000 to 2019. The consumption is divided into three main sectors: Industry, Transport, and Buildings. The industry sector consistently accounted for the largest share of energy consumption, followed by the transport sector, and then buildings. Despite minor fluctuations, the overall consumption patterns remained stable, with a slight increase in energy efficiency and a gradual shift towards more sustainable energy usage in the buildings sector. This stability reflects France's consistent energy demand across its key sectors over the two decades. (Figure 2.9)

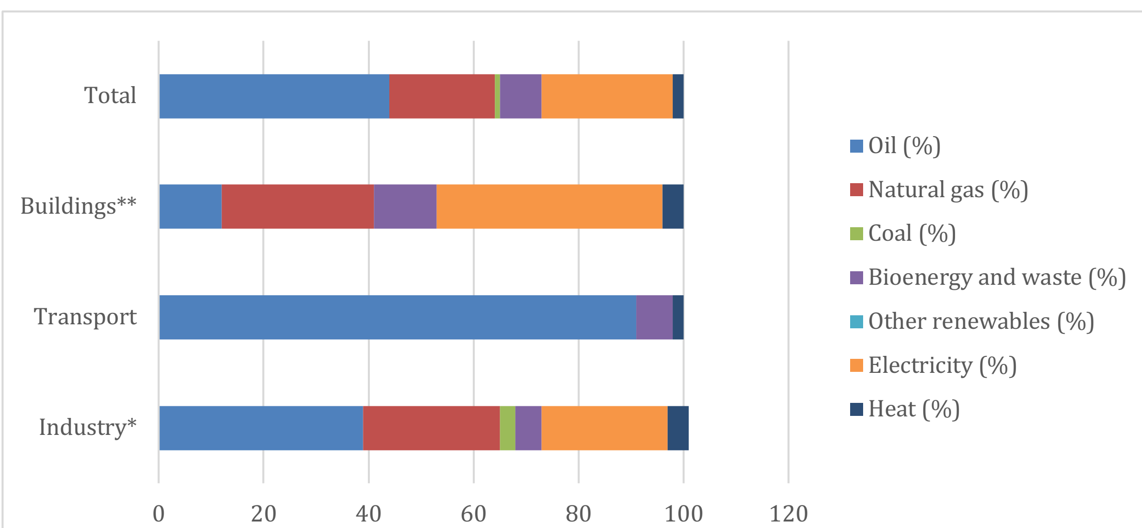


Figure 2.9 – Total final consumption in France per sector and per fuel, 2019 [37]

The European Green Deal, evolving geopolitical context, and energy crisis have prompted the EU and its Member States to accelerate the energy transition and set more ambitious energy and climate objectives, focusing on diversifying energy supplies. These developments are reflected in the legislative framework of the Fit for 55 package and the REPowerEU Plan.

France's draft updated national energy and climate plan (NECP), submitted on 17 November 2023, partially incorporates this new geopolitical and legislative framework.

Energy Security: France benefits from diversified access to natural gas and sets ambitious targets for renewable gases and gas demand reduction.

Energy Efficiency: The updated NECP includes comprehensive measures addressing building, transport, and business sectors.

Energy Poverty: The NECP assesses current household situations and includes specific indicators on energy poverty.

Competitiveness: The plan outlines national objectives and investments in clean energy technologies to support French companies in the global market.

Just Transition: France is developing sectoral action plans to ensure a skilled workforce for its climate and energy transition efforts. [38]
However, the plan has some shortcomings:

Renewable Energy: France needs to significantly raise its overall ambition and implement additional measures to achieve these targets.

Internal Energy Market: The plan lacks detailed measures to enhance electricity system flexibility and ensure non-discriminatory participation of new flexibility services.

Climate Adaptation: The plan does not adequately address climate vulnerabilities and risks, which may hinder achieving energy and climate mitigation objectives.

Land Use, Land Use Change and Forestry (LULUCF): The projections indicate that France will fall short of its 2030 ambition, highlighting the need for enhanced climate action [39].

Furthermore, Italy has made considerable strides in transforming its energy landscape over the past decade. Significant changes in the country's energy mix, policy advancements, and efforts towards achieving climate goals highlight Italy's ongoing commitment to a sustainable energy future.

Since 2010, Italy’s energy system has undergone notable changes, with a marked increase in natural gas and renewable energies and a reduction in coal and oil. From a lower base than the IEA average, Italy’s energy intensity, measured by the ratio of total final consumption (TFC) to gross domestic product (GDP), declined by 15% between 2005 and 2021. This reflects a shift from an industrial to a service-oriented economic structure, coupled with improvements in energy efficiency [40].

Italy is on track to meet the emissions reductions and energy efficiency targets outlined in its National Energy and Climate Plan (NECP) for 2030. However, substantial additional efforts are required to align with the more ambitious 2030 targets set by the European Union's (EU) Fit-for-55 (FF55) package and the REPowerEU plan aimed at rapidly reducing the EU's reliance on Russian fossil fuels. Between 2005 and 2019, Italy reduced total greenhouse gas (GHG) emissions by nearly 30%. While there was a significant dip from 2019 to 2020 due to the COVID-19 pandemic, preliminary data for 2021 show a rebound in emissions, though still 4% lower than in 2019. Italy is committed to achieving carbon neutrality by 2050.

Energy poverty has been a significant policy issue since the Clean Energy for All Europeans package was introduced in 2016, gaining further importance with recent substantial increases in natural gas and electricity prices. The government has implemented several policy measures to restore affordability, but there is room for more targeted interventions to combat energy poverty effectively.

The Italian energy system has experienced major changes since 2010, with total energy demand declining and the energy mix now including more natural gas and renewables, and less coal and oil. The Russian invasion of Ukraine underscored the importance of accelerating the clean energy transition for energy security. Natural gas dominates Italy's energy mix and electricity output, with a high dependence on Russian imports. There is potential to save energy and accelerate renewable deployment across all sectors in line with the European Commission's proposed REPowerEU plan, which aims to reduce the EU's dependency on Russian fossil fuels by increasing the share of renewables in the EU's gross final energy consumption to at least 45% by 2030 [40].

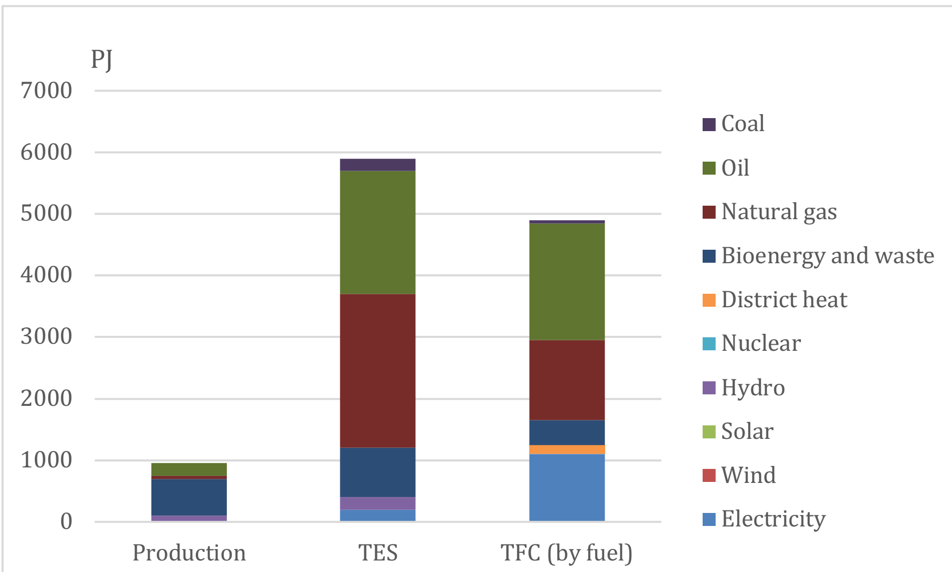


Figure 2.10 – Overview of energy production, supply and demand in Italy, 2021 [40]

Italy is a net energy importer, with an average of 80% of its total energy supply (TES) being imported between 2016 and 2021, mostly oil and gas. Domestic production primarily consists of renewable energy sources such as bioenergy, hydro, solar, and wind. Renewable energy production has increased over the last decade, reaching 74% of domestic energy production in 2021, with limited production of oil and natural gas.

Italy relies heavily on natural gas imports, particularly from Russia, which accounted for 41% of its total gas imports in 2021. In the same year, about 23% of the country's electricity generation depended on fossil fuel imports from Russia, the second-highest dependency among International Energy Agency (IEA) member countries, just after Hungary. Energy imports from Russia significantly impact final energy consumption (FEC) [40].

Natural gas dominates Italy's electricity mix, covering 50% of total electricity generation in 2021, the second-highest share among IEA countries after Mexico. Hydro was the second-largest source of electricity (16% of electricity output) in 2021, followed by solar (9%), bioenergy and waste (8%), and wind (7%). Coal accounts for a minor and decreasing share (5% in 2021), followed by oil (3%) and geothermal (2%).

Fossil fuels also dominate final energy demand, covering two-thirds of TFC. In 2021, TFC was primarily covered by oil, mainly used in transport, and natural gas, primarily used in industry and buildings. Electricity accounted for 21.5% of TFC, slightly below the IEA average of 23%. There is potential for greater electrification of end-uses, especially in buildings and transport. Bioenergy and waste, district heat, and solar accounted for the remaining TFC.

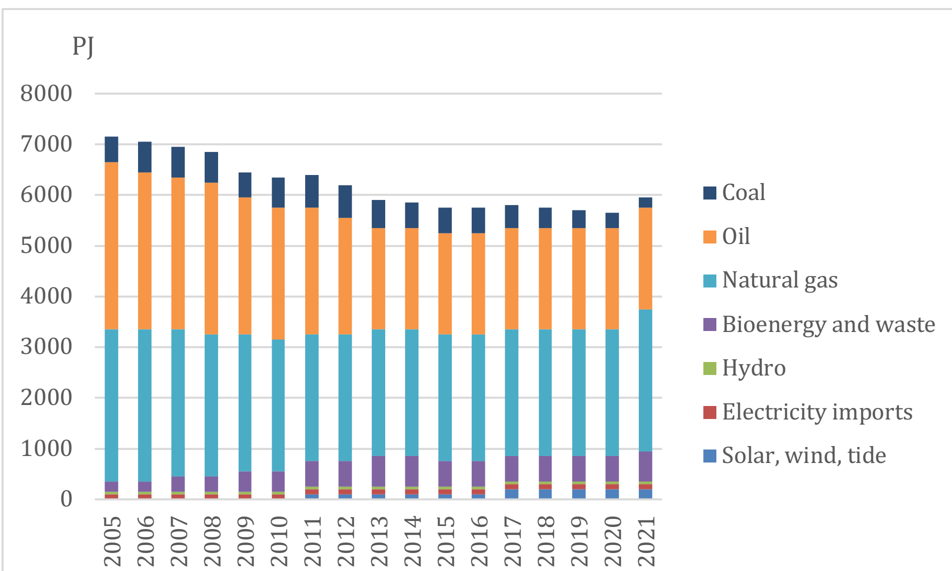


Figure 2.11 – Total energy supply by source, total final consumption and GDP in Italy, 2005-2021 [40].

Since 2008, buildings have been the largest energy-consuming sector, accounting for about 40% of TFC. Transport and industry have each hovered around 30% of TFC over the past decade. In 2021, natural gas covered more than half of energy use in buildings, which also had the highest share of demand covered by renewables (25.3%), primarily bioenergy and renewable electricity. Oil dominates fuel use in transport (89% in 2021), while electricity, oil, and natural gas contribute nearly equal shares to industrial energy use.

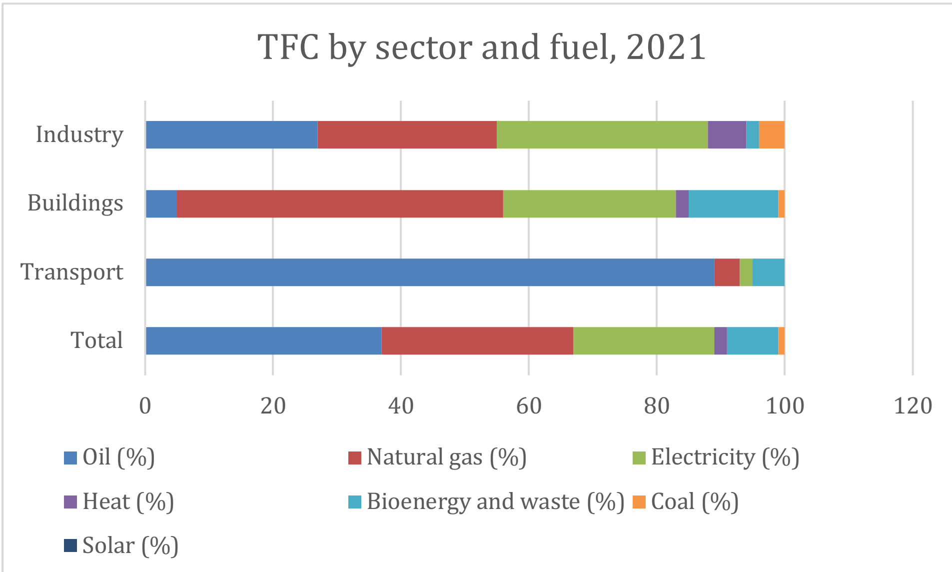


Figure 2.12 – Energy demand by sector and fuel in Italy [40]

The European Green Deal, evolving geopolitical contexts, and the energy crisis have led the EU and its Member States to accelerate the energy transition and set more ambitious energy and climate objectives, with a strong focus on diversifying energy supplies. These developments are reflected in the legislative framework adopted under the 'Fit for 55' package and the REPowerEU Plan [41].

Italy's draft updated national energy and climate plan (NECP), submitted on 19 July 2023, partially incorporates this new geopolitical and legislative framework. The plan includes several key measures:

Renewable Energy: The plan lists comprehensive measures adopted or intended to support renewable energy deployment, including designated 'renewable acceleration areas' with faster and simpler procedures.

Energy Efficiency: The plan outlines comprehensive measures addressing most relevant sectors, including buildings, energy distribution, transport, and business, with detailed information on energy savings for public bodies.

Energy Security: The plan sets out high ambition, concrete policies, and measures to enhance Italy's energy system security, particularly for gas diversification and reducing gas demand.

Internal Energy Market: The plan includes measures to ensure non-discriminatory participation of new market entrants and to encourage flexibility services, though without clear objectives.

Phasing Out Fossil Fuel Subsidies: The plan explains the mapping exercise and describes the governance structure for the progressive phase-out of fossil fuel subsidies. However, the plan also has several shortcomings:

Buildings: It does not include more ambitious targets than those in Italy's 2020 long-term renovation strategy and lacks estimates of financial needs or funding sources for most proposed energy efficiency measures.

Energy Poverty: The draft updated NECP does not contain a target for reducing energy poverty and does not report on the number of households currently affected.

Research, Innovation, and Competitiveness: The plan does not provide sufficient information on measures and investments to support research and innovation in clean energy technologies, scaling up manufacturing capacities for net-zero technologies, and addressing skills gaps.

Adaptation to Climate Change: The plan does not assess relevant climate vulnerabilities and risks for achieving Italy's energy and climate objectives, policies, and measures. Adaptation policies and measures to address these risks and vulnerabilities are inadequately described.

Just Transition: The plan is not aligned with the commitments in the adopted Territorial Just Transition Plans, particularly for the Sulcis Power Plant [42].

On the other hand, over the last four decades, Germany's energy supply has shifted from a clear dominance of coal and oil to a more diversified system. Nuclear energy, first introduced in the 1970s, is being replaced by more renewables, in line with Germany's energy transition targets. Furthermore, coal, which represents the largest source for power generation today, is planned to be fully phased out by 2038.

Still, Germany is struggling to achieve its climate change ambitions, and is not on track to meet its near-term emissions reduction targets. The growth in electricity generation from renewables has lowered emissions, but the nuclear phase-out as well as higher electricity exports have offset some of the emissions benefits. That said, the government's planned coal phase-out could help reset the country on a path to achieving its longer-term emissions targets in the electricity sector [43].

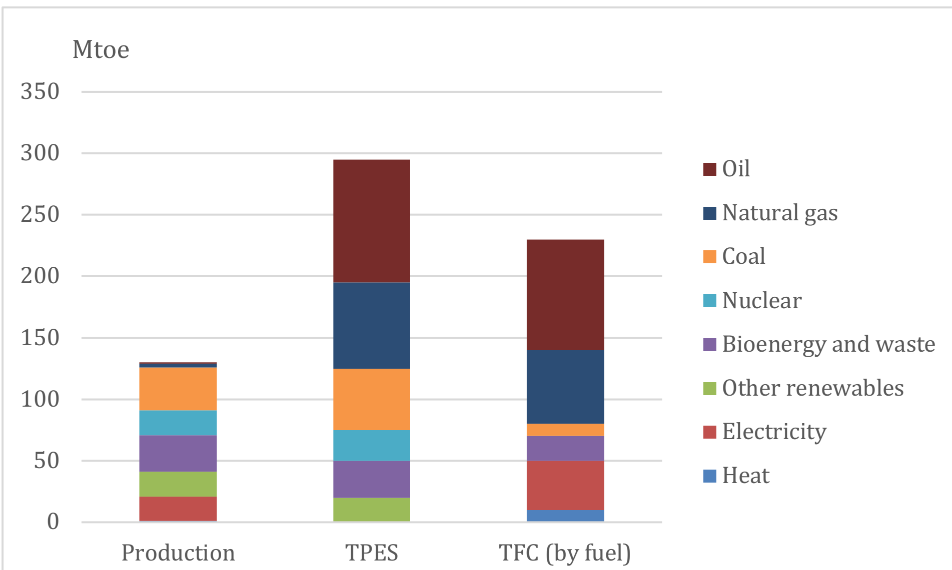


Figure 2.13 – Overview of the German energy system by fuel and sector, 2018 [43]

Despite a recent surge in renewable energy sources, Germany's energy system still depends largely on fossil fuels. (Figure 2.14) Oil and gas are the largest energy sources in total primary energy supply (TPES) and total final consumption (TFC), and coal remains the largest source for power generation. Nevertheless, renewable energy sources, including bioenergy, wind, and solar, are making fast progress. Statistically, they have de facto replaced a large share of conventional power in Germany (Figure 2.14).

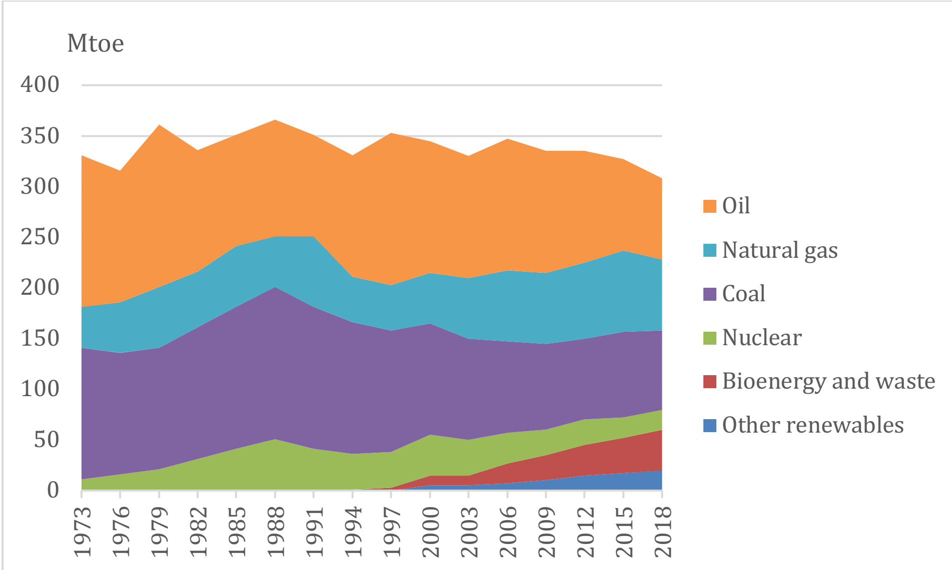


Figure 2.14 – TPES by source, 1973-2018 [43]

Domestic production of oil and natural gas is small, and the country relies on imports. In 2018, total domestic energy production was 112 Mtoe, just over a third of TPES. Coal accounts for the largest share of Germany's energy production, but it is not enough to cover domestic demand, and nearly half of the country's coal supply is imported. Bioenergy and waste account for the second-largest share of domestic production, half of which is used in heat and power generation and the other half in final consumption, either as biofuels in transport (8% of total bioenergy supply), for heating in residential and commercial buildings (28%), or for industry purposes (13%).

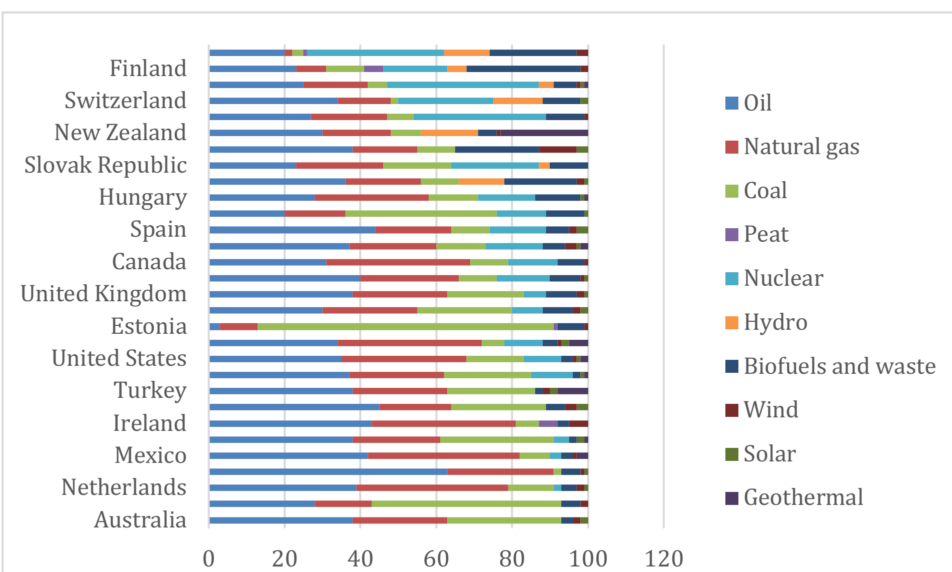


Figure 2.15 – Breakdown of TPES in IE*: IEA (2019a), World Energy Balances 2019 [43]*

TPES was 298 Mtoe in 2018, with an additional 12 Mtoe of oil products used in international bunkers. Oil, natural gas, and coal together accounted for 80% of TPES. While coal, nuclear, and most renewable energy sources are used in power generation, oil and gas are used mostly in final consuming sectors. TFC was 227 Mtoe in 2017, of which oil accounted for 41%, natural gas for 24%, and electricity for 20%. The residential and commercial sectors together consumed 40% of TFC, the industry sector 35%, and the transport sector 25%.

Germany's energy transition is clearly visible in domestic energy production. In the decade from 2008 to 2018, fossil fuel production declined by a third while nuclear production nearly halved. These declines were largely offset by increased production of renewable energy, so total domestic energy production fell by only 16%. In 2018, renewables and waste accounted for 41% of total domestic production. The growth in renewable energy production has also helped Germany keep a steady level of energy self-sufficiency of around 40% of TPES [43].

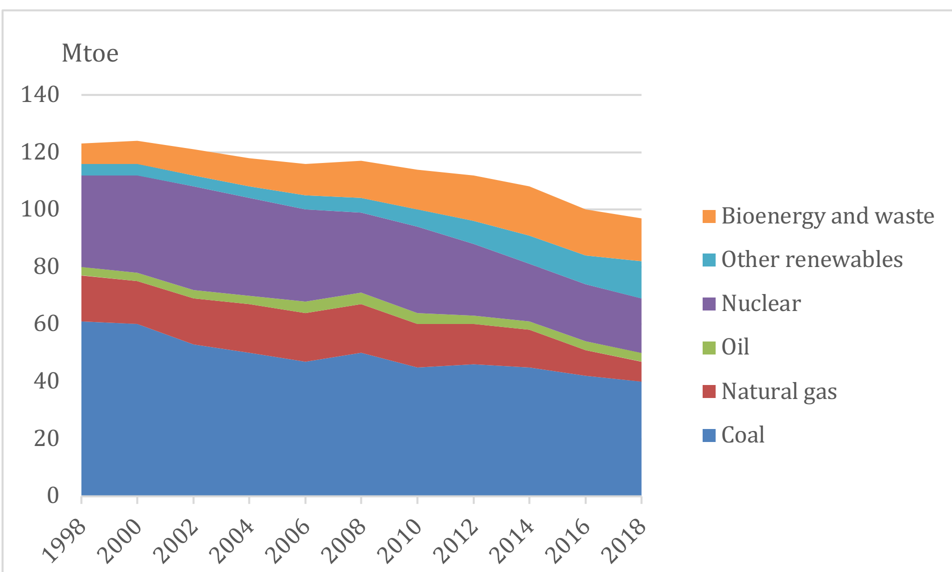


Figure 2.16 – Energy production by source, 1998-2018 [43]

The European Green Deal, the fast-evolving geopolitical context, and the energy crisis have led the EU and its Member States to accelerate the energy transition and set more ambitious energy and climate objectives, including objectives to diversify energy supplies. These developments are reflected in the legislative framework adopted under both the Fit for 55 package and the REPowerEU plan [43].

Germany's draft updated national energy and climate plan ('the draft updated NECP' or 'the plan'), submitted on 3 November 2023, partially takes into account this new geopolitical and legislative framework [44].

Strengths:

Internal Energy Market: The draft updated NECP includes measures on consumer protection, consumer empowerment, and a focus on infrastructure development, particularly of electricity grids.

Renewable Energy: Germany is working on an import strategy for renewable hydrogen and has already reached a long-term import agreement with Norway.

Energy Efficiency: The plan is comprehensive, ambitious, informative, and detailed, presenting a wide range of measures covering all sectors.

Competitiveness: The German plan contains some measures to support the competitiveness of clean energy technologies and manufacturing.

Decarbonisation: The plan pays attention to mitigating non-CO2 emissions in different sectors. In agriculture, the plan covers methane emissions from enteric fermentation and manure management, as well as N2O from agricultural soils. In waste management, the plan addresses methane emissions from landfill sites. In addition, on F-gases, the plan includes a public procurement measure. Finally, the plan mentions the use of bio-methane in transport.

Weaknesses:

Energy Security: The draft updated NECP does not envisage additional objectives nor measures to further diversify gas supply.

Public Consultation: The draft updated NECP does not outline a procedure to ensure early public participation before decisions were taken and throughout the decision-making process.

Investment Needs: The plan does not provide any estimates of the investments required for the climate and energy transition.

Land Use Land Use Change and Forestry (LULUCF): The plan is based on outdated projections that do not consider the latest updated inventory.

Adaptation to Climate Change: The plan does not consider relevant climate vulnerabilities and risks, and this may put the achievement of energy and climate mitigation objectives at risk. Adaptation policies and measures to address these risks and vulnerabilities are not adequately described [45].

Having explored the diverse energy policy frameworks and implementation strategies adopted by developed countries, it is crucial to contextualize these insights within the unique socio-economic and geopolitical landscape of Ukraine. It’s important to analyze how the lessons learned from these international examples can be adapted to enhance Ukraine's energy policy. By examining the successes and challenges faced by countries like Japan, Germany, and Canada, we can identify best practices and potential pitfalls. This understanding will aid in formulating a robust, resilient, and adaptive energy policy framework tailored to Ukraine's specific needs and circumstances.

1. Diversification and Security of Energy Supply

- Japan: The emphasis on enhancing energy security through diversification, particularly the increased focus on renewable energy and hydrogen, can be a valuable lesson. Ukraine could adopt similar strategies to reduce its dependence on a limited range of energy sources and imports.

- Germany: Germany's gradual phase-out of coal and nuclear energy, coupled with a significant increase in renewable energy, provides a roadmap for Ukraine to follow. The adoption of diversified energy sources can enhance energy security and sustainability.

2. Integration of Renewable Energy

- Japan: The introduction of the Feed-In Tariff (FIT) in Japan significantly boosted investment in renewable energy, particularly solar photovoltaics. Ukraine could implement a similar FIT scheme to attract investment in renewables, which would not only diversify the energy mix but also reduce greenhouse gas emissions.

- Canada: Canada's success in creating one of the cleanest electricity supplies globally through stringent regulations and a commitment to reducing GHG emissions is noteworthy. Ukraine could adopt comprehensive regulations and incentives to boost its renewable energy sector.

3. Energy Efficiency and Conservation

- France and Germany: Both countries have made strides in energy efficiency, with detailed plans and measures to reduce energy consumption across various sectors. Ukraine could develop and enforce rigorous energy efficiency standards, especially for buildings and industries, to reduce overall energy demand and improve sustainability.

- EU Initiatives: The EU's Fit for 55 and REPowerEU plans include extensive measures to enhance energy efficiency and accelerate the transition to clean energy. Ukraine can align its policies with these initiatives, setting ambitious targets and ensuring the implementation of energy-saving measures.

4. Infrastructure Modernization and Resilience

- Japan: The emphasis on modernizing energy infrastructure and ensuring resilience against natural disasters, such as seismic activities, is crucial. Ukraine could focus on modernizing its aging grid infrastructure to handle a more decentralized and renewable-based energy system, improving its resilience against disruptions, including those caused by ongoing conflicts.

- Germany: Germany's focus on developing infrastructure for renewable energy and smart grids can be a model for Ukraine. Investments in smart grid technology and enhanced interconnections within the country and with neighboring countries can improve energy stability and integration.

5. Addressing Energy Poverty and Ensuring Social Justice

- Italy and France: Both countries have measures in place to address energy poverty and ensure that vulnerable populations are protected. Ukraine could implement targeted policies to alleviate energy poverty, ensuring that energy reforms do not disproportionately affect low-income households.

- EU Social Climate Fund: The proposed fund aims to support vulnerable households and businesses during the energy transition. Ukraine could seek similar support mechanisms from international partners to ensure a just transition.

6. Legal and Regulatory Framework

- Canada and EU: Strong legal frameworks and consistent policy enforcement have been critical in shaping Canada's and the EU's energy landscapes. Ukraine should continue to align its energy legislation with European standards, ensuring transparency, market integrity, and compliance with international best practices.

- Ukraine's Recent Progress: Despite challenges, Ukraine has made legislative advancements in energy market integrity and renewables. Continued focus on robust legal and regulatory frameworks will be essential for sustained progress.

By learning from the experiences of developed countries, Ukraine can implement a multifaceted approach to energy policy that prioritizes security, sustainability, and resilience. Diversifying energy sources, enhancing infrastructure, fostering public-private partnerships, and ensuring social justice will be key to transforming Ukraine's energy sector. Through these measures, Ukraine can build a more secure, efficient, and environmentally sustainable energy future, even in the face of ongoing challenges.

2.2 Determinants of energy policy in Ukraine

For this study I developed causal loop diagram (CLD) for Ukrainian energy market based on conceptual model of the Australian energy sector, using Causal Loop Diagrams, designed in Laimon et al. [56] I also referenced Mohamd Laimon et al. study [57].

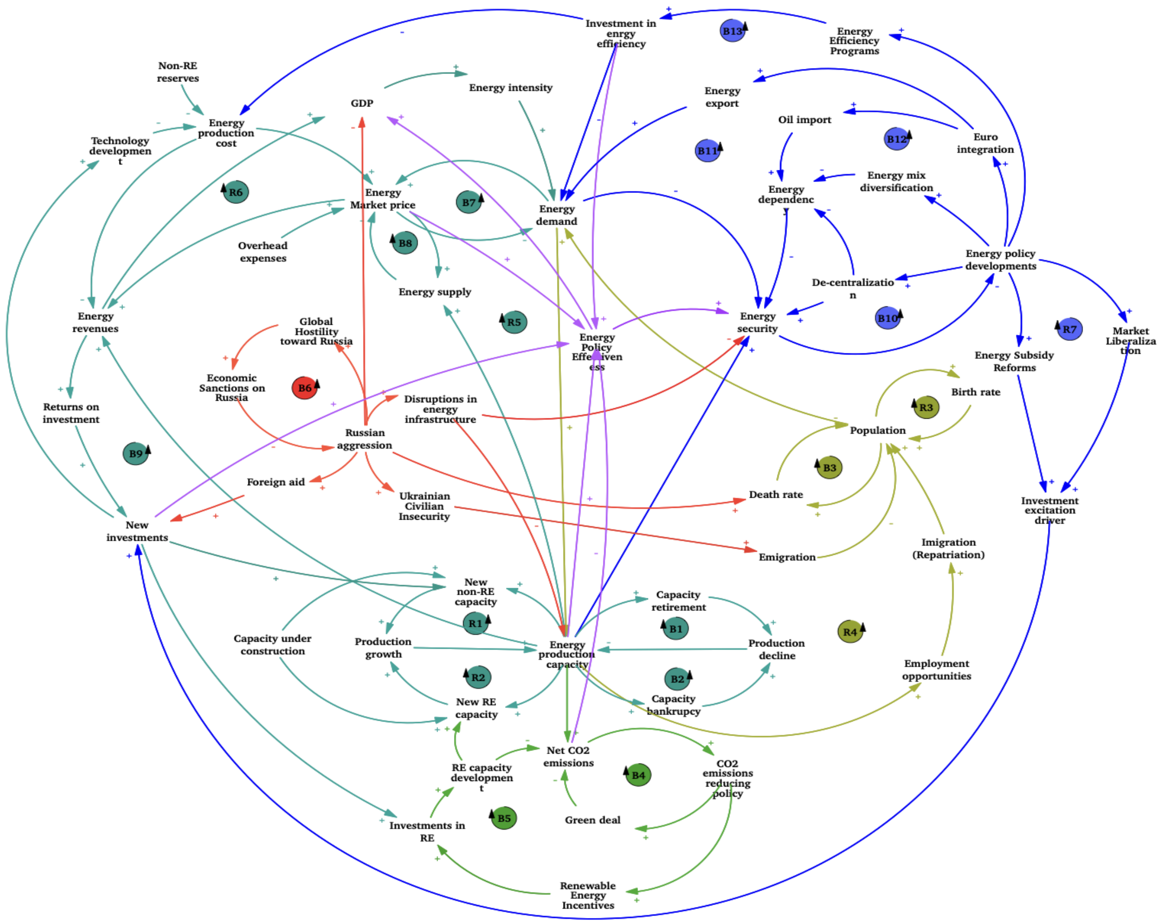


Figure 2.17 – Model of the Ukrainian energy sector

Source: compiled by the author based on her own research

The model above visualizes the Ukrainian energy sector. It is based on the study by Laimon et al. of the Australian energy sector, which provides a detailed description of the model. Therefore, in my study, I have omitted some descriptions that can be found in Laimon et al.'s study. *Energy Market Laws (Turquoise Arrows)*

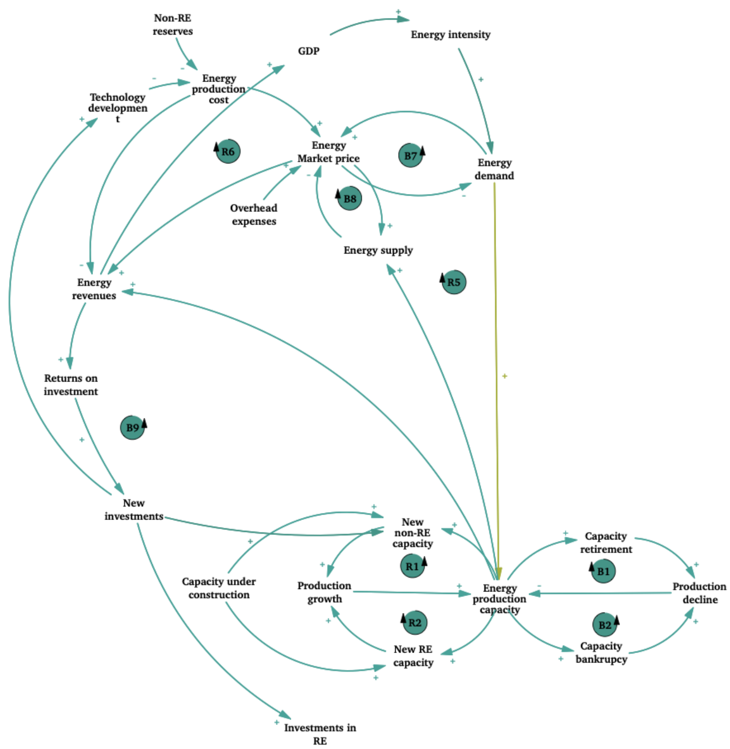


Figure 2.18 – Model of the Ukrainian energy market laws

Source: compiled by the author based on her own research

The turquoise part of the model describes the default energy market laws, which are detailed in the referenced study. Hence, the description of this section will be brief. It is important to note that the Ukrainian energy market differs in that the "Energy Market Price" is not equal to the Real Energy Price. As the energy market in Ukraine is predominantly centralized and heavily regulated, the real price of energy is determined by the government. However, I retained this part because, firstly, the Energy Market Price does influence the Real Energy Price to some extent. Secondly, the energy sector in Ukraine is currently undergoing significant changes to liberalize the energy market, and the presented model reflects the future goal of having the Energy Market Price equal to the Real Energy Price [48].

Additionally, for the same reason of market centralization, Capacity bankruptcy in Ukraine is negligible. I included it in the model to maintain accuracy, as it would be misleading to claim it is zero.

Population Dynamics (Yellow Arrows)

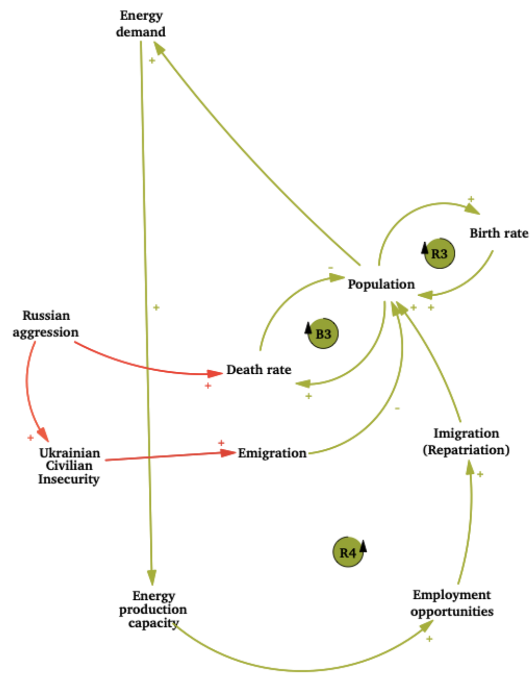


Figure 2.19 – Model of the Ukrainian population dynamics

Source: compiled by the author based on her own research

Population dynamics, represented by the purple cycles, including birth rate, death rate, immigration (repatriation), and emigration, impact both energy demand and energy security. A growing population increases energy demand, while a declining population reduces it. A unique aspect of the current Ukrainian energy market is that the decrease in population is heavily influenced by the new variable "Russian aggression." This aggression results in fatalities among Ukrainian residents, thereby reducing energy demand, and causes others to emigrate, seeking safety outside the country. Another distinctive feature for Ukraine is that employment opportunities scarcely attract new immigrants due to the war, which is a critical factor. However, these opportunities do influence the rate of repatriation of Ukrainians who, unable to find better living conditions abroad, are drawn back by new opportunities in their home country. The interplay between population changes and energy demand highlights the socio-economic dimensions of the energy market.

Green Development and CO2 Emissions (Green Arrows)

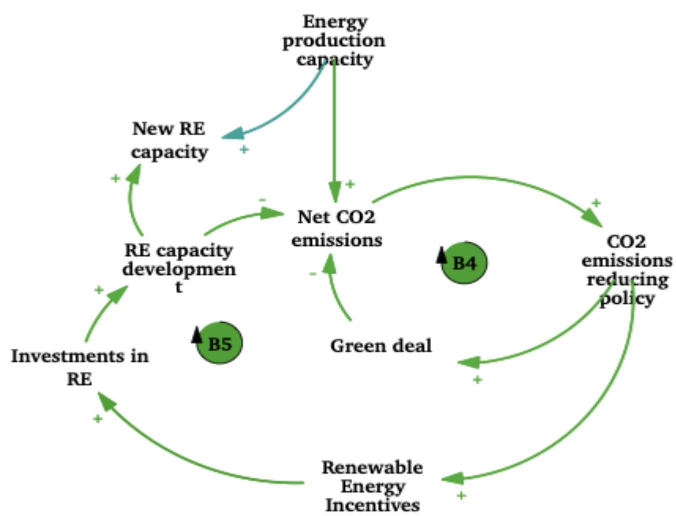


Figure 2.20 – Model of the Ukrainian energy sector green development

Source: compiled by the author based on his own research

The model also emphasizes green development, particularly the reduction of CO2 emissions. Net CO2 emissions are a critical stock influenced by energy production and green policies. Policies aimed at reducing CO2 emissions, such as renewable energy incentives and the Green Deal, promote the adoption of cleaner energy sources. Investments in renewable energy (RE) capacity directly contribute to reducing CO2 emissions, supporting the overall goal of sustainable development. This part of the model remains largely unchanged, so refer to the original study to learn more about the relationships between the variables.

Russian Aggression (Red Arrows)

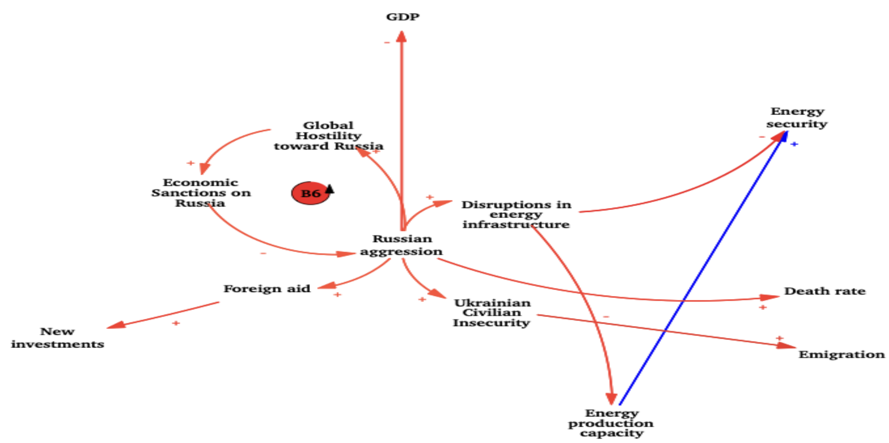


Figure 2.21 – Model of the effect of Russian aggression on Ukrainian energy sector

Source: compiled by the author based on her own research

The main difference between the CLD in this research and Laimon's et al. is the addition of the "Russian aggression" factor, which is unique to Ukraine and wasn't accounted for in the original CLD for Australia for obvious reasons. "Russian aggression" is a hard-to-predict factor that results in the destruction of Ukrainian assets, consequently negatively affecting the country's GDP. However, assets are not the only thing Ukraine is losing; as the invasion continues, there are also numerous fatalities, so "Russian aggression" increases the "Death rate in Ukraine."

Another important factor that's hard to measure is "Ukrainian Civilian Insecurity." During wartime, this factor is crucial, as studies have shown that increased insecurity leads to higher emigration rates. As Russian aggression increases and the war prolongs, people feel less secure about the country's victory, which results in increased emigration. The global community does not remain passive during the conflict and provides financial aid while imposing sanctions on Russia. Loop B6 suggests that the growth of "Global Hostility toward Russia" is a direct result of "Russian aggression," which demonstrates the necessity of boycotting Russia and its products, thereby provoking international responses through sanctions. These sanctions are intended to reduce aggression by slowing down the Russian economy, making it harder for Russia to fund the war, thereby decreasing the "Russian aggression" factor over time. Furthermore, financial aid provided to Ukraine plays a central role in the model. Foreign aid provides additional financial resources that drive "Energy production capacity" up by facilitating "New investments."

In the context of this paper, the result of "Russian aggression" that interests us the most is "Disruptions in energy infrastructure," as it causes significant decreases in energy security. These disruptions also significantly reduce "Energy production capacity," caused by the destruction or occupation of energy infrastructure by Russian forces. For instance, the destruction of key facilities like the Zaporizhzhya NPP and Okhtyrskaya CHPP illustrates the extent of this impact [58]. As stated before, "Russian aggression" causes increases in "Emigration" and "Death rate," which in turn decreases the population and thus energy demand. Intuitively, as the population decreases, energy demand decreases as well. This leads to an increase in "Energy production capacity" by stimulating the market. This creates new "Employment opportunities," as increased capacity requires more labor. While immigration levels are low in Ukraine during wartime, I have kept this parameter to consider "returned emigrants" as "immigrants." Over the past two years, many emigrants have returned to Ukraine due to various reasons, with a significant factor being the inability to find better employment opportunities or maintain their lifestyle abroad. *Energy Policy Effectiveness (Purple Arrows)*

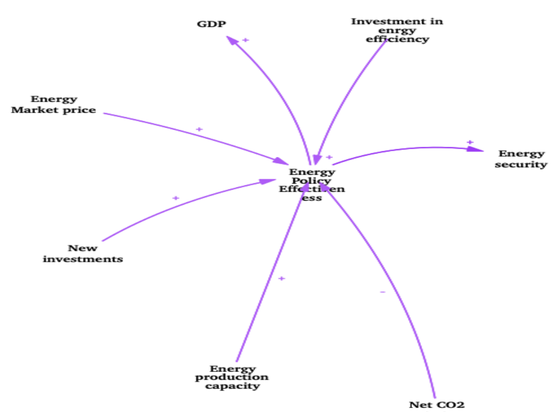


Figure 2.22 – Model of the Ukrainian energy policy effectivness
Source: compiled by the author based on his own research

The focus of this study is on Ukrainian energy policy, which is why a separate variable, “Energy policy effectiveness,” has been created. This variable uses specific markers to determine whether the policies implemented are effective. The factors determining effectiveness include New Investments, Energy Market Price, Energy Production Capacity, Net CO2 Efficiency, Investments in Energy Efficiency, and Energy Security. Energy policy effectiveness, in turn, influences GDP, as effective policies foster a stable and growing economy by ensuring a reliable energy supply, attracting investments, and promoting sustainable practices.

According to the Ministry of Ukraine, power restoration now encompasses repair, reconstruction, construction, and the creation of reliable protection for power generation and distribution facilities. It also includes enhancing energy efficiency and promoting frugal energy consumption. The Ukrainian energy system, now integrated into the European network, continues its further integration by implementing EU standards and market mechanisms that ensure transparency and create investment opportunities. The physical capabilities for exporting and importing electricity with European Union countries are expanding, providing greater flexibility and security. [59]

Measures are being undertaken to increase gas production, aiming to meet Ukraine's internal needs. Active efforts are in place to attract private investors, including major global companies. Ukraine has set an ambitious goal to become the gas hub of Europe, leveraging the continent's largest gas storage facilities.

The ultimate goal of these changes is to achieve energy independence and security for the state. By being self-sufficient and capable of exporting energy resources, Ukraine aims to contribute to the “green” energy transition across Europe and guarantee a safe environment for future generations.

Energy Security (Blue Arrows)

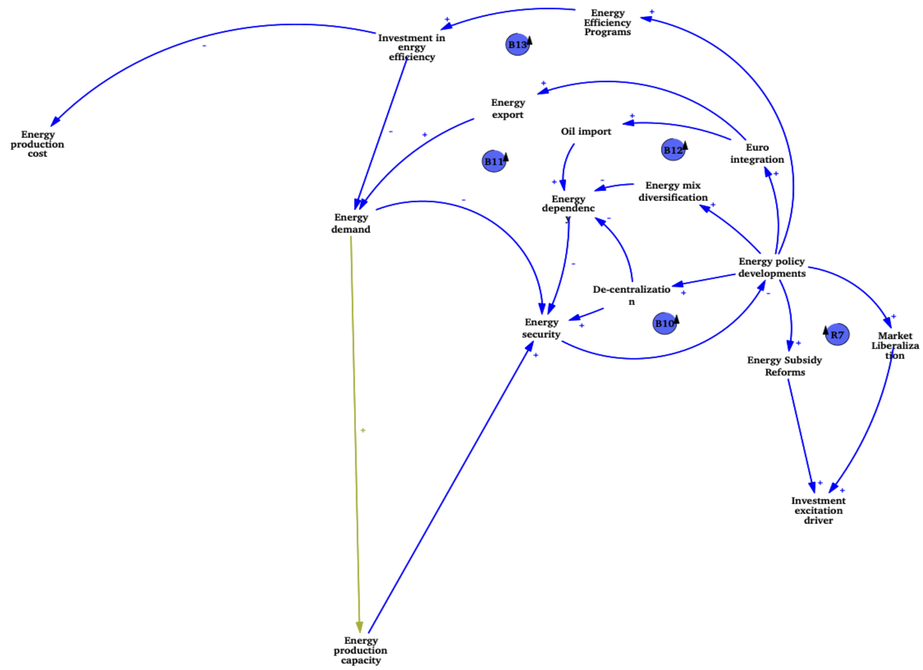


Figure 2.23 – Model of the energy security of the Ukrainian energy sector

Source: compiled by the author based on her own research

At the core of the model is the variable of energy security, which is influenced by a multitude of factors. Energy policy development plays a crucial role in enhancing energy security by introducing measures such as energy efficiency programs and market liberalization. These programs aim to reduce energy demand and promote the use of energy-efficient technologies, thereby bolstering the stability of energy supply. Market liberalization introduces competition, diversifying supply sources and reducing dependency on a single source. Decentralization further enhances energy security by minimizing the impact of disruptions in any single part of the infrastructure.

As depicted in the model, energy security is central to the Ukrainian energy policy. The Ministry of Energy outlines several key areas of focus:

1. Restoration of Generation and Distribution Systems

Following Russian attacks on the Ukrainian energy system, the state launched a large-scale campaign to repair, rebuild, and reconstruct the energy infrastructure. This includes creating reliable active and passive protection for energy generation and distribution facilities. This effort is represented in the model by the arrows indicating the flow of resources towards repairing disruptions in energy infrastructure [60].

2. Further Integration of Energy Systems of Ukraine and Europe

Ukraine is implementing European regulatory documents and market rules in accordance with European standards. In March 2022, Ukraine received "energy visa-free" status from the EU, joining ENTSO-E initially on a temporary basis, and from November 28, 2023, on a permanent basis. The model shows this integration through the variable "Euro integration," which influences energy policy development and market liberalization efforts. The government continues to work on increasing the physical capacity to export and import electricity with EU countries, as shown by the arrows linking energy security to energy export and import capabilities [59].

3. Extraction and Storage of Natural Gas

The strategic goal of the government is to ensure Ukraine's self-sufficiency in natural gas consumption. To this end, the government will continue to develop public-private partnerships, implement joint production agreements, and launch new gas production projects. This is depicted in the model by the arrows leading from investments to new non-renewable energy (non-RE) capacity and the development of gas storage facilities. Despite the ongoing conflict, Ukraine's certified underground gas storage facilities are storing unprecedented volumes of gas, aiming to become the "gas safe" of Europe [61].

4. Development of Small Generation, Decentralization of the Energy System, and the "Green Course"

To reduce vulnerability to hostile attacks, the state encourages the development of small-scale generation and continues to implement the energy system decentralization program. This is visualized in the model through the flow towards decentralization and the promotion of renewable energy incentives. Ukraine is also committed to the provisions of the European Green Deal, enhancing sustainability and reducing carbon emissions [63].

Energy dependency is another critical factor affecting energy security. A higher dependency on external sources reduces energy security, making the system more vulnerable to external shocks. The model highlights this through the arrows connecting energy dependency to energy security. Disruptions in energy infrastructure, often exacerbated by Russian aggression, directly threaten energy security. The model illustrates how global hostility towards Russia and subsequent economic sanctions lead to increased Russian aggression. This aggression results in significant disruptions to Ukraine's energy infrastructure, as shown by the arrows leading from Russian aggression to disruptions in energy infrastructure. This escalation heightens Ukrainian civilian insecurity and complicates the energy market dynamics.

By comprehensively addressing these factors, the model provides a detailed overview of the interconnected variables influencing Ukraine's energy security and the broader energy policy landscape [62].

In the model, GDP is an essential marker of energy policy efficiency, reflecting the overall economic health and its interplay with the energy sector. GDP is closely linked to both energy production capacity and energy demand. Energy production capacity is divided into renewable (RE) and non-renewable (non-RE) capacities. Investments in renewable energy (RE) capacity, driven by technology development and green policies, contribute to the overall growth of production capacity. These investments are essential for achieving sustainable economic growth and reducing dependency on non-renewable energy sources.

However, the growth in production capacity can be offset by capacity retirement and production decline, which may result from infrastructure aging, policy shifts, or disruptions caused by external factors such as Russian aggression. The balance between the development of new capacity and the retirement of old capacity determines the net growth of energy production capacity. This production capacity, whether renewable or non-renewable, directly influences the energy market price.

The energy market price, depicted in the model, is a crucial variable that affects energy demand. Higher energy prices can curb demand, as consumers and businesses seek to minimize energy costs. Conversely, lower prices can stimulate energy demand by making energy more affordable. This relationship between energy market price and demand is fundamental to understanding the dynamics of the energy sector.

Energy demand, on the other hand, is driven by GDP, reflecting the overall economic activity. Higher GDP levels typically correlate with increased energy demand, as economic activities such as industrial production, transportation, and services consume significant amounts of energy. Energy intensity, which measures the amount of energy required per unit of GDP, plays a significant role in this relationship. Policies aimed at reducing energy intensity, such as investments in energy efficiency, aim to make the economy less energy-dependent and more resilient to energy price fluctuations.

The energy market price, influenced by the supply and demand dynamics, affects both energy demand and supply. Energy exports and imports, shown in the model, balance the supply-demand equation, ensuring market stability. The ability to export excess energy or import energy during shortages is crucial for maintaining a stable energy market and supporting economic growth.

In summary, GDP serves as a critical indicator of energy policy efficiency in the model. Effective energy policies that promote investments in renewable energy, enhance energy efficiency, and ensure a stable energy market contribute to robust GDP growth. This, in turn, supports higher energy demand, creating a positive feedback loop that reinforces economic development and energy sector stability.

2.3 Modeling the impact of energy policy on the economic development of Ukraine

The energy sector is vital for Ukraine's economic development, especially during the ongoing conflict with Russia. The importance of this sector, which includes electricity production, distribution, and use, has grown as it directly affects the country’s ability to maintain its economy. Understanding how energy policies impact the economy is essential, but this task is difficult due to a lack of detailed data. The Ukrainian government has restricted access to energy data to prevent it from being used by hostile forces to attack the infrastructure.

Since the full-scale invasion in 2022, Ukraine's energy infrastructure has suffered significant damage. Before the invasion, the country's energy production capacity was about 55 gigawatts (GW). Due to Russian missile and drone attacks, aging infrastructure, and economic challenges, 27 GW of this capacity has been lost. Additionally, about 10 GW of capacity is in territories controlled by Russia and is not connected to the national grid, causing severe power outages.

In this context, modeling the impact of energy policy on Ukraine's economic development is challenging. The lack of reliable data makes it necessary to use simplified models and rough estimates. It is important to stress that the following tables and analyses are based on very rough estimates and do not reflect the reality accurately. The main goal of this exercise is to create a framework that policymakers can use to analyze available data and make informed decisions.

To simplify the model, many variables from the original, more complex model have been omitted. The streamlined model focuses on key variables that are believed to have the most significant impact on economic development in the current situation:

Energy Policy Effectiveness (EPE)

$$EPE=\alpha 1\times NI+\alpha 2\times EPR+\alpha 3\times EPC+\alpha 4\times EE+\alpha 5\times ES$$

where:

- NI = New Investments
- EPR = Energy Market Price
- EPC = Energy Production Capacity
- EE = Energy Efficiency
- ES = Energy Security

GDP (G)

$$G=\beta 1\times EPE+\beta 2\times EPC-\beta 3\times RA$$

where:

- EP = Energy Policy Effectiveness
- EP = Energy Production Capacity
- RA = Russian Aggression

Population (P)

$$dP/dt=B-DR-EM+R$$

where:

- B = Birth Rate
- DR = Death Rate
- EM = Emigration
- R = Repatriation

Energy Efficiency (EE)

$$dEE/dt=\delta1\times EEP+\delta2\times EPD-\delta3\times ED = EIR$$

where:

- EIR = Energy Efficiency Improvement Rate
- EEP = Energy Efficiency Programs
- EPD = Energy Policy Developments
- ED = Energy Demand

Energy Production Capacity (EPC)

$$dEPC/dt=PR$$

$$PR=\epsilon1\times NI+\epsilon2\times EPD-\epsilon3\times DEI$$

where:

- PR = Production Rate
- NI = New Investments
- EPD = Energy Policy Developments
- DEI = Disruptions in Energy Infrastructure

Energy Security (ES)

$$ES=\gamma1\times RER+\gamma2\times EPD-\gamma3\times RA-\gamma4\times DEI$$

where:

- RER = Energy Resilience Enhancement Rate
- EPD = Energy Policy Developments
- RA = Russian Aggression
- DEI = Disruptions in Energy Infrastructure

To navigate these challenges, we employ a scenario analysis approach to model the potential impacts of different energy policy scenarios on Ukraine's economic development. The purpose of this analysis is to provide a strategic framework that helps policymakers understand the possible outcomes of their decisions under varying conditions. By simulating best-case, most-likely, and worst-case scenarios, we can explore a range of possibilities and identify key factors that influence the effectiveness of energy policies.

The scenario analysis is structured around three distinct scenarios—best case, most likely, and worst case. Each scenario is defined by specific assumptions about key variables such as energy policy effectiveness, Russian aggression, emigration and repatriation rates, European integration, GDP growth rate, energy production capacity, energy efficiency improvement rate, and new investments.

Best Case Scenario: This scenario assumes high effectiveness of energy policies, minimal Russian aggression, high repatriation rates, and strong economic growth. It represents an optimistic outlook where favorable conditions lead to significant improvements in the energy sector and economic performance.

Most Likely Scenario: This scenario represents a balanced outlook with moderate policy effectiveness and external challenges. It assumes a realistic set of conditions where both positive and negative factors are at play, resulting in steady progress in the energy sector and economy.

Worst Case Scenario: This scenario assumes low policy effectiveness, high levels of Russian aggression, and significant economic and demographic challenges. It represents a pessimistic outlook where adverse conditions severely impact the energy sector and economic stability.

By analyzing these scenarios, we aim to provide policymakers with valuable insights into the potential impacts of their decisions. The goal is to help them develop strategies that enhance energy security, support economic growth, and build resilience against external shocks. Despite the limitations imposed by data unavailability, this scenario analysis serves as a crucial tool for guiding energy policy in Ukraine during these challenging times.

Table 2.1 – Metrics for the possible scenarios

Metric	Best Case Scenario	Most Likely Scenario	Worst Case Scenario
Energy Policy Effectiveness	90%	60%	30%
Russian Aggression	10%	35%	60%
Emigration Rate	10%	30%	60%
Repatriation Rate	80%	50%	20%
Energy Production Capacity	90%	60%	30%
Energy Efficiency Improvement Rate	90%	60%	30%
New Investments	90%	60%	30%

Source: compiled by the author based on her own research

It is important to highlight that the data used in this model are not precise. The estimates are rather rough and were taken from official sources designed to show potential relationships and outcomes. The Ukrainian government deliberately limits detailed data on energy infrastructure to protect national security. Thus, the model and its results should be seen as a potential framework for understanding rather than an exact representation of the current situation.

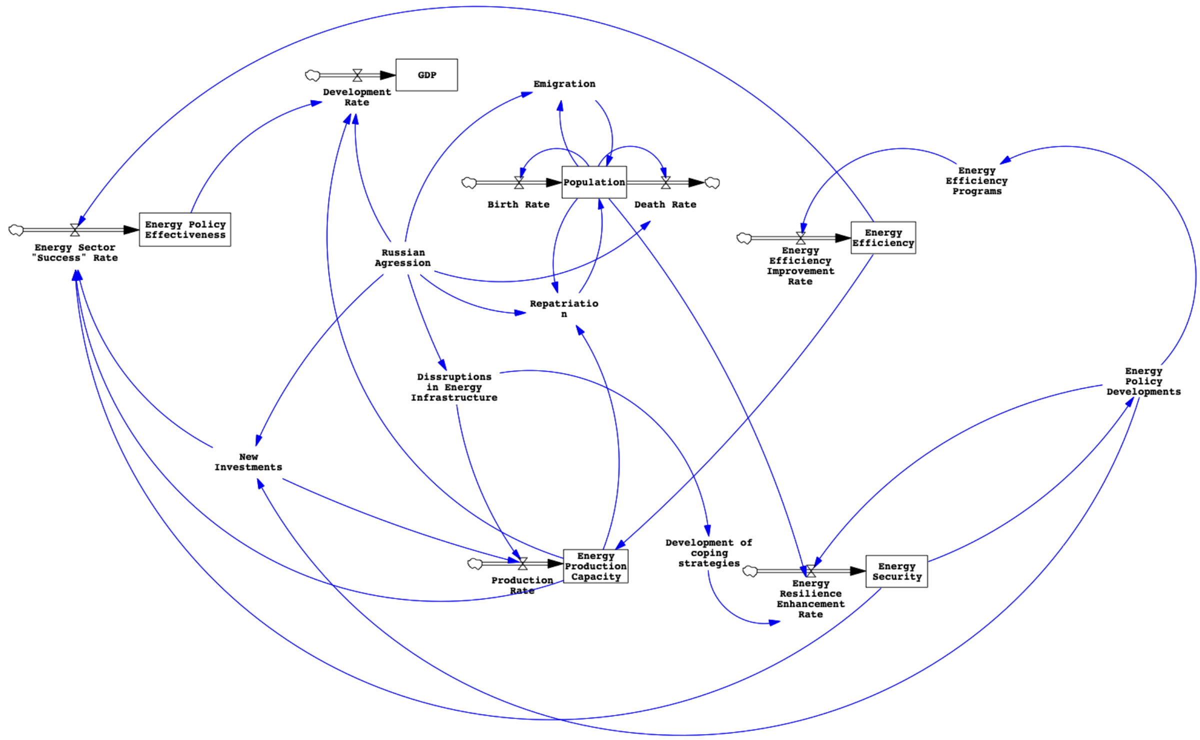


Figure 2.24 – Stock and flow model of the Ukrainian energy sector (simplified)

Source: compiled by the author based on her own research

The formulas for emigration and repatriation rates are as follows:

Emigration Rate: 0.0007 * Population + α1 * Russian Aggression

α1: Emigration due to Russian aggression rate coefficient (determined in the table)

0.0007: Natural emigration rate coefficient, observed before the full-scale invasion. Determined by dividing the number of emigrants (28,673 [72]) by the current population (41,148,884 [64]).

Repatriation Rate: 0.000631 * Population + α2 * (Energy Production Capacity - Russian Aggression)

0.000631: Natural repatriation rate, observed before the full-scale invasion. Calculated by dividing the number of repatriated immigrants (1,143,250 [65]) by the current population (41,148,884 [64]).

α2 : Repatriation rate coefficient (as determined in the table).

These formulas provide a quantitative approach to understanding the impact of population dynamics and external factors on emigration and repatriation rates in the context of Ukrainian economic development.

As you can see, the model is incomplete and lacks many variables from the original model. However, let's model the best case scenario. The projection time is one year, but given the current rapid changes, weekly modeling would be more appropriate.

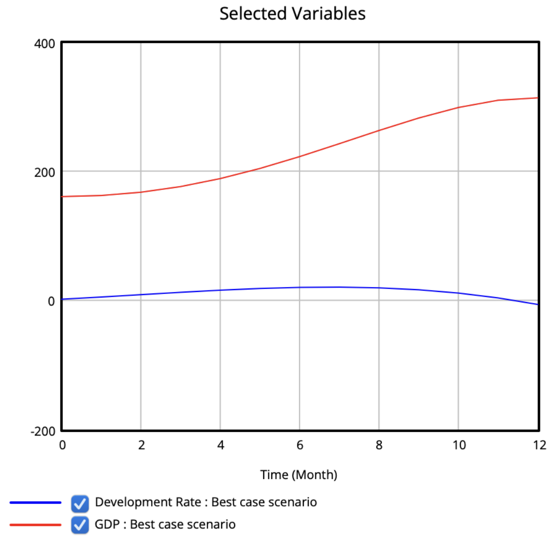


Figure 2.25 – GDP graph in base case scenario

Source: compiled by the author based on his own research

GDP growth is used as an indicator of policy success. The model shows GDP growth, but potential dips can occur due to the model not accounting for financial aid. Financial aids respond to such downturns, mitigating unwanted declines.

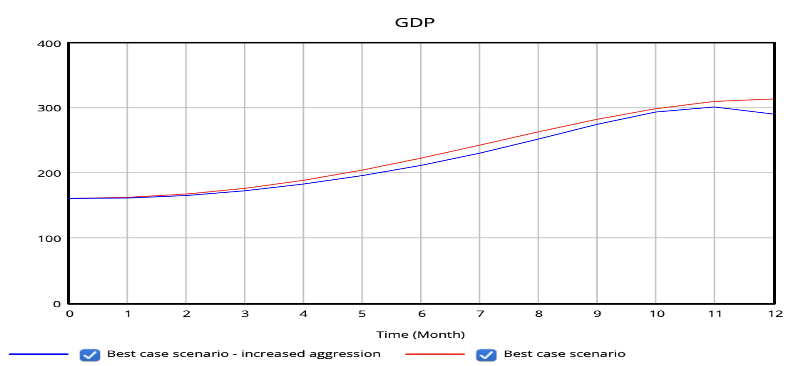


Figure 2.26 – GDP graph in base case scenario and with increased Russian aggression

Source: compiled by the author based on her own research

After increasing the variable "Russian Aggression" by 0.05 percent, we see that the GDP initially does not react dramatically. However, long-term effects show a GDP decline towards the end of the year.

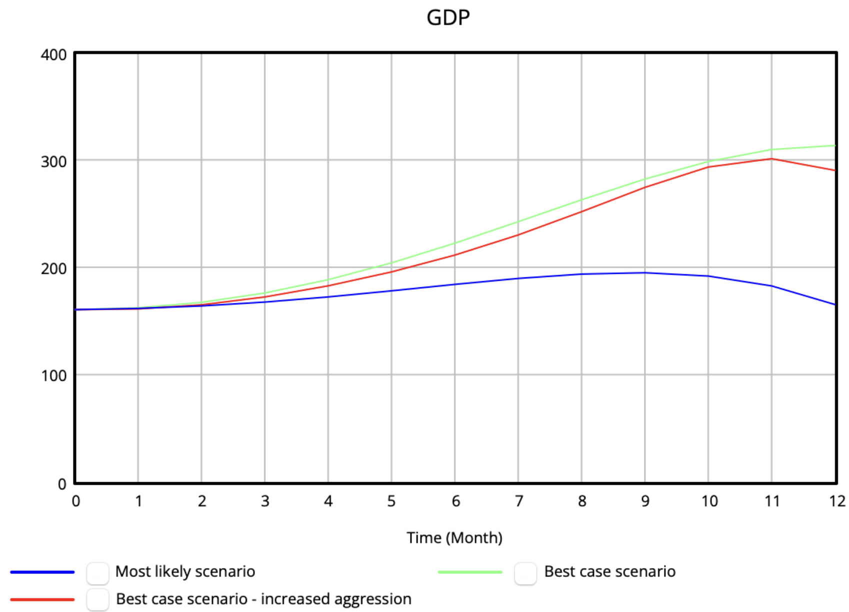


Figure 2.27 – GDP graph in base case scenario and most likely scenario

Source: compiled by the author based on her own research

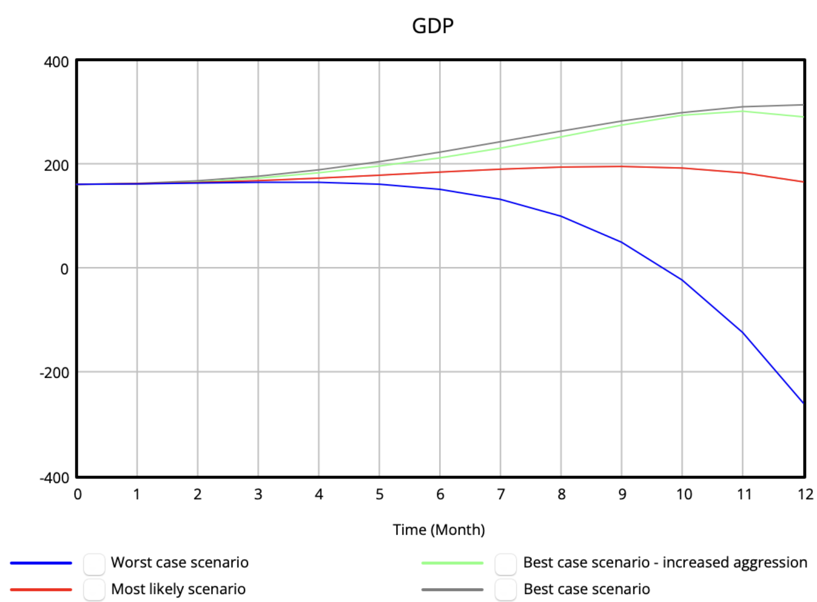


Figure 2.28 – GDP graph in base case scenario, most likely scenario, and worst case scenario

Source: compiled by the author based on her own research

Most Likely Scenario: Reflects moderate outcomes with balanced energy policy effectiveness and Russian aggression.

Worst Case Scenario: Depicts a dramatic negative impact with high Russian aggression and low energy production capacity.

From the analysis, it is evident that international support is crucial for the Ukrainian economy. The best case scenario underscores the importance of effective energy policies and low levels of Russian aggression. Conversely, the worst case scenario highlights the severe impacts of high Russian aggression and low energy production capacity. Therefore, it is imperative to focus on enhancing energy policies, securing international support, and improving energy production and efficiency to stabilize and grow the Ukrainian economy.

The ongoing conflict in Ukraine has placed unprecedented stress on its energy infrastructure, necessitating urgent and strategic measures to ensure energy security, reduce demand, and enhance self-sufficiency. Drawing from the key policies proposed by Michael G. Pollitt of the Energy Policy Research Group at the Judge Business School, University of Cambridge, this conclusion outlines a comprehensive approach for Ukraine to navigate its current energy challenges.

Wartime Policy 1: General Energy Demand Reduction

The lack of gas supply for heating and electricity underscores the need for a significant demand reduction program. This should be achieved through monitoring, incentives, and strict limitations on the use of electricity and gas for non-essential services. Specific measures include:

1. Temperature Regulation in Buildings: Commercial buildings and government offices should maintain lower winter temperatures and higher air conditioning settings during summer compared to previous years.

2. Energy Conservation Practices: Implement bans on open doors in commercial buildings during winter and encourage buildings to go dark at night. The target should be a 15% reduction in weather-corrected demand.

3. Incentivizing Reduced Consumption: Offer incentives to households and businesses that successfully reduce their energy consumption, leveraging high energy prices as a natural deterrent to excessive use.

Wartime Policy 2: Targeted Gas Demand Reduction

Given the critical importance of gas, it is essential to focus specifically on reducing gas demand. Strategies include:

1. Energy-Intensive Industry Adjustments: Discourage the protection of energy-intensive industrial output when goods can be imported from countries with cheaper energy prices.

2. Optimizing Energy Use Based on Renewable Availability: Encourage energy use during periods of high wind and solar energy generation, and discourage it on low renewable output days.

3. Household Energy Management: Promote the use and charging of household devices during peak renewable energy times.

Wartime Policy 3: 'Dig for Victory' in Energy

Accelerated investment in energy production and efficiency is crucial. A 'dig for victory' approach involves:

1. Promoting Solar PV Installation: Encourage the installation of photovoltaic (PV) panels on private homes and commercial buildings. The historical peak of 57,000 installations in a month (November 2011) demonstrates the feasibility of large-scale solar adoption.

2. Energy Efficiency Programs: Revitalize programs providing energy efficiency advice and interventions, aiming to match or exceed past peak installations of 825,000 measures annually.

3. Efficient Public Space Utilization: Encourage the efficient use of public spaces for heating, turn off unused devices, and reduce heating in unoccupied rooms.

4. Streamlining Local Energy Schemes: Local authorities should expedite planning permissions for local energy projects, removing bureaucratic hurdles.

Wartime Policy 4: Fair Pricing in Wartime

A fair pricing scheme is essential to encourage energy saving while ensuring affordability. This can be achieved through:

1. Rising Block Tariff: Implement a rising block tariff with a rebate system, where each household and business receives a low-price energy allocation with sharply rising prices for consumption beyond the allocated amount.

2. Encouraging Reduced Consumption: Combine the tariff scheme with rewards for reducing energy consumption compared to the previous year, excluding vulnerable customers from assumed reductions.

3. Equitable Allocation: Ensure the low-price allocation includes a significant assumed reduction in demand relative to the previous year, fostering equitable and sustainable energy use [66][67].

Ukraine has successfully significantly lowered the amounts of energy consumed. Furthermore, with support of European partners Ukraine discovers alternative energy sources such as biomethane and bioethanol and tries to maximize profits by storing natural gas [68] [69].

In addition to demand reduction and efficiency, exploring alternative energy sources is vital for Ukraine's energy security. Notable options include:

1. Small Modular Reactors (SMRs): SMRs looks like an interesting alternative to large nuclear reactors that can improve energy efficiency. There are some ongoing European projects like TANDEM and ELSMOR aim to address these issues, presenting a possible long-term solution for Ukraine [70].

However, seemingly interesting alternative looks like a bad fit for Ukraine. According to the Institute for Energy Economics and Financial Analysis small modular reactors. A key tenet for SMR proponents is that the new reactors will be economically competitive. But the on-the-ground experience with the initial SMRs that have been built or that are currently under construction shows that this simply is not true. A second tenet for SMR backers is that the reactors can be built quickly—in sharp contrast to recent history with larger units. But just as with the cost claims, the rhetoric here does not match reality. Southern Company, Georgia Power’s parent, just wrapped up what even its executives acknowledged was an “arduous journey” to complete construction at the two-unit expansion of its Vogtle nuclear plant, with commercial operation at Unit 4 beginning in April (Unit 3 began operations in July 2023) [71].

2. Biomethane Production: Biomethane production is a promising alternative for Ukraine. With European support, Ukraine is investing in biomethane and bioethanol production, reducing dependence on traditional gas supplies and enhancing self-sufficiency at the household level.

Promoting self-sufficiency at the household level is key to Ukraine's energy strategy. Ukrainian citizens have shown readiness to adopt sustainable energy practices. Encouraging the development and use of biomethane production can significantly bolster Ukraine’s energy security. Households equipped with biomethane systems can generate their own energy, reducing the overall demand on national supplies and contributing to a more resilient energy system.

In conclusion, Ukraine's wartime energy policy should focus on a multi-faceted approach: reducing demand, promoting energy efficiency, and investing in alternative energy sources. Implementing targeted demand reduction measures, encouraging energy-efficient practices, and exploring innovative solutions like SMRs and biomethane production are essential steps. Achieving self-sufficiency at the household level is critical, and Ukrainian citizens have demonstrated their willingness to adopt sustainable energy solutions. These strategies will not only address the immediate energy crisis but also pave the way for a more sustainable and secure energy future for Ukraine.

CONCLUSION

In conclusion, understanding and implementing an effective energy policy is critical for Ukraine's economic development, national security, and environmental sustainability. The analysis presented in this thesis demonstrates that energy policy in Ukraine must be adaptive, comprehensive, and responsive to the rapid changes in technology, market dynamics, and geopolitical landscapes.

Ukraine's energy policy must address the immediate needs of energy production and distribution while aligning with broader societal objectives such as sustainability, equity, and long-term environmental protection. The ongoing conflict with Russia and its impact on Ukraine's energy infrastructure necessitate a focus on enhancing energy security and resilience. This includes diversifying energy sources, improving energy efficiency, and fostering the adoption of renewable energy to reduce dependence on external energy supplies and mitigate environmental impacts.

Lessons learned from the energy policies of developed countries, such as Japan's focus on renewable energy, Germany's energy transition strategy, and Canada’s regulatory frameworks, provide valuable insights for Ukraine. These examples highlight the importance of strategic investments, robust regulatory frameworks, and the integration of modern technologies in achieving a resilient and sustainable energy sector.

Furthermore, the analysis underscores the critical role of international support in Ukraine's energy policy. International partnerships and financial aid can provide the necessary resources and technical expertise to rebuild and modernize Ukraine's energy infrastructure. The synchronization of Ukraine's energy system with the European grid and alignment with EU energy regulations are significant steps towards achieving energy security and integration with the European energy market.

Additionally, promoting the self-sufficiency of households is crucial in enhancing energy resilience. Encouraging the adoption of small-scale renewable energy systems, such as solar panels and home batteries, can reduce household dependence on the national grid and increase energy security at the grassroots level. This approach not only empowers individual households but also contributes to the overall stability and sustainability of the energy sector.

Ukraine faces challenges that none of the European countries were fully prepared for, including large-scale destruction of energy infrastructure due to military actions. The resilience shown by Ukraine in maintaining energy supplies and continuing to develop energy policies under these conditions is commendable. However, more can be done to strengthen this resilience. The circumstances are challenging and require a fast and adaptive system with responsive policies that can swiftly address emerging issues and leverage opportunities for improvement.

By implementing a comprehensive and adaptive energy policy, Ukraine can enhance its energy security, support economic growth, and contribute to global efforts to combat climate change. This requires a multifaceted approach that includes strong government commitment, strategic investments in renewable energy, improvements in energy efficiency, and the development of resilient energy infrastructure.

Ultimately, a meticulously crafted energy policy is essential for Ukraine to navigate its current challenges and build a sustainable and secure energy future. The insights and strategies discussed in this thesis provide a roadmap for policymakers to develop and implement energy policies that will contribute significantly to Ukraine's economic development, national security, and environmental stewardship.

REFERENCES

1. Owen, A. D. (n.d.). Energy Policy. School of Economics, University of New South Wales, Australia. ©Encyclopedia of Life Support Systems (EOLSS). URL: https://www.eolss.net/sample-chapters/C08/E3-21.pdf

2. Tosun, J. (2017). Energy Policy. Oxford Research Encyclopedia. Published online: 29 March 2017. URL: https://oxfordre.com/politics/display/10.1093/acrefore/9780190228637.001.0001/acrefore-9780190228637-e-174#acrefore-9780190228637-e-174

3. Ozcan, M. S. O. (2023). Analyzing Energy Crises and the Impact of Country Policies on the World. IGI Global. URL: https://www.igi-global.com/book/analyzing-energy-crises-impact-country/322404

4. The Canadian Encyclopedia. (n.d.). Energy Policy. URL: https://www.thecanadianencyclopedia.ca/en/article/energy-policy

5. European Parliament. (2015). Energy Policy: General Principles. URL: https://www.europarl.europa.eu/factsheets/en/sheet/68/energy-policy-general-principles

6. Government of South Africa. (n.d.). Industrial Energy Management Training Course, Module 4, "Developing an Energy Policy". URL: https://www.energy.gov.za/EEE/Projects/Industrial%20Energy%20Management/IEM%20Training/Modules/IEMTCModule4_final.pdf

7. OLADE. (2016). Energy Policy: A Practical Guidebook. September 2016; Authors: Victorio Oxilia and Gerardo Blanco. ESENERG - Energy Strategies for Sustainable Development. URL: https://biblioteca.olade.org/opac-tmpl/Documentos/old0359.pdf

8. Stanford Energy. (n.d.). Fast Facts about Energy Policy. URL: https://understand-energy.stanford.edu/tools/energy-policy#:~:text=Tax%20credits%2C%20direct%20spending%2C%20and,for%20damages%20from%20climate%20change

9. Jollands, N., Heffner, G., Pasquier, S., Saussay, A., Ürge-Vorsatz, D., Harutyunyan, N., de Buen, O. (2010). Energy Efficiency Governance. International Energy Agency OECD/IEA. URL: https://www.researchgate.net/publication/264083653_Energy_Efficiency_Governance

10. Das, A., Datta Peu, S., Akanda, M. A. M., Towfiqul Islam, A. R. M. (2023). Peer-to-Peer Energy Trading Pricing Mechanisms: Towards a Comprehensive Analysis of Energy and Network Service Pricing (NSP) Mechanisms to Get Sustainable Enviro-Economical Energy Sector. URL: https://www.mdpi.com/1996-1073/16/5/2198

11. Mulder, M. (n.d.). Regulation of Energy Markets Economic Mechanisms and Policy Evaluation, Second edition, pp. 85-90.

12. Taylor, C. M., Gallagher, E. A., Pollard, S. J. T., Rocks, S. A., Smith, H. M., Leinster, P., Angus, A. J. (2019). Environmental regulation in transition: Policy officials' views of regulatory instruments and their mapping to environmental risks. Science of The Total Environment, 646, pp. 811-820. URL: https://www.sciencedirect.com/science/article/pii/S0048969718327086#bb0030

13. U.S. Energy Information Administration. (2023). International Energy Statistics; Vortexa. URL: https://www.eia.gov/international/data/world

14. Agency for Natural Resources and Energy. (2021). Japan's Energy: 10 Questions for Understanding the Current Energy Situation. URL: https://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2021.pdf

15. IEA. (2021). Japan 2021-Energy Policy Review. URL: https://iea.blob.core.windows.net/assets/3470b395-cfdd-44a9-9184-0537cf069c3d/Japan2021_EnergyPolicyReview.pdf

16. Padoba, Z. S. (2021). Energy Strategy and Transition to Green Energy in Japan. Russian Japanology Review, 2, pp. 29-53. URL: https://cyberleninka.ru/article/n/energy-strategy-and-transition-to-green-energy-in-japan/viewer

17. Agency for Natural Resources and Energy of Japan. (2021). 6th Strategic Energy Plan. URL: https://www.enecho.meti.go.jp/category/others/basic_plan/pdf/strategic_energy_plan.pdf

18. Aldrich, D. P. (2013). Rethinking Civil Society–State Relations in Japan after the Fukushima Accident. Polity, 45(2), pp. 249-264. URL: https://www.jstor.org/stable/24540207

19. Hughes, L. (2020). The Oxford Handbook of Japanese Politics. URL: https://books.google.com/books?hl=uk&lr=&id=wRpREAAAQBAJ&oi=fnd&pg=PA377&dq=japan+energy+policy&ots=115B6N3VXq&sig=UcmE3iT8eY1iSHh3416f1GjpylY#v=onepage&q=japan%20energy%20policy&f=false

20. Tanaka, K., Sekito, M., Managi, S., Kaneko, S., Rai, V. (2017). Decision-making governance for purchases of solar photovoltaic systems in Japan. Energy Policy, 111, pp. 75-84. URL: https://www.sciencedirect.com/science/article/pii/S0048969718327086#bb0030

21. IEA. (2023). Policy on Initiatives for Ensuring Stable Supply of Critical Minerals. URL: https://www.iea.org/policies/18004-policy-on-initiatives-for-ensuring-stable-supply-of-critical-minerals

22. IEA. (2023). CCS Long-Term Roadmap. URL: https://www.iea.org/policies/17537-ccs-long-term-roadmap

23. IEA. (2023). Amendment to the Energy Conservation Act. URL: https://www.iea.org/policies/17441-amendment-to-the-energy-conservation-act

24. IEA. (2023). Japan-Indonesia Cooperation Agreement on Decarbonization Technologies. URL: https://www.iea.org/policies/14737-japan-indonesia-cooperation-agreement-on-decarbonization-technologies

25. IEA. (2022). Canada 2022 Energy Policy Review. URL: https://iea.blob.core.windows.net/assets/7ec2467c-78b4-4c0c-a966-a42b8861ec5a/Canada2022.pdf

26. Scarfe, B. L. (1981). Fed Budget Energy Review. Canadian Public Policy / Analyse de Politiques, 7(1), pp. 1-14. URL: https://www.jstor.org/stable/3549850

27. Trefler, D. (2004). The Long and Short of the Canada-U.S. Free Trade Agreement. The American Economic Review, 94(4), pp. 870-895. URL: https://www.proquest.com/docview/233029034?parentSessionId=ZL9TehsW6lbC6vdjOD2sT6Gby0KX6eW4COgtQ0hL328%3D&pq-origsite=primo&accountid=7118&sourcetype=Scholarly%20Journals

28. Schwanen, D. (2000). Tackling Canada's Commitments on Greenhouse Gas Emissions. URL: https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed//sch-08.pdf

29. Doern, G. B., Maslove, A. M., Prince, M. J. (2013). Canadian public budgeting in the age of crises: Shifting budgetary domains and temporal budgeting. URL: https://www.researchgate.net/publication/287299025_Canadian_public_budgeting_in_the_age_of_crises_Shifting_budgetary_domains_and_temporal_budgeting

30. IEA. (n.d.). Pan-Canadian Framework on Clean Growth and Climate Change. URL: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html

31. PBS. (2023). Energy Switch - EU Energy and Climate Policy Part 1. URL: https://www.pbs.org/video/eu-energy-and-climate-policy-part-1-j8bejr/

32. PBS. (2023). Energy Switch - EU Energy and Climate Policy Part 2. URL: https://www.pbs.org/video/eu-energy-and-climate-policy-part-2-uccqf7/

33. Dekanozishvili, M. (2023). Dynamics of EU Renewable Energy Policy Integration. URL: https://link-springer-com.ezproxy.lib.utexas.edu/book/10.1007/978-3-031-20593-4

34. Hancher, L., de Hauteclocque, A., Huhta, K., Sadowska, M. (2022). Capacity Mechanisms in the EU Energy Markets: Law, Policy, and Economics (2nd edn). URL: https://academic.oup.com/book/45365?login=true

35. European Commission. (2022). Communication from the commission to the european parliament, the european council, the council, the european economic and social committee and the committee of the regions REPowerEU Plan. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483

36. IEA. (n.d.). Europe Region Overview. URL: https://www.iea.org/regions/europe

37. IEA. (2021). France 2021-Energy Policy Review. URL: https://iea.blob.core.windows.net/assets/7b3b4b9d-6db3-4dcf-a0a5-a9993d7dd1d6/France2021.pdf

38. European Commission. (2023). COMMISSION STAFF WORKING DOCUMENT Assessment of the draft updated National Energy and Climate Plan of France. Brussels, 18.12.2023. URL: https://commission.europa.eu/document/download/08c3a6d0-fe0c-4acc-a828-7bde5b309577_en?filename=SWD_Assessment_draft_updated_NECP_France_2023.pdf

39. European Commission. (2023). France's Draft Updated National Energy and Climate Plan. URL: https://commission.europa.eu/document/download/3bf413ba-0125-4314-b999-2f3121b07292_en?filename=Factsheet_Commissions_assessment_NECP_France_2023.pdf

40. IEA. (2023). Italy 2023-Energy Policy Review. URL: https://iea.blob.core.windows.net/assets/71b328b3-3e5b-4c04-8a22-3ead575b3a9a/Italy_2023_EnergyPolicyReview.pdf

41. European Commission. (2023). COMMISSION STAFF WORKING DOCUMENT Assessment of the draft updated National Energy and Climate Plan of Italy. Brussels, 18.12.2023. URL: https://commission.europa.eu/document/download/48b5cf3e-36b8-421e-b142-e5ff3b278c8d_en?filename=SWD_Assessment_draft_updated_NECP_Italy_2023.pdf

42. European Commission. (2023). Italy's Draft Updated National Energy and Climate Plan. URL: https://commission.europa.eu/document/download/1bc05587-1cac-4334-b7af-090fd658b217_en?filename=Factsheet_Commissions_assessment_NECP_Italy_2023.pdf

43. IEA. (2020). Germany 2020-Energy Policy Review. URL: https://iea.blob.core.windows.net/assets/60434f12-7891-4469-b3e4-1e82ff898212/Germany_2020_Energy_Policy_Review.pdf

44. European Commission. (2023). COMMISSION STAFF WORKING DOCUMENT Assessment of the draft updated National Energy and Climate Plan of Germany. Brussels, 18.12.2023. URL: https://commission.europa.eu/document/download/8bc322cc-f9b3-466d-99f7-ef201a8a3d1c_en?filename=SWD_Assessment_draft_updated_NECP_Germany_2023.pdf

45. European Commission. (2023). Germany's Draft Updated National Energy and Climate Plan. URL: https://commission.europa.eu/document/download/b7b669bc-47bd-4b89-8074-650938085217_en?filename=Factsheet_Commissions_assessment_NECP_Germany_2023.pdf

46. Ministry of Energy of Ukraine. (n.d.). History of Energy. URL: https://mev.gov.ua/storinka/istoriya-enerhetyky

47. Prokip, A. (2024). The State of Ukraine's Energy Sector after Ten Years of War. URL: https://www.wilsoncenter.org/blog-post/state-ukraines-energy-sector-after-ten-years-war

48. IEA. (n.d.). Ukraine Energy Profile. URL: https://iea.blob.core.windows.net/assets/ac51678f-5069-4495-9551-87040cb0c99d/UkraineEnergyProfile.pdf

49. Naftogaz. (2019). Sky-High Stakes / Stockholm Arbitration: What Naftogaz Gained and Gazprom Lost. URL: https://biz.nv.ua/ukr/sky-high-stakes-stockholm-arbitration-what-naftogaz-gained-and-gazprom-lost-50015765.html

50. OECD. (n.d.). Energy Investment Policy Review of Ukraine - Energy Infrastructure in Ukraine. URL: https://www.oecd-ilibrary.org/sites/0eafbf43-en/index.html?itemId=/content/component/0eafbf43-en

51. Ministry of Energy of Ukraine. (n.d.). Energy Front. URL: https://www.mev.gov.ua/reforma/enerhetychnyy-front

52. IEA. (n.d.). Ukraine Country Overview. URL: https://www.iea.org/countries/ukraine

53. Dreves, H., Fall, S., McCan, I. (2023). Ukraine Fights To Build More Resilient, Renewable Energy System in Midst of War. URL: https://www.nrel.gov/news/features/2023/ukraine-fights-to-build-a-more-resilient-renewable-energy-system-in-the-midst-of-war.html

54. Ministry of Energy of Ukraine. (n.d.). Energy Strategy. URL: https://www.mev.gov.ua/reforma/enerhetychna-stratehiya

55. European Commission. (2023). Ukraine 2023 Report. Brussels, 8.11.2023. URL: https://neighbourhood-enlargement.ec.europa.eu/system/files/2023-11/SWD_2023_699%20Ukraine%20report.pdf

56. Laimon, M., Yusaf, T., Mai, T., Goh, S., Alrefae, W. (2022). A systems thinking approach to address sustainability challenges to the energy sector. URL: https://research.usq.edu.au/download/da273eb16fcc5913e6cc4bd2053bada4a42ad84d3a6b3682bfe6dd90b25410dc/2061156/Laimon%20at%20al%202022.pdf

57. Laimon, M., Mai, T., Goh, S., Yusaf, T. (2019). Energy Sector Development: System Dynamics Analysis. URL: https://www.mdpi.com/2076-3417/10/1/134#B1-applsci-10-00134

58. Ministry of Internal Affairs of Ukraine. (2022). Zaporizhzhya NPP: Occupiers Capture, Nuclear Terrorism. URL: https://mvs.gov.ua/news/zaporizka-aes-zaxoplennia-okupantami-iadernii-terorizm

59. Ministry of Energy of Ukraine. (n.d.). Integration into the European ENTSO-E Power Grid. URL: https://mev.gov.ua/reforma/intehratsiya-u-yevropeysku-elektromerezhu-entso-e

60. Ministry of Energy of Ukraine. (2023). Preparation for Winter: Of the Planned 1.7 GW of Additional Capacity, 1.5 GW Have Already Been Added to the Power System. URL: https://www.kmu.gov.ua/news/pidhotovka-do-zymy-iz-zaplanovanykh-17-hvt-dodatkovykh-potuzhnostei-v-enerhosystemu-vzhe-dodani-15-hvt

61. Naftogaz. (n.d.). Natural Gas Storage. URL: https://www.naftogaz.com/business/natural-gas-storage-business-unit

62. UNDP. (2023). Energy Damage Assessment for Ukraine Reveals Continued Vulnerabilities. URL: https://www.undp.org/uk/ukraine/press-releases/otsinka-zbytkiv-u-sferi-enerhetyky-svidchyt-pro-zberezhennya-vrazlyvosti-yiyi-enerhosektoru-zvit-proon

63. Office of Deputy Prime Minister for European and Euro-Atlantic Integration of Ukraine. (2020). Ukraine's Participation in the European Green Deal. URL: https://mon.gov.ua/storage/app/media/nauka/2020/European%20Green%20Deal/Informatsiyni%20materialy/ukraines-participation-in-the-european-green-dealcompressed.pdf

64. State Statistics Service of Ukraine. (2022). Population Data. URL: https://www.ukrstat.gov.ua/

65. Global Data Institute. (2023). Ukraine: Report on Returns to Ukraine - General Population Survey 14 (September 3 - 25, 2023). URL: https://dtm.iom.int/reports/ukraina-zvit-pro-povernennya-v-ukraini-opituvannya-zagalnogo-naselennya-14-3-25-veresnya

66. Pollitt, M. G. (2022). UK Energy Policy in Time of War. Energy Policy Research Group, Judge Business School, University of Cambridge. EPRG Winter Seminar Cambridge. URL: https://www.eprg.group.cam.ac.uk/wp-content/uploads/2023/01/PollittEPRGWinterSeminar.pdf

67. Pollitt, M. G. (2022). The Energy Market in Time of War. Centre on Regulation in Europe, Brussels and Energy Policy Research Group, University of Cambridge. URL:

https://cerre.eu/wp-content/uploads/2022/09/The-War-Economy-and-Energy-CERRE_edited-TC_2AM-PDF.pdf

68. Naftogaz Ukraine. (2024). ENG | The First Ukraine Biomethane Forum. URL: https://www.youtube.com/watch?v=_nsSNzeS-xQ

69. Government of Ukraine. (n.d.). Energy Independence - The Government Priorities. URL: https://www.kmu.gov.ua/en/the-government-priorities/energy-independence

70. Begun, V., Hashymov, A. (2023). Construction of Small Modular Reactors in Ukraine - Prospects and Challenges. Inudeco. URL: https://drive.google.com/file/d/1VVL5JZWUz0xa9OZObT5s4u2QzXXND3G9/view

71. Schlissel, D., Wamsted, D. (2024). Small Modular Reactors: Still Too Expensive, Too Slow and Too Risky. Institute for Energy Economics and Financial Analysis. URL: https://ieefa.org/sites/default/files/2024-05/SMRs%20Still%20Too%20Expensive%20Too%20Slow%20Too%20Risky_May%202024.pdf

72. State Statistics Service of Ukraine. (2021). Emigration/Immigration Data. URL: https://www.ukrstat.gov.ua/

73. Energies. (2023). Peer-to-Peer Energy Trading Pricing Mechanisms: Towards a Comprehensive Analysis of Energy and Network Service Pricing (NSP) Mechanisms to Get Sustainable Enviro-Economical Energy Sector. URL: https://doi.org/10.3390/en16052198

APPENDIX

Appendix A

Figure A.1 Overview of Japan's energy system by fuel and sector, 2019 [25]

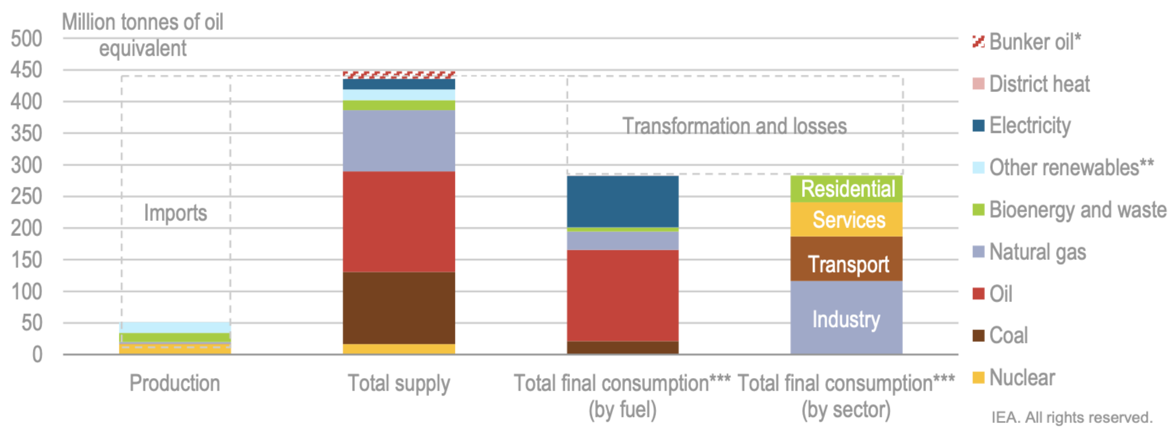
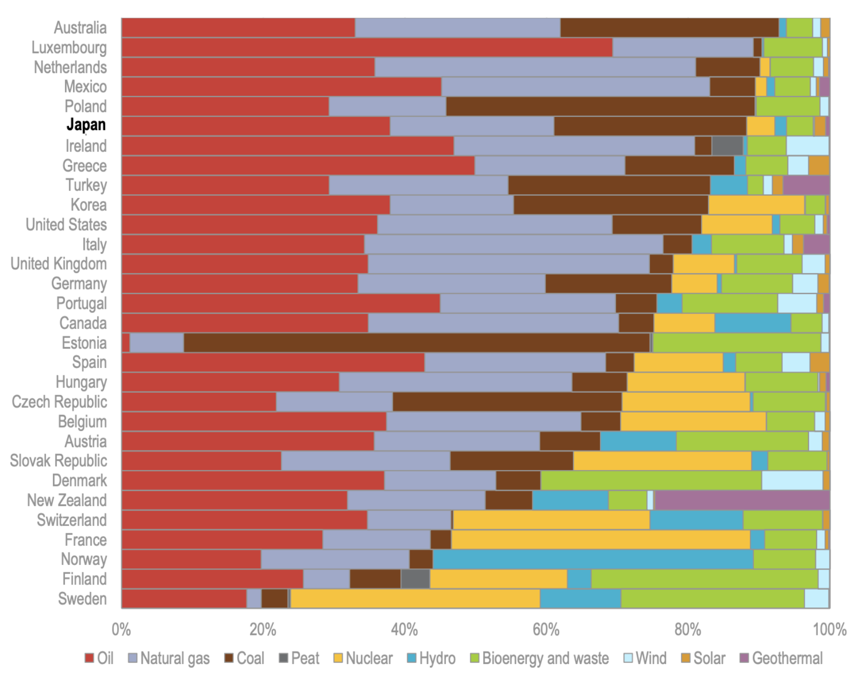


Figure A.2 Breakdown of total primary energy supply in IEA member countries, 2019 [25]



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