Energy Transition and the Post-Covid-19 Socioeconomic Recovery: Role of Women and Impact on Them

Kankana Dubey
UNECE Consultant

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Acronyms and Abbreviations

ADB	Asian Development Bank
BECCUS	Bioenergy Carbon Capture, Utilization, and Storage
Belstat	National Statistical Committee of the Republic of Belarus
CCUS	Carbon Capture, Utilization, and Storage
CEO	Chief Executive Officer
CO2	Carbon Dioxide
COVID-19	Coronavirus Disease 2019
CPU	Central Processing Unit
CSR	Corporate Social Responsibility
DAC	Direct Air Capture
DRI	Direct Reduced Iron
EBRD	European Bank for Reconstruction and Development
EIGE	European Institute for Gender Equality
EU	European Union
EV	Electric Vehicle
FAO	Food and Agriculture Organization of the United Nations
FEEM	Fondazione Eni Enrico Mattei
gCO2	Grams of Carbon Dioxide
GBV	Gender Based Violence
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPU	Graphical Processing Unit
GWh	Gigawatt-hour
GWNET	Global Women's Network for the Energy Transition
ICT	Information Communication and Technology
IEA	International Energy Agency
IFC	International Finance Corporation
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
kJ	Kilojoules
kt	Kilotons
KTOE	Thousand Tonnes of Oil Equivalent
kWh	Kilowatt-hour
LCE	Low-Carbon Energy
LED	Light Emitting Diode
MJ	Megajoules
MSME	Micro-, Small-, and Medium Enterprise
Mt	Megatonnes
MTOE	Million Tonnes of Oil Equivalent
MW	Megawatt
NDC	Nationally Determined Contribution
NECP	National Energy and Climate Plan
OECD	Organisation for Economic Co-operation and Development
OFGEM	Office of Gas and Electricity Markets
PPA	Power Purchasing Agreement
PV	Photovoltaic
PwC	PricewaterhouseCoopers, LLP

RAC	Refrigeration and air-conditioning
R&D	Research and Development
RIIO	Revenue = Incentives + Innovation + Output
SDG	Sustainable Development Goal
SDSN	Sustainable Development and Solutions Network
SME	Small- and Medium Enterprise
STEM	Science, Technology, Engineering, and Mathematics
TJ	Terajoules
TRL	Technology Readiness Level
TWh	Terawatt-hour
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
WEF	World Economic Forum
WGEO	World Green Energy Organization

Executive Summary

There are several pathways through which energy systems are transitioning to a decarbonized, sustainable economy primarily supported by six broad technology types: zero-carbon electricity generation, electrification of end-use, alternative fuels, smart power grids, materials efficiency, and sustainable land use. Development and implementation of these technologies are being driven by innovation in a wide variety of technologies, from digitalisation, to building energy efficiency, to direct air capture. While much of the world was focused on making this transition, the COVID-19 pandemic hit the world suddenly and unexpectedly. As the global economy slid into a lockdown, the sustainable energy transition lost importance temporarily. Now that most economies are emerging, governments are focused on driving a sustainable socioeconomic recovery from the COVID-19 pandemic, but there is an endemic issue which must be addressed.

The energy sector is missing out on the experiences, skills, and talents of much of half the human population, which severely constrains the sustainable energy transition. In addition to a larger skilled workforce, there are several advantages in bridging the gender gap within the energy sector. Gender disparities in the energy sector have been observed around the world. Women are less represented in policymaking, corporate leadership and governance, as entrepreneurs and venture capitalists, and in the labour workforce. Indeed, as it relates to employment, the energy sector is the least gender diverse. While predominantly embedded in the traditionally male-dominated energy sector, opportunities for women abound throughout all these areas. For example, firms with greater female board representation experienced significantly fewer environmental lawsuits. Firms with a female CEO were significantly associated with fewer environmental lawsuits, and firms led by a male CEO with a gender-diverse board also had fewer cases of environmental misconduct. The benefits of increasing gender diversity extend beyond the corporate world, and into politics. There is some evidence that the participation of women improves political decision-making processes, as women work more effectively across party lines.

Many of the opportunities in the transitioning energy sector rely on professional education qualifications - such as education, business administration, and law – which many women already hold, and can transfer from other industries. Studies have identified several possible reasons why women tend not to participate in the energy sector. These include women's own perceptions of the industry, insufficient access to information, finance, and training, corporate human resources practices, and cultural biases and norms about gender roles. These barriers are surmountable using a two-way complementary approach, which is simultaneously bottom-up - action by women and society to bridge the gap of gender inequality in the energy sector – and top-down – government and policymakers need to develop policy tools to encourage women's participation in the energy sector.

Founded on empirical case studies of five United Nations Economic Commission for Europe (UNECE) member States, the following are recommendations for priority actions that countries and firms can take to encourage the participation of women in the energy sector to drive a sustainable socioeconomic recovery from the COVID-19 pandemic.

Recommendations

Recommendation a: **Adoption of a low-carbon energy pathway**: This will drive countries towards a structural economic shift by driving technological innovation, creating jobs, and developing opportunities to build a greener and sustainable economy.

Recommendation b: **Invest in technological development**: The development of national policy instruments across economies - including public investments, phased elimination of fossil fuel subsidies, market mechanisms, and regulatory frameworks - is imperative, and goes hand-in-hand with the development and implementation of technological solutions.

Recommendation c: **Promote change in demand-side**: Awareness-raising on energy efficiency and automation technologies can help decrease power demand; developing regulations and guidance can support changes in consumption patterns.

Recommendation d: **Challenge social and cultural perception**: Empower women by helping them develop skills to build confidence to address cultural norms that may discourage them from participating in sectors like energy.

Recommendation e: **Information and data collection**: There is a need for collection, monitoring, evaluation, and publication of data regarding the participation of women in the energy sector. Analysing such data can help in promoting policies and monitoring trends in the gender gap.

Recommendation f: **Ensure national energy security**: Transitioning towards sustainable energy can create direct and indirect job opportunities in the energy sector and develop opportunities for building new supply chains. This transition can create opportunities for investment, entrepreneurial activities, and the development of a skilled workforce. There may also be significant potential in building local supply chains.

Recommendation g: **Non-discrimination in property rights and access to finance**: Ensure there is no gender-based discrimination in property rights and access to finance.

Recommendation h: **Networking and mentoring**: Promote mentorship platforms to preferentially encourage women professionals and subject matter experts from the energy sector to support connections among the female workforce through networking.

Recommendation i: **Capacity development**: Provide opportunities for women to access training and education programmes that improve entrepreneurship and technical skills; this will increase their opportunities for participation in the energy sector and its subsectors.

Recommendation j: **Green economic recovery**: Financial investments in the energy sector, supporting innovation, green growth, and sustainable development, can create multiple opportunities for women to participate in "build back better" and promote low-carbon solutions during the socioeconomic recovery from the COVID-19 pandemic.

Recommendation k: **Capacity building through upskilling the current workforce**: Provide access to training to improve current skillsets; this can help in career development and future opportunities.

Recommendation l: **Review gender diversity gaps**: Assess human resources policies to review the gender gap and analyse best practices adopted by other industries and organizations.

Recommendation m: **Promote networking and mentoring**: Promote networking group platforms for women within the organization and across industry. A mentorship program can be beneficial for new entrants.

Introduction

Objective

The COVID-19 pandemic hit the world suddenly and unexpectedly, at a time when transitioning the global energy system to sustainability was at the forefront of many countries' energy policies. As the global economy slid into a lockdown, the green economy lost importance temporarily. Now that most economies are emerging, governments are developing policies to drive an economic recovery. Society now has the perfect opportunity to simultaneously recover into a greener, more sustainable economy, while creating new opportunities for building a more equal society.

Gender disparities in the energy sector have been observed around the world. Women are less represented in policymaking, corporate leadership and governance, as entrepreneurs and venture capitalists, in the labour workforce, and as consumers (decision makers). The energy sector is missing out on the experiences, skills, and talents of much of half the human population, which severely constrains the green energy transition.

The Albanian National Agency of Natural Resources (AKBN), the Department for Energy Efficiency of the State Standardization Committee of the Republic of Belarus, and the State Agency on Energy Efficiency and Energy Saving (SAEE) of Ukraine have requested the United Nations Economic Commission for Europe (UNECE) to conduct a study on the topic of the Energy transition and post-COVID-19 socioeconomic recovery, with a focus on the role of women and impact on them. This report focuses on this aspect of the energy transition and post-COVID-19 socioeconomic recovery.

Scope

This report's scope is multi-faceted, covering six major topics:

1. transitioning towards sustainable energy with gender equality and women's empowerment
2. overview of the developments in the energy sector; trends, developments, and innovation in the energy sector
3. assessing the impact of the COVID-19 pandemic on the energy sector, economy and social well-being. Impact on women
4. participation of women in the economy, and specifically in the energy sector
5. gender equality and diversity in the energy sector: opportunities and challenges
6. promoting women participation to ensure transition to sustainable energy and green post-Covid-19 economic recovery

These six topics are supported by case studies from five countries in the UNECE region: Albania, Belarus, Ukraine, the United Kingdom, and Uzbekistan. Recommendations are made for each country individually, and the report culminates in a set of recommendations that will be useful for UNECE member States in their decision-making.

Methodology

Compilation of this report entailed extensive desktop-based analysis of a variety of sources, including national policies, government-led programmes, the role of local and international institutions, financial mechanisms, the industrial climate, academic literature, published news articles, market-based reports, and public databases. The research was complemented with the inputs of national and international subject matter experts, who reviewed and provided feedback on the report and case studies.

Chapter 1 Transitioning Towards Sustainable Energy with Gender Equality

Energy is an underlying resource that interconnects every aspect of life; it is the most important component which drives the existence of our planet. In addition to renewable forms of energy, society currently requires fossil fuel-based energy to meet our needs. However, the drive to meet our collective insatiable needs and desires has caused immense damage to natural ecosystems, created challenging circumstances for the planet, and paradoxically threatened our own well-being.

Sustainable Energy to Build a Balanced Society / Build back better

While a complete transition away from fossil-based energy is not currently possible, there are various potential ways to mitigate the environmental damage and transform the world with a sustainable transition. Driven by the international climate change agenda and the Nationally Determined Contributions (NDCs), countries around the world are pursuing strategies to transition their energy systems away from fossil fuels. There is a wide diversity of strategies, as they are shaped by varied national strategic interests – especially those concerning economy, society, security, and sustainability. The goals of a sustainable energy system transition interlink with preservation of the natural environment, continuous economic progress, and social well-being - a just use of natural resources, human capital, and international cooperation. In fact, a sustainable energy transition can act as an enabler to achieve many of the United Nations Sustainable Development Goals (SDGs). In addition to the obvious environmental benefits, adopting a low-carbon approach for energy generation creates new pathways leading countries towards a structural economic shift by driving technological innovation, creating jobs, and developing opportunities to build a greener and sustainable economy. Moreover, a significant co-benefit of transiting towards a low-carbon or carbon-neutral energy system – a green sustainable economy – is that it creates new opportunities for building a more equal society. Perhaps the world's efforts to transition towards building a sustainable society can be achieved if countries can implement the 17 SDGs (Dubey, 2020, pp. 17-18).

Labour and Skills

Despite the many benefits expected, there are substantial risks threatening an effective sustainable transition. Institutions that enable a coherent approach to transitioning current economies to green economies are needed to create an enabling environment. Examples include institutions that enable enterprises to innovate, re-educate and upskill the labour force, and ensure that the green job concepts of decent work, social justice, and equal opportunity actually exist. Equality of opportunity is an especially important characteristic of the improved "human well-being and social equity" expected of a green and sustainable economy (ILO, 2017). Broad considerations of equity also include relative wages, working hours, the work environment, and even basic needs (clean water, food, shelter, hygiene); these considerations can highlight important differences between labour policies in developing and developed countries. Of particular importance is the availability of a skilled labour force that must be equipped to meet the challenges of the transition and the dynamics of changing production and consumption patterns. In part, this risk can be resolved by a combination of pivoting on existing skillsets towards newer skills and developing entirely new jobs. Substantial investment in education and training programmes will be needed to support existing and new workforce participants. Governments, social partners, and stakeholders must understand all these considerations, to ensure social equity concerns are addressed by providing access to relevant training and education, upgrading jobs and wages (based on skills and ability), and encouraging equality of gender participation (ILO, 2018). This latter point is especially true regarding the energy sector.

The IEA (2020b) report on energy and gender highlights the stark reality of the energy sector, as the "least gender diverse sector". Some of the key findings of the report indicate that women constitute 22% of the oil and gas and 32% of the renewable energy workforce. The gender gap varies across various sub-sectors of the energy industry, and has possibly slowed the sector's advancement, specifically in innovation and entrepreneurship. For example, the energy sector accounts for a low number of patent applications filed by women in association with innovations, whereas an increasing number of women are inventors in the life sciences and technology (IEA, 2020b). The challenge of the gender gap is discussed in more detail in chapter five.

Benefits of Increasing Women's Leadership in Energy

There are several advantages in bridging the gender gap within energy sector; including wider availability of the skilled labour workforce. Some academic studies suggest that women as corporate leaders may tend to be more balanced in their ambition vis-à-vis the environmental consequences. In a research study, C. Liu (2018) examined all environmental lawsuits filed (1,893 lawsuits against 221 firms) in the United States Federal Court system from 2000 to 2015, and drew on gender socialization theory, diversity theory, and the literature on overconfidence. The author determined that firms with greater female board representation experienced significantly fewer environmental lawsuits. Firms with a female Chief Executive Officer (CEO) were significantly associated with fewer environmental lawsuits, and firms led by a male CEO with a gender-diverse board also had fewer cases of environmental misconduct. The study attributed these observations to the claim that women are more concerned with the welfare of stakeholders, making them more likely to take action to pre-empt environmental risks that can harm communities.

There are several other areas where women can contribute immensely due to their diverse skills and knowledge. According to the policy brief on women's leadership published by the United Nations (C3E, 2017), the participation of women improves the political decision-making process, as women work across party lines to promote gender equality issues. A 2019 study regarding gender and climate (Mavisakalyan & Tarverdi, 2019) investigated the influence female parliamentarians held on climate change policy outcomes. The study determined that female representation was positively correlated with the adoption of more stringent climate change policies that resulted in reduced carbon emissions.

It has been suggested that women are intuitively more inclined towards protecting the environment, but there is limited data to support this claim. Perhaps it is their competency in managing resources, a result of the active role they play in ensuring the well-being of their households, and also considering their role in the agriculture sector. Women comprise almost half of the world's farmers (World Bank, 2017). In fact, the concept of Sustainable Development took centre stage based on the findings of the Bruntdland Commission in 1983, which was led by Gro Harlem Brundtland, a female former Prime Minister of Norway.

Socioeconomic Linkages and the Energy Transition

There are various energy transition strategies with varying impacts on which resources people will be able to use, how these resources can be used, and for what purposes. Transitioning towards a low-carbon and energy-efficient society will increasingly benefit women around the world; for example, they will be able to access better technology and renewable energy to change household consumption patterns. To give an illustrative example of socioeconomic linkages, consider women's role in the agriculture sector. Although agriculture is not an energy intensive sector, it does have an impact on natural and ecological resources such as water and forestry. Evolving agricultural practices, changing production methods by increasing resource efficiency, can lead to a structural transformation of the sector. Employment opportunities can be created in dependent and ancillary sectors. A potential

change in the agriculture sector can come from undertaking research and development of nutrients, development of innovative practices, reduction of waste, improvement of infrastructure, transportation, and storage systems, and enhancement of education. While highly dependent on unskilled labour, the sector is currently facing a shortage of skilled labour – reliant upon relatively basic education and training – required for sustainable agriculture (Cedefop, 2019). Particularly in developing countries, there are green job creation opportunities for farm field schools, adult literacy education, and other training programmes for women. With their knowledge, experience, and influence in the foundational agricultural sector, women are in a prime position to drive the transition to sustainability and a green economy; their lack of participation severely limits the possibility of development.

The transition of the global energy system is leading us towards an innovative future, offering an opportunity to transcend the current global economy in favour of a green and sustainable economy. Equal gender participation in this endeavour can help society leap to a future of technological advancement in the energy sector. It is disappointing to note that the participation of women continues to be low across the spectrum of the sector, from policymaking to the labour workforce.

Chapter 2 Overview: Developments in the Energy Sector

The current energy transition can be viewed as the fourth in a series of fundamental structural transformations in how energy is generated. V. Smil (2018, cited in Hafner & Tagliapietra, 2020) defines the first energy transition as the half-century between 1840 to 1890, which saw the shift from small-scale biomass combustion to large-scale combustion of coal. During this period, the share of coal in the energy mix grew from 5% to 50%. The second began almost two decades later and lasted for 60 years, as oil as a source of energy grew from 3% in 1915 to 45% by 1975. The third transformation, which began during the second transition around 1930 and lasted until 2017, saw natural gas being added into the energy mix and taking some of the shares of both coal and oil. As compared to our current transition away from fossil fuels, these were all fundamentally different, in that they were driven only by increasing economic efficiency. According to Smil, the fourth energy transformation began in 2017, with the increasing share of renewable energy (excluding hydropower) in total primary energy consumption. The rapid increase in the share of renewables can primarily be attributed to the need to counter global climate change and to achieve compulsory energy sector decarbonisation targets agreed nationally and internationally. Today, the energy transition is driven by a complex variety of drivers, primarily climate-focused geopolitical agendas and technological progress. The availability of new technologies is dramatically increasing the efficiency of the energy sector and evolving new pathways for economies to become energy efficient. This, in turn, is allowing countries to ensure the competitiveness of their national economies, boost development with affordable energy, and enhance energy security. The latter, of course, ties back into political agendas.

There is significant technological progress across the world in designing innovative solutions for decarbonising the energy generation system. The development of national policy instruments across economies - including public investments, phased elimination of fossil fuel subsidies, market mechanisms, and regulatory frameworks - are imperative and go hand-in-hand with the development and implementation of technological solutions. A strongly integrated approach between policy instruments and technological innovations is essential for supporting the energy transition and solving climate change issues. Municipal, regional, and national institutions are simultaneously designing pathways around technological innovations to promote sustainable practices. Examples include:

- policy drivers are promoting smart energy generation, transmission, and supply systems
- the development of stringent building codes is reshaping the construction sector
- energy rating systems for home appliances are helping consumers make informed choices
- technological development in the transport sector is leading to rapid upgrades of infrastructure development to pave the way for electric vehicles

Energy Supply and Demand - an Integrated Systems Perspective

Transitioning to a low-carbon economy requires transformation at multiple levels, and must be implemented in system-wide initiatives to simultaneously transform energy supply and demand:

1. Energy supply – renewable and non-renewable sources of energy generation, transmission and distribution systems, short-term and long-term energy storage.
2. Energy demand – energy consumption patterns, buildings, transport and infrastructure.

An integrated systems perspective is crucial, as it starts with the recognition of the interconnectivity of all the components of the energy system, and the energy sector's linkages with the rest of the economy. The result of a policy instrument or technology implementation may be beneficial to one component or sector, while being detrimental to another. The combined benefits of multiple instruments/technologies could cancel themselves out or amplify their cumulative effects to achieve

multiple objectives. The development of effective decarbonisation policies relies on detailed assessment of technological choices and their effect on energy demand and consumption patterns to avoid rebound effects (SDSN and FEEM, 2019). To avoid unintended consequences, mitigation measures and complementary instruments/technologies should be considered (Hafner & Tagliapietra, 2020), such as:

- intermittency – wind, solar, and to some extent seasonal hydropower generation are inherently intermittent; digital systems will fill a crucial role in augmenting the electric utility grid with the requisite flexibility
- zero-carbon technologies – zero-emissions vehicles rely on zero-carbon energy sources and public fuelling infrastructure
- natural and engineered systems – the preservation of existing, and restoration of degraded, natural habitats will be crucial to achieving net negative emissions; transformation of land use, such as the clearing of natural forest cover for agricultural practices, can lead to carbon emissions while destroying natural carbon sinks
- mitigation and adaptation – some adaptation measures can contribute to mitigation; for example, forest restoration and coastal wetland protection help resist rising sea levels and promote food production, while sequestering carbon
- complementary actions across economies – renewable energy source capacity varies geospatially, and the availability of natural resources and land can cause challenges to implement a common practice across countries; however, ingenious local solutions can help meet common global objectives

The case studies presented in this report reflect that there is no one-size-fits-all solution for all countries. Each country varies in terms of energy policies, availability of natural resources, human capital, and existing social infrastructure. These differences lead to different optimal approaches to energy transition policy- and decision-making.

Technology Pathways to Decarbonisation

Technological pathways to decarbonisation are supported by six primary technology pillars (SDSN and FEEM, 2019):

- zero-carbon electricity generation - a shift in electricity generation away from fossil fuel combustion
- electrification of end-use - increasing the penetration of electricity can enable the electrification of economic sectors that currently use fossil fuels
- alternative fuels – are under development for use in sectors that are harder to electrify; examples include hydrogen, fuel from waste, coal and biomass to liquids
- smart power grids – the deployment of smart grids will allow more efficient, economic, and reliable transmission and distribution system operations, especially as the share of intermittent power sources increases
- materials efficiency – waste and emissions can be reduced by better choices of materials and their utilization patterns; the circular concepts of “reduce, reuse, recycle” or “recycle, reuse, remanufacture” are examples
- sustainable land use – this primarily applies to agriculture, which contributes up to a quarter of all greenhouse gas (GHG) emissions

Table 1 gives an overview of several areas of energy supply, enabling, and demand technologies, and how they map to key technology gaps.

Table 1 – Overview of energy systems technologies, and the gaps they fill. TRL stands for Technology Readiness Level, with the colors indicating the status; green: on track, yellow: more efforts needed, and red: not on track.

Grouping	Technology Area		Examples of Innovation Priorities to Maximize Technology Potential and their Current TRL	TRL
Energy Supply Technologies	Wind		Floating Offshore Wind	8
	Solar	Solar PV	Concentrated PV	9
			Organic Printable Thin-film PV	6
		Solar Thermal	Linear Fresnel Reflectors	7
		Other Solar	Mass Production of Solar Thermal Heating	9
	Other Renewables	Geothermal Energy	Kalina Cycle Low Temperature Geothermal	6
		Hydro Power	Further Standardization and Environmental Protection	9
		Ocean Power	Ocean Thermal Energy Conversion	4
			Wave Energy Converters	4
			Salinity Gradient	3
	Fuel of non-fossil Origin	Bioenergy	Lignocellulosic Ethanol via Enzymatic Fermentation	8
		Fuel from Waste	Waste Gasification and Syngas Fermentation	7
		Other	Liquid Fuels from Hydrogen and CO_2	6
	Combustion Technologies with Mitigation Potential		Waste Heat Recovery Systems using Phase Change Materials	8
			Integrated Gasification Combined Cycle to Enable CO_2 Capture	7
	Energy Generation of Nuclear Origin (Electricity)		Light Water Reactor-based Small Modular Reactor	6
			Fusion	3
Enabling Technologies	CCUS		CO_2 Storage in a Saline Formation	9
			Direct Air Capture	6
	Batteries		Redox Flow	8
			Solid State Lithium Metal Battery for Vehicles	5
	Hydrogen and Fuel Cells		Salt Cavern Hydrogen Storage	9
			Polymer Electrolye Membrane	8
			Solid Oxide Electrolyser Cell	7
	Other		Compressed Air Energy Storage	8
			Virtual Inertia for Fast Frequency Response	6
	Smart Grids		Smart Inverter	8
			Transactive Energy	4
			Gamification of Demand Response	8
			Level 4+ Automated and Connected Vehicles	6
End-use Technologies	Buildings		Organic and Polymer LED	9
			Highly Insulating Window	8
			Direct Current Building, Direct Current Microgrid	7
			Water Heating Heat Pump	7
	Production / Chemical and Oil Refining		BTX from Methanol or Lignin	6
			Oxy Fluid Catalytic Cracking	5
			Steam Cracker Electrification	3
	Production / Metal and Minerals Processing		CCUS on DRI Steel Production	9
			DRI Steel Based on 100% Hydrogen	5
			Cement Kiln Oxy Fueling with CCUS	6
	Production / Other	Agriculture	Electromagnetic Heating for Large-scale Industrial Processes	5
		Consumer Products	Folding Shearing	3
		Other Production		
	Transportation / Electrical Vehicles and EV Infrastructure	EV and Infrastructure	Electric Heavy-duty Trucks	9
			Conductive Electric Road Systems	8
		Fuel Cells for Road Vehicles	Fuel Cell Truck	7
			Low-platinum Intensity PEM Fuel Cell	7
	Transportation / Other Road Technologies		(Bio)gas Internal Combustion Engine Vehicles	9
	Other Transportation	Aviation	Ultra-high Bypass Ratio Engine	9
			Electric Taxiing	6
			Battery and Hydrogen Planes	4
		Maritime and Waterways	Rotor Sail or Kite	9
			Battery Electric Ship	8
			Solid Oxide Ammonia Fuel Cell Ship	4
		Railways	Hydrogen Fuel Cell Train	8
			Gas Hybrid Train	7
	Computing and Communication		Power Efficient CPUs and GPUs	

Source: IEA, 2021a

Trends in Energy Supply and End-use Technologies

Low-carbon energy (LCE) supply technologies supporting the energy transition include renewable energy (e.g., wind, solar, tidal, hydropower, and geothermal energy), alternative fuels (e.g., biofuels and fuels from waste), nuclear fission, and efficient combustion technologies with the potential to reduce GHG emissions. Examples of their evolution in the transportation structure most visibly include electric vehicles and charging technologies and innovations to reduce the carbon footprint of internal combustion engines. Besides road transport, there is corresponding progress in aviation, rail, marine, and inland waterway transport. Consider also the evolution of the built environment. The efficiency of lighting, heating, air conditioning, and home appliances – as well as construction methods and materials – continues to advance. Energy efficiency rating systems help consumers choose the most efficient appliances, which can even factor into real estate value. With the continual and rapid increase of digital computation and communication requirements, there is an acute need to reduce the energy

consumption by all types of IT devices and within the Information Communication and Technology (ICT) sector.

There are several studies available (SDSN and FEEM, 2019; Hafner & Tagliapietra, 2020) detailing the development of technologies used for energy supply and demand. However, many of the newest trends and developments are in cross-cutting technologies such as batteries, hydrogen fuel, smart grids, and carbon capture, usage, and storage (CCUS), which are set to play a pivotal role in the energy transition. These technologies are enabling the deployment of clean energy sources on the supply side, while facilitating their integration (in particular, renewable energy electricity in home use) in end-use sectors (IRENA, 2018). Progress in such enabling technologies is, therefore, a powerful driver of innovation in energy generation and consumption, which are increasingly intertwined.

The concepts of energy efficiency and the circular carbon economy are being increasingly adopted and influencing consumption patterns in society. Supported by innovative technologies, energy efficiency measures are promoting generation capacity, while eliminating waste. Improvements in energy generation are not enough, however, as a successful energy transition will require further changes in demand-side consumption patterns. Buildings, for example, still account for more than 35% of the European Union's (EU) energy-related GHG emissions (SDSN and FEEM, 2019). There are already solutions in place to reduce these emissions: for example, deep renovation and a switch to renewable heat generation – heat pumps in residences for example. Perhaps the most important barriers, however, are behavioural. Improved awareness and intelligent use of building automation technologies will help to further decrease demand. Regulations and guidance are key in this area.

Behavioural Change Influencing Consumption Patterns

Social behaviours hinder progress in other areas as well. As consumerism continues to increase – especially as much of the world is lifted out of poverty – the production of waste is expected to increase. According to The World Bank (2018), global waste in 2016 was approximately 2 billion tonnes, and is forecast to increase to over 30 billion tonnes annually over the next 30 years. To combat this worrying trend, many countries are undergoing large-scale transitions to develop circular economies ("reduce, reuse, recycle" / "recycle, reuse, remanufacture"). There are many benefits to this new paradigm of consumption, in addition to increasing the productivity of resources, including (OECD, 2017a):

- creation of economic opportunities
- emissions and waste reduction
- promotion of innovation
- generation of skilled green jobs

It is hard to overestimate the benefits that could accrue from transitioning to a circular economy. A report by the International Labour Organization (ILO, 2018) estimates that the circular economy could create nearly 6 million new jobs. In addition, the development of the requisite technological and infrastructure capacity is expected to create more indirect jobs. Further, the paradigm of the circular economy should drive beneficial behavioural changes, encouraging the manufacture and use of more durable products, an increase in rentals of some goods, and a stronger emphasis on repair. All of this should create further indirect green jobs.

Applying the circular economy paradigm to carbon will be especially effective in responding to climate change. Carbon is, and may always be, the backbone of our economies, but society must transition to consuming carbon without the associated emissions. CCUS – currently a focus of extensive R&D - is a critical class of technologies concerned with both capturing carbon dioxide (CO_2) before it is emitted

and removing existing CO_2 from the atmosphere. The captured CO_2 can either be sequestered or used in the manufacture of valuable products. In some uses, captured CO_2 is injected into wells to increase the efficiency with which petroleum products are extracted. However, stringent policies and extensive financial resources are needed to make carbon circularity a thriving economic opportunity.

Chapter 3 Assessing the Impact of COVID-19 on the Energy Sector and on Women

Since early 2020, the COVID-19 pandemic has had a substantial negative impact across the world, threatening people's livelihoods, ways of living, and their very lives. The high level of risk has caused many governments to dramatically curtail many facets of economic activity and trade, triggering extensive losses. No nation has escaped unscathed. The globally interconnected nature of today's world, which relies on complex global supply chain networks and the relatively free movement of people, goods, and services, has amplified the pandemic in multiple ways. Firstly, the virus itself took advantage of the global linkages to propagate faster than would have otherwise been possible. Secondly, disruption of international trade during the initial days of the pandemic had left many countries vulnerable, as domestic economies could no longer access imported goods. However, the situation was resolved in time, although the health and well-being of many populations were affected in multiple ways over and above the direct dangers of the virus itself.

In response to the disruption in international trade, some countries that are largely reliant on imports are considering redeveloping their domestic markets to regain a measure of self-reliance. However, there are risks that they could adopt unsustainable practices. Perhaps a silver lining to the pandemic, international trade links will likely be restructured to safeguard individual nations' economic interests and reduce vulnerability. This restructuring could boost local economies and lead to the creation of local jobs. The COVID-19 pandemic may even have presented countries with opportunities for green economic recovery, employing environmentally friendly, energy-efficient processes. As new investments will be needed to support the adoption of advanced technologies and the development of the requisite skilled workforce, there will be opportunities to create green and decent jobs. COVID-19 mitigation measures, such as working from home, social distancing, or using local products, are encouraging investments in innovative and efficient digital technologies. Overall, the current pandemic situation is creating new opportunities for structural economic shifts (World Bank, 2020).

COVID-19 Impact on the Energy Sector

The impact of national lockdowns across the globe has created market imbalances. Analysis published by Wood Mackenzie (2020) on the volatility of European power and renewable markets during COVID-19 assessed the impact on electric utilities, distributed solar generation, and energy storage. In the residential sector, maintaining social distancing due to COVID-19 created difficulties in services for rooftop solar installation. Issuing planning permits became a low priority for government organizations, and unemployment and related financial challenges resulted in a decline in renewable energy services. Lockdown restrictions stalled industrial and commercial sectors, leading to substantial cuts in power demand; the resultant oversupply of energy led to financial losses and job reductions for energy companies. For example, the year 2020 was the first when more electricity was generated in the US by nuclear plants than coal-fired power plants (Wood Mackenzie, 2021), largely driven by the reduction in demand. Fossil-fuel based energy generation was already on a relative decline due to the growing penetration of, and preference for, renewable energy. Across the world, significant reductions in the levels of air pollution have been witnessed, which led to public demand for policy action to reduce dependency on fossil fuels and develop cleaner and greener fuel choices to promote social well-being and protect the environment.

Coinciding with the rollout of vaccination programmes (Wood Mackenzie, 2020) and lifting of lockdown restrictions, green growth recovery packages are being rolled out across countries to accelerate economic recovery, boost job creation, promote energy security, and drive transition to sustainable energy systems. For example, the EU has committed to a €750 billion post pandemic

recovery fund, which will be delivered to EU countries in the form of grants and loans and is planned to invest in green projects to stimulate economic recovery and growth (European Commission, 2021) The proposal aligns with the EU's renewable energy and carbon emissions targets for 2030 and 2050.

In order to receive support from the Recovery and Resilience Facility, EU countries plans are asked to set out a coherent package of projects, reforms and investments in six policy areas:

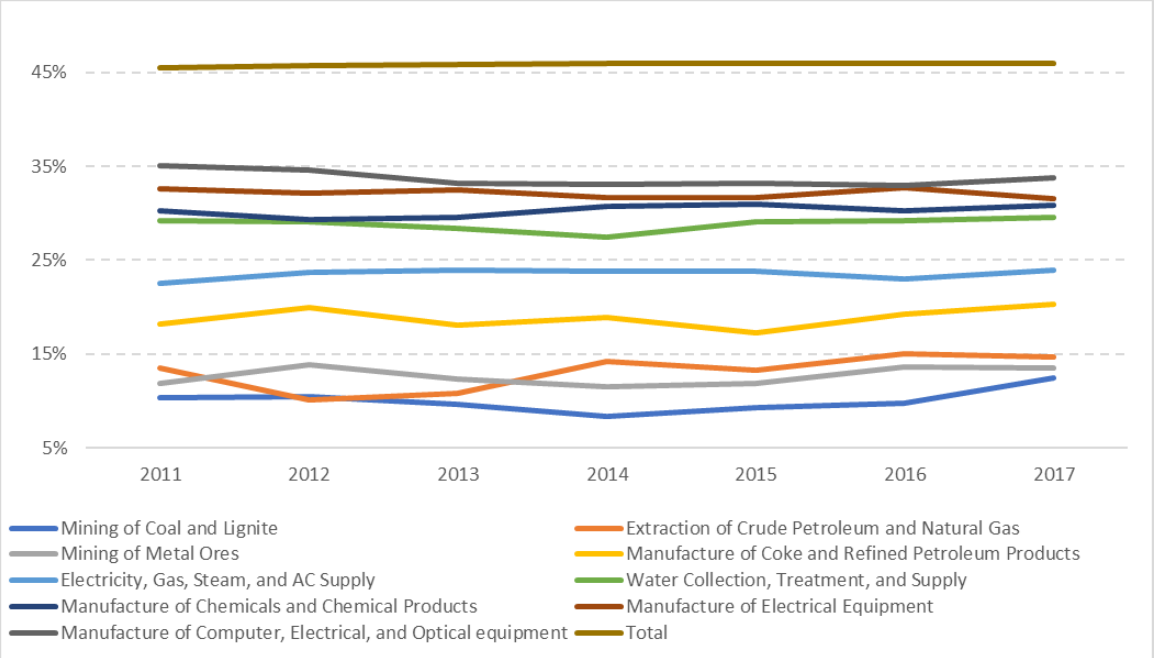
- the green transition
- digital transformation
- smart, sustainable and inclusive growth and jobs
- social and territorial cohesion
- health and resilience

Depending on their implementation, these efforts could pave the way for creating decent and gender-equal employment and business opportunities.

COVID-19 Impact on Women

Despite the fact that women account for 48% of the global workforce, the proportion of women in the energy sector workforce is very low: 22% of the oil and gas workforce are women, and the percentage increases to 32% in renewable energy (IEA, 2020). As seen in Figure 1, women's share of employment in the EU in the energy sub-sectors are the lowest (the lowest being coal mining) compared to other industrial sub-sectors. In extractive industries, fewer than 15% of senior roles are filled by women. Women in the energy sector tend to hold administrative positions with limited decision-making power, while men tend to work in engineering and business services roles.

Figure 1 - Proportion of female employees in the energy sector in the European Union, 2011-2017.



Source: IEA. (2020b).

The recession caused by the COVID-19 pandemic had a disproportionate impact on both unskilled labour and women. As schools closed, women experienced high levels of job losses, as they were either made redundant or had to make a choice to take the role of a carer. In the European Union, it is estimated that the poverty rate among women will increase to 1.9% (European Commission, 2020). As governments take advantage of the economic recovery to transition to sustainable energy systems,

a Just Transition is needed to support international recovery efforts to rebuild robust economies while supporting gender equality and the economic empowerment of women.

New Opportunities and Challenges

Achieving energy transition objectives and pursuing the deployment of low-carbon technologies post-COVID-19 will disproportionately impact the more vulnerable sections of society, due to the initial transition in employment, supply chains, and energy costs; a Just Transition is needed to tide over the initial stages of transition. By offering financial and skill building support to workers transitioning from brown to green jobs, society can undergo evolution rather than revolution (WGEO, in press). The idea that environmental security should not be compromised to achieve economic prosperity is foundational to Just Transition, introduced by the International Labour Organization (ILO) in the 1970's (ILO, 2011). A powerful narrative born by the ideas of social and environmental justice to support the interests of workers and communities, Just Transition has itself evolved. The narrative has expanded to include the joint transformative approach of transitioning from a brown (energy intensive sectors) to a green/blue economy (low carbon economy), with the creation of decent jobs. In 2015, the ILO endorsed and adopted guidelines based on the shared experience of country's policies and sectoral strategies by putting forward a policy framework for a "Just Transition". Just Transition attempts to address the objectives of climate change, sustainable development, and support for green and decent jobs while securing fairness of existing jobs. Just transition also means ensuring evolution in industrial activities by combining resource efficiency and emission reduction. An effective transition would also require the shifting of skillsets by upskilling existing skills to meet the demand for a low carbon future so the current labour force can transfer their skills to meet the needs of new and future sectors, moving from brown to green jobs (ILO, 2015).

Chapter 4 Participation of Women in Economic Sectors, Focusing on the Energy Sector

Gender participation has recently started to feature within the domain of energy, becoming a pivotal point of concern among corporate sector policymakers, international institutions, and academic researchers (Osunmuyiwa & Ahlborg, 2019; Ryan, 2014). Academic discussions around the confluence of gender, climate change, and energy have typically occurred in two relatively disjoint bodies of literature. The first has focused on developing nations, attempting to characterize the inequalities in energy access and climate change impacts on the lives of rural women. The narratives around the "poverty of women" and the "low quality of energy access and its adverse impact on health and safety" have predominantly taken the focus. This body of literature has largely ignored broader topics such as equal participation in energy sector decision-making, or climate change policy development. Baruah (2017) and Listo (2018) claim that women's access to new employment is often constrained by legal and social barriers in developing countries. These barriers may limit their education, property rights, land ownership, and access to credit. According to these authors, public policies must address these issues to develop economic opportunities for women (Baruah, 2016; Listo, 2018). The literature analysing the role of women in the energy sector in the developed world has largely focussed on the gender divide in perceptions of climate change (McCright, 2010) and differences in energy sector careers (Pearl-Martinez & Stephens, 2016).

Clancy et al. (2017) claims that the analysis of energy poverty vis-à-vis gender reveals a significant effect of gender on energy access. Income disparities mean women have a higher risk of living in poverty, they tend to live longer, and have a higher tendency to head single-parent households. Analysis by the 2015 EIGE Gender Equality Index suggests that women in the EU earn an average of €565 per month less than men (EIGE, 2015). The observed income disparity has narrowed over the decade that the EIGE has been gathering and analysing data, but a significant gap of up to 20% appears to remain. Over the course of an entire career, these disparities compound, resulting in a substantial 40% gap in retirement pension amounts. Women often work as home-makers, work part-time, receive lower wages; on average, women's careers are 5 years shorter than men's. These factors all contribute to increased risk of poverty in old age. In the EU, 18% of women aged 75 or higher are at risk of monetary poverty, compared to 12% of men, according to the EIGE (2017). Since women tend to live longer than men, it stands to reason that they may also tend to live longer in poverty than men.

Decision-making Roles: Women as Agents of Change

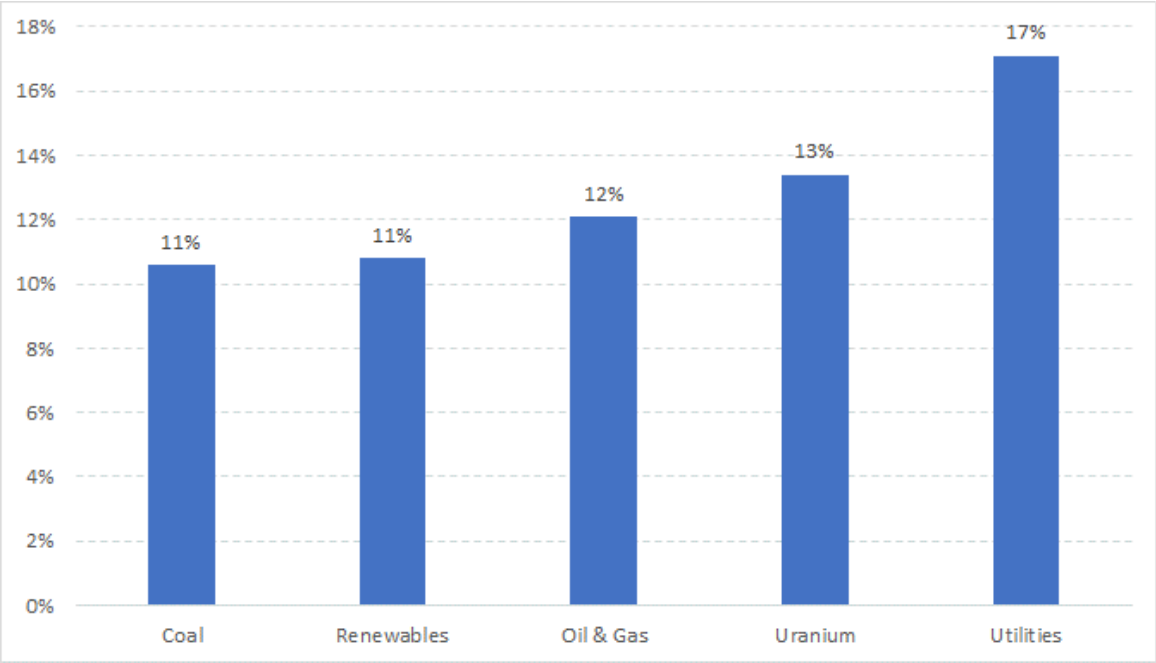
According to Kronsell (2013), there is evidence that organizations and governments behave differently when women are more represented in positions of power. In addition, the rise of women's status in a nation is associated with greater support for environmental protection. Considering the importance of reversing the environmental impacts of climate change, this is a potentially important finding.

Despite the potential benefits to energy transition efforts, women tend to be underrepresented in political decision-making. Germany, Italy, Finland, and Sweden implemented a joint project in 2003 and 2005 entitled "Climate for Change – Gender Equality and Climate Policy", which aimed to promote the participation of women in climate change-related policymaking. This project found that the participation of women was low across the EU, with only slight differences between member states. Pearl-Martinez et al. (2016) analysed 72 countries and found that only 6% of ministers accountable for national energy policies and programmes were women. Indeed, as recently as March 2019, only four member states of the European Union (Belgium, Bulgaria, Estonia, Germany) had a female energy minister (Clancy & Feenstra, 2019, p.22)

Role of Women in the Energy Sector

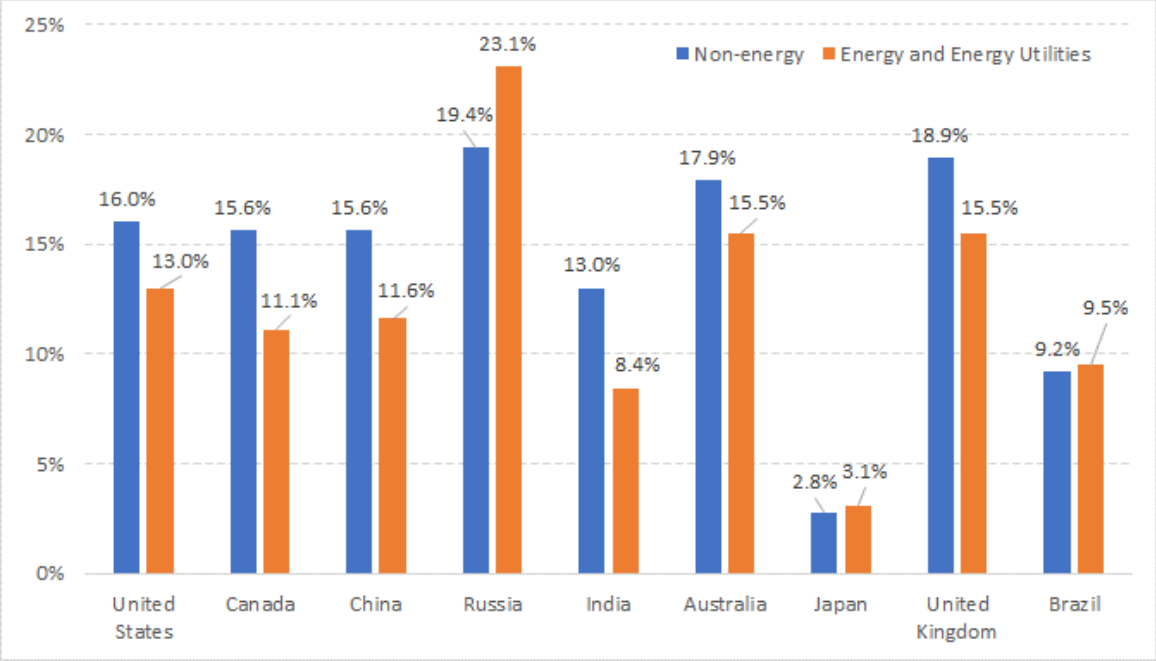
In addition to energy policymaking, women participate less in decision-making in energy companies. The IEA (2021b) analysed 2,500 energy and utility firms (38,000 employees), finding that approximately 14% of senior management are women. This is only slightly lower than the 15.5% observed in the 30,000+ non-energy firms sampled. Reviewing energy companies in more detail, the proportions vary slightly (see Figure 2).

Figure 2 - Women in senior management roles by energy sub-sector, 2019.



Source: IEA (2021b).

Figure 3 - Gender diversity of senior management by country headquarters location, 2021.



Source: IEA (2021b).

As can be seen in Figure 3, women have a higher tendency in most countries to hold senior management roles in non-energy firms, as compared to energy companies. The only significant

exception is the Russian Federation (IEA, 2021b). The nearly eight-fold difference between the countries with the highest (23.1%) and lowest (3.1%) participation of women, but there could be many reasons why countries have low participation and requires detailed analysis of policies, labour capital and social environment.

While the observed disparities in holding senior management roles could be explained by behavioural, preferential, or sociocultural reasons, they cannot be explained by purely academic qualifications. According to the IEA (2021b), education levels are roughly the same for executives of both genders. Approximately 50% hold a bachelor's degree, 35% hold a master's degree, and 15% hold doctoral degrees; there is no significant difference in these quantities between energy vs. non-energy companies.

The data that inform these and related studies remain limited, and are generally only reported at highly aggregated levels, constraining the level of analyses that could be performed. The knowledge gap is decreasing, but there is still much to be done to improve the acquisition, reporting, and analysis of relevant data. Most importantly, observational data cannot identify causality; progress to an equitable future does not end with baselining information (GWNET, 2019).

Given the environmental benefits that the evidence suggests accrue from having more women in senior management and corporate leadership positions, the observed disparities in gender diversity across the energy sector, including renewables, are disconcerting. The important business of sustainable energy could be missing out on the opportunity to reach its full potential and drive the energy system transition due to the less diverse workforce. Considering the critical nature of the current green economy transition, governments, businesses, and societies should be doing all they can to ensure it is successful; suboptimality can have dire consequences. (GWNET, 2019).

The current global focus on transitioning to sustainability presents many opportunities to simultaneously transition to a more diverse and inclusive workforce. However, there is much to be done beyond observing disparities, as there could be many reasons for the lack of diversity. Experience shows that the simplest proposed solution – quotas – actually hurts society; diversity solutions need to be more nuanced to be truly effective. A deeper understanding is needed of why women tend not to work and lead in the energy sector. Relevant career paths, the breadth of skills, and opportunities across the sector must be identified and analysed. Together, these two types of analyses can inform efforts to attract more women to the energy sector.

Chapter 5 Gender Equality and Diversity in the Energy Sector to Tackle Economic and Energy Challenges

Challenges

Before any policy changes can be made to drive increased participation of women in the energy sector, policymakers must assess the extent to which the observed gender gaps reflect possible underlying preferences, market dynamics, socio-cultural constraints, or even policy failures.

Contextual Obstacles

One possible reason for the low participation of women in the energy sector is women's own perceptions. Studies (Baruah, 2016; Listo, 2018; and Liu, 2018) on women's career choices have suggested that women tend to perceive energy careers as highly technical and requiring physical strength. While the latter point may have been true in the past, the sector has evolved, with digitalisation and automation taking the place of manual labour. Women's own biases are holding themselves back from realizing their full potential to support society and the sustainable energy transition. The energy sector could make stronger efforts to eliminate these false perceptions and promote more gender diversity.

While it is certainly true that innovation in the energy sector relies on highly technical roles, this fact should not hinder women with relevant qualifications from contributing more. The European Patent Office's Word Patent Statistical Database (IEAa, 2021) has documented that energy sector patent applications are less likely to include female authors than in other technical sectors. For patents related to energy technologies – combustion equipment, engines, pumps, etc. – women are listed on approximately 10% of patent applications. This percentage rises to 15% for climate-change mitigation technologies. However, women inventors are listed on more than 20% of patent applications related to health and chemical technologies. The business platform Crunchbase (IEAa, 2020) documents that only about 11% of energy sector start-ups are founded by women, while approximately 20% of start-ups in almost all other sectors are founded by women. Even considering energy sector roles that require a high degree of technical knowledge, there seems to be no reason why more women could not fill those roles.

Economic Obstacles

According to the GWNET study survey (2019), the primary barriers against working in the energy sector, as self-reported by women, vary by type of economy. In industrialized countries, women indicate that their perception of the workplace culture is a hindrance. In emerging economies and developing countries, however, they claim the primary barrier is financing and training. It should also be noted that a high proportion of people in developing countries are employed in informal work. This is particularly true for women and may be part of the reason that access to finance and training to enter the formal labour market is the greatest obstacle. These differences should be systematically analysed to most effectively guide efforts to create more energy sector jobs for women.

The report on women, gender and the energy transition in the EU (Clancy & Feenstra, 2019) mentions suggests women lack time to seek employment, and this is due to the inequalities between men and women in taking housework and other home caring responsibilities. Lack of financial support creates difficult circumstances for women to hire the services of domestic support. With financial support and corporate/ subsidized day care, women will be able to further engage in economic activities.

Soft obstacles

A survey by IRENA (2018) suggests that talent acquisition practices may be a significant barrier to the recruitment and retention of women in the renewable energy sector. Literature regarding employment in the energy, mining, and transportation sectors has found that men have a higher tendency to apply for jobs even without meeting all the requirements – something women tend not to do (Baruah & Biskupski-Mujanovic, 2018). Women are also less likely than men to negotiate salaries and benefits. Women working in male-dominated sectors claim to have observed disconnections between rhetoric around recruiting women and their perception of entrenched male preferences (Baruah & Biskupski-Mujanovic, 2018). Turnbull (2013) suggests that jobs in the energy and related sectors were not originally designed for women, so managers are less likely to regard women as suitable candidates.

Lack of information regarding employment opportunities may also act as a barrier to women's employment in energy and other non-traditional sectors. While energy companies advertise jobs through formal, organized forums, these channels are often supplemented by personal networks. Since the majority of the energy sector workforce is male, men have access to much more extensive relevant personal networks. This may give men an advantage to learning about employment opportunities (IRENA, 2019).

Another persistent barrier to women's participation in the energy sector, as mentioned earlier in this report, is the low rate of women's representation in senior management and corporate leadership. Having access to mentors and role models who can advocate equality of opportunity, could help women rise above the so-called "glass ceiling" and increase the representation of women in positions of leadership (IRENA, 2019).

Opportunities

As discussed in Chapter 2, the newest trends and developments across technologies such as batteries, hydrogen fuel, smart grids, and CCUS are set to play a pivotal role in the current energy transition. Cooperation between governments, business and society is needed to capitalise on the development of innovative technologies to encourage women's participation in the energy transition which is reshaping the sector with advanced solutions. There is a substantial need to develop institutional measures to promote social inclusion.

Energy Transition

Energy Generation and Storage

Increasing the penetration of renewable energy sources is a primary objective of decarbonising the power sector. A major challenge with this transition is that renewable energy sources tend to be highly intermittent; in a system in which supply must always match demand, intermittency introduces substantial risks. To mitigate these risks, power generated from sources such as solar and wind must be associated with additional flexibility technologies, including dispatchable generation, electricity storage, grid interconnections, demand-side management, and sectoral coupling. Other supplemental low-carbon electricity sources are also important – namely nuclear and CCUS-enabled fossil fuel combustion. With all these technologies, there is an abundance of opportunities in the energy sector for innovation, entrepreneurial investment, and employment (Hafner & Tagliapietra, 2020).

Carbon Capture, Utilization, and Storage

CCUS is a set of technologies which captures CO_2 from the combustion of fossil fuels, generation of bioenergy (BECCUS) and directly from the atmosphere (direct air capture - DAC). While still relatively immature and expensive, DAC is an extremely exciting technological advancement, allowing us to

remove excess CO_2 from past emissions from the atmosphere. Beyond energy generation, CCUS has important applications in energy-intensive sectors. A significant portion of global emissions is from the production of products such as cement, iron, steel, and chemicals. In addition to simply capturing and storing the CO_2, there are many potential applications for its productive use in a carbon circular economy. Despite the progress already made, investment and innovation are still needed, which could be stimulated with incentive mechanisms such as tax credits. In addition to filling a key role in climate change mitigation, CCUS could create many lucrative entrepreneurial opportunities (SDSN and FEEM, 2019).

Carbon Circularity and Material Efficiency

The circular economy paradigm is based on the efficient reuse of raw materials by minimizing waste and promoting sustainable production and consumption (UNECE, 2021). In addition to reducing societies' environmental footprint, systematic reuse and recycling has the potential to create a wide variety of jobs from low-skilled labour for reuse/recycling, to medium-skilled jobs e.g., for remanufacturing and biorefining, and more professional and technical skillsets; some companies are transitioning into using services as a growth driver. This is in addition to the investments and jobs needed to adapt existing manufacturing and infrastructure assets (Green Alliance, 2015). Applying the circular economy paradigm to carbon will be especially effective in responding to climate change. The CO_2 captured from electricity generation, manufacturing processes, and directly from the air can be used to manufacture products. As this recycled carbon is used more, less carbon will need to be extracted, further reducing environmental degradation. As CCUS technologies mature, carbon circularity has the potential to dramatically leverage and multiply the impact of many innovations. In consideration of the expected economic benefits, several countries – both developed and developing – are promoting the circular economy. Analysing the potential promised by the circular economy, the European Commission (2015) suggested that EU businesses can save over half a trillion euros (8% of annual turnover) and create approximately 580,000 jobs, while reducing CO_2 emissions by nearly half a billion tonnes by 2030.

Social Context

As the economic recovery from the COVID-19 pandemic progresses, governments and businesses should adopt measures on gender equality in their plans. To act otherwise could risk losing prior progress on the economic empowerment of women. For example, NextGenerationEU, and the European Union recovery plan (European Commission, 2021) - developed to help countries transform their economies and create opportunities post pandemic - are also implementing a strong gender preference towards women as central to their economic recovery. The COVID-19 crisis made the inequality between men and women more evident such as the wage gap and split of home responsibilities. The Horizon 2021-2027 programme is aimed to integrate gender into research and innovation across all sectors of economy and political levels. Targeted programmes and policies that preferentially support the empowerment of women are particularly important now – policies providing paid leave, ensuring equal pay, and addressing any gender bias in hiring.

Several governments are implementing quota systems to increase the participation of women in senior management and corporate leadership roles, which they believe will promote social understanding and counter any subconscious bias (GWNET, 2019). The European Women on Boards Organization has documented an increase from 13.9% (2012) to 25% (2015) (GWNET, 2019) of women on the boards of European companies, which is an obvious result of a forced quota system.

Job Creation and Diversity in Energy Entrepreneurship

Several gender-based research studies (Baruah, 2016; Listo, 2018; and Liu, 2018) have suggested various reasons why women tend not to work in the energy sector:

- traditional roles attributed to women within society
- low number of women graduates in science, technology, engineering and mathematics (STEM)
- perception of the energy sector as technologically complex.

In reality, many entrepreneurial activities and employment opportunities have limited demands for specialized technical skills. Some jobs have no technical requirements at all – there is substantial scope for the social sciences in the energy sector. It is possible that the studies have overlooked alternative, and simpler causal factors, such as gender-based differences in preference and interests; these are important topics that should be further explored.

A shift towards decentralized energy generation is a major component of transitioning the energy sector. In addition to creating opportunities for new actors to enter the energy sector and fill roles that large electric utilities may not be able to, decentralization introduces new forms of governance and influence. According to the Right to Energy (2020), decentralized energy generation is a useful tool to reassess and improve relevant domestic energy policies and involve citizens in climate change issues. For example, local energy initiatives, such as cooperatives, can be developed in conjunction with community members. Since women tend to prefer working in cooperative groups in which they find solidarity and support to overcome challenges, this approach has the potential to create more energy sector jobs for women.

In summary, the GWNET (2019) study has demonstrated that the sustainable energy sector, in supporting a green energy transition, can create employment opportunities for people from a diverse array of backgrounds, skillsets, and interests.

Chapter 6 Case Studies

Albania

Energy and Electricity

Albania is an oil-producing nation (911 kt in 2018), but most of it is exported as unrefined crude oil (IRENA, 2021); the oil and refined petroleum products consumed in Albania are predominantly imported and used by the transportation sector. The country has one gas/oil-fired power plant, but it has never been functional. Due to the variability in rainfall, hydropower (a substantial share of the energy mix; mostly three power plants on the Drin river) is intermittent. Thus, the country remains a net importer of energy; nearly a quarter of the country's total primary energy supply was imported in 2018 (IRENA, 2021). Table 2 lists some key energy indicators; except where otherwise noted, all the data in this section is from the IEA (2019).

Table 2 - Key energy indicators for Albania - 2000, 2018.

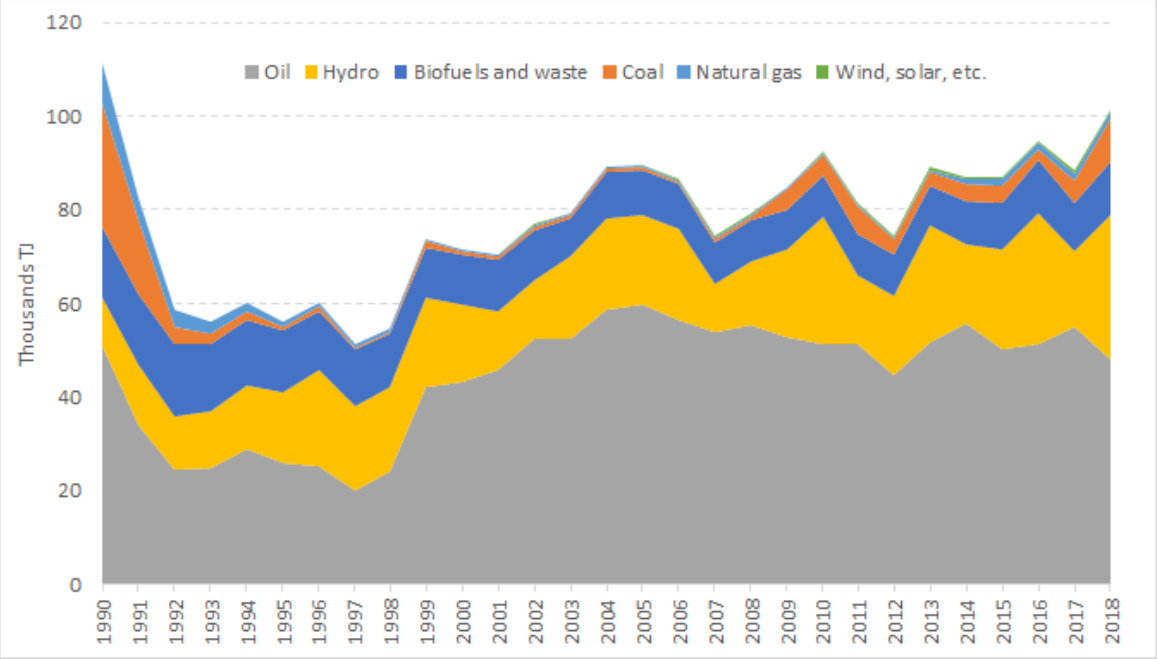
	2000	2018	Δ FROM 2017
ENERGY PRODUCTION (MTOE)	0.99	2.0	↑0.37
TOTAL PRIMARY ENERGY SUPPLY (MTOE)	1.79	2.34	↑0.01
ELECTRICITY FINAL CONSUMPTION (TWH)	4.48	6.53	↑0.37
TOTAL CO_2 EMISSIONS (MT)	3.08	4.30	↑0.04
SHARE OF RENEWABLES IN ENERGY MIX (%)	23	31	↑11.9

Source: IEA, 2019

Energy Generation

Albania's energy system relies primarily on oil and hydropower. In 2018, 48,016 TJ (47.3%) of energy was generated from oil, followed by 30,788 TJ generated by dams (30.4%). The remainder, plotted over time in Figure 4, is generated from biofuels/waste (11.2%), coal (9.2%), natural gas (1.3%), and wind and solar (<1%).

Figure 4 - Total energy supply by source for Albania, 1990-2018.



Source: IEA,2019.

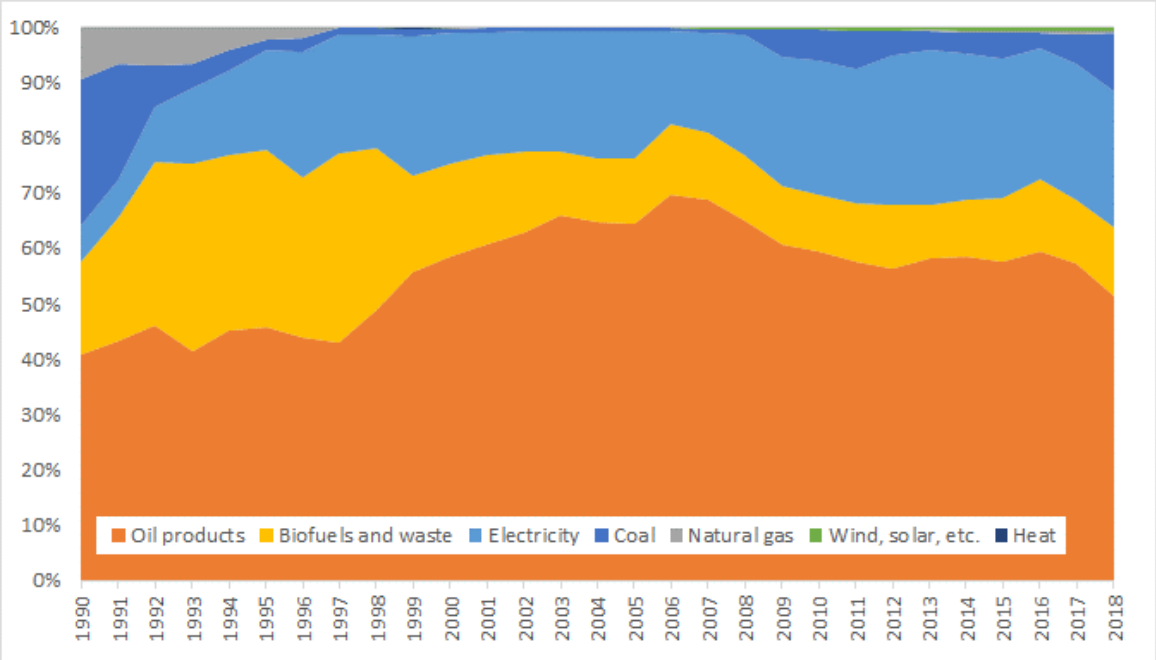
With its extensive river and reservoir resource, nearly all the electricity demand is met by hydropower. Albania is the only country in the Balkans to continue completing new high-capacity dams. While renewable energy generation is a major component of a sustainable energy transition, the extensive

exploitation of the riverways may be contributing to environmental degradation, potentially cancelling out some of the benefits (Bankwatch Network, 2017). To develop the nation's first large-scale solar power plant and encourage diversification in the renewable energy sector, Albania's Ministry of Infrastructure and Energy held in 2018 an auction for the development of 100 MW of solar capacity (IEA, 2018). Under this Power Purchasing Agreement (PPA), half of the generated power would be sold to the government at a fixed feed-in tariff (Bankwatch Network, 2020). In 2020, the country launched a tender for the development of up to 150 MW of wind capacity, which would also be sold to the government under a 15-year PPA (IRENA, 2021).

Energy Consumption

According to the IEA (2019), the vast majority of Albania's total final energy consumption since 1990 has been met by petroleum products (45,803 TJ in 2018), electricity (21,906 TJ in 2018), and biofuels/waste (11,267 TJ in 2018). As can be observed in Figure 5, the combustion of biofuels/waste peaked in 1992, reaching 15,199 TJ; it was largely supplanted by petroleum products and electricity. Figure 5 shows the trend in energy consumption by source over the past 3 decades.

Figure 5 - Relative total final consumption by source for Albania, 1990 – 2018.



Source: IEA, 2019

In 2018, 39% of energy was consumed in transport (828 KTOE), followed by 507 KTOE for residential use (23.9%). The industrial sector consumed 20.7% of energy in Albania (439 KTOE). According to the World Atlas, the biggest industries are oil and gas, mining (coal, chromium, nickel, copper), textiles, and tourism.

Economic Interlinkages of the Energy Sector

While the majority of electricity is generated by renewables in Albania, accounting for nearly a third of the total energy mix, it was mostly concentrated in large hydropower until recently. The government began efforts in 2017 to diversify renewable energy technology into wind and solar, offering long-term PPAs with fixed pricing. With the support of international aid from organizations such as USAID and Energy Community, ambitious renewable energy production targets have been set. In addition, Albania plans to build over 500 MW of gas-fired power plants, with the support of the IFC (Bankwatch Network, 2018). Energy efficiency is a key factor in the National Energy and Climate Plan

(NECP), as the country has targets to increase energy efficiency by 20% and reduce power distribution losses from 26.4% in 2017 down to 10% by 2030 (Jonuzaj, 2018).

Challenges and Opportunities for Women in the Energy Sector

While the proportion of the Albanian working population has increased substantially between 2013 and 2017, the gender gap has fallen only slightly – from 20% to 18.2%. The nation's labour market is divided (by gender) both horizontally (type of job) and vertically (hierarchical level). Horizontal division is demonstrated in Table 3. The differences range from 94% (men in construction) to 74% (women in human health and social work activities). It is interesting that women account for more than 60% of manufacturing, which is the largest (in terms of headcount) sector.

Table 3 – Shares of employment by sector, by gender, 2017.

Sector	Employees (thousands)	Women (%)	Men (%)
Construction	40	5.6	94.4
Other Industry (Mining, Energy, Water supply)	27	11.8	88.2
Transportation and Storage	17	13.4	86.6
Agriculture, Forestry, and Fishing	14	24.9	75.1
Public Admin. and Defence; Compulsory Social Security	64	30.0	70.0
Information and Communication	10	34.3	65.7
Accommodation and Food Service Activities	35	36.2	63.8
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	51	40.3	59.7
Administrative and Support Service Activities	32	45.7	54.3
Financial and Insurance Activities	10	46.4	53.6
Professional, Scientific, and Technical Activities, and Real Estate	6	49.5	50.5
Other Services	20	59.2	40.8
Manufacturing	101	64.0	36.0
Education	57	73.3	26.7
Human Health and Social Work Activities	42	73.8	26.2
Total	**526**	**45.5**	**54.5**

Source: World Bank, 2019a

Table 4 – Shares of employment by occupation group, by gender, 2017.

Occupation Groups (ISCO-08)	Women (%)	Men (%)
Armed Forces	15.4	84.6
Craft and Related Trade Workers	19.5	80.5
Managers	30.2	69.8
Skilled Agricultural, Forestry, and Fishery Workers	30.7	69.3
Service and Sales Workers	37.5	62.5
Clerical Support Workers	44	56
Technicians and Associate Professionals	46.7	53.3
Elementary Occupations	51.6	48.4
Plant and Machine Operators and Assemblers	53.7	46.3
Professionals	61.2	38.8
Total	**45.5**	**54.5**

Source: World Bank, 2019a

While these data cannot explain what causes the disparities, horizontal occupational division is one barrier hindering both genders from realizing their full potential in the labour market. This division

limits career development opportunities and confines both genders – though more so for women – from picking up certain professions. Table 4 presents the vertical division in Albania. Armed forces (85%), craft/trade (81%), and managerial (70%) roles have a higher tendency to be filled by men. Women have the highest share of professional roles (e.g., accountant, economist, lawyer, 61%).

Table 3 shows that the participation of women in the Other Industry category - including the energy sector - is the second lowest (11.8% for mining, energy, and water supply). There are no studies available to analyse this gender gap, although a detailed study by The World Bank (2019a) was undertaken recently to assess women's participation in the construction sector. This study found no evidence of systemic bias against promoting education and higher studies for females, in fact, more college graduates are women. However, the distribution across field of study is unequal. The percentage of female college graduates in 2017 is as follows:

- Education: 84%
- Health and Welfare: 73%
- Social Sciences: 70%
- Engineering, manufacturing, construction: 37%

While the proportion of women who study engineering, manufacturing, and construction is higher in Albania than in most countries, they tend to get jobs in other fields upon graduation. While the World Bank study found no evidence of systemic bias, this may be a manifestation of gender stereotyping. Danaj and Wittberger (2011, cited in World Bank, 2019a) suggest that courses available for vocational studies are mostly considered as "male professions," such as industrial trade, electromechanics, and construction. This suggested stereotyping may create obstacles for female graduates in finding suitable job opportunities in a so-called "masculinized labour market", influencing the perception of a gender dimension to occupational profiles and constraining educational decisions, hiring practices, and compensation levels.

The expansion of renewable energy projects in Albania will create direct and indirect job opportunities in the energy sector and associated supply chains. This transition will create opportunities for investment, entrepreneurial activities, and the development of a skilled workforce. As the renewable energy sector (not accounting the hydro power) is in its infancy, opportunities for women in knowledge creation, data analytics, vocational education, research, and training will abound. There may also be significant potential in building local supply chains. In support of the post-COVID-19 economic recovery, the government should create investment mechanisms to support women entrepreneurs in taking advantage of the efforts to diversify renewable energy.

Good Practices for Gender Equality

In Albania, women own or manage approximately 29% of all enterprises. Many of these are small and medium enterprises (SMEs) in informal (family businesses and farms) lower value-added sectors with low GDP contributions. More than 40% of companies have no women on their governing boards. Only approximately 28% (World Bank, n.d.) of board members are women. The civil code protects women's right to own property, but traditions and social norms may undermine this basic right; this is particularly true in rural regions. It is often difficult for women to access essential information about their rights. Furthermore, even when women do own land, it is often administered as family property. Since bank loans require capital or collateral, and relatives who actually administer property tend not to support women's business endeavours, it can be difficult for women to start businesses (World Bank, n.d.).

The Albanian Government, as part of its Economic Reform Programme 2016, approved several initiatives to promote increased employment. Along with the UN Women's Economic Empowerment Programme, national gender equality priorities were outlined in the following. These programmes support the Albanian Government in meeting its international obligation for the economic empowerment of women (World Bank, n.d.):

- National Strategy for Gender Equality and Reduction of Gender Based Violence (2016-2020)
- The Beijing Platform for Action
- Convention on the Elimination of All Forms of Discrimination against Women

Putting women at the centre of governmental economic policies, the Economic Empowerment Programme supports key ministries and institutions in implementing policies oriented to preferentially empowering women. The focal policy areas intended to strengthen women's equal access to economic opportunities include:

- strategies and policies for better education, vocational training, and higher decent employment
- reduced labour market gender segregation
- laws that strengthen women's rights in the workplace
- greater knowledge and skills for rural women
- women's self-employment and entrepreneurship opportunities
- a favourable environment for women-led businesses
- data collection to support business development
- mentoring programmes and business networks for women entrepreneurs in SMEs

For the first time in Albania's history, half of government cabinet positions (nine out of 17) were held by women in 2017.

Recommendations

Policies are needed to support women in managing home and family responsibilities to encourage economic participation and remove barriers for women stemming from prevailing social norms that may limit their opportunities despite the existing legal framework. Recommendations to policymakers include:

- Facilitating women's access to training and information regarding property ownership and inheritance rights and procedures.
- Policies to preferentially promote women's access to credit and finance for education and entrepreneurship should be developed. In support of the post-COVID-19 economic recovery, the government should create mechanisms to support women entrepreneurs in developing the renewable energy sector in Albania.
- A detailed gender assessment of women's participation in the energy sector should be undertaken, analysing the economic impact of gender gaps in the labour market, and reviewing the expected impacts of potential policies to close these gender gaps.
- Education and training programmes for women should be developed, including vocational training for illiterate women and apprenticeships in the renewable energy.
- Public policy incentives promoting women's access to economic opportunities should be explored; these could address incentives to train and hire women, conduct gender certification programmes and training for public servants to support women working in the energy sector.
- Utilize digital media platforms to influence women's career aspirations and expectations, through informational campaigns and programmes based on mentors/role models.

Belarus

Energy and Electricity

Belarus has few domestic energy reserves and relieson oil and gas imports from the Russian Federation for a substantial portion of total primary energy supply (Patonia, 2021). Much of the imported oil (19 Mt in 2018) is refined and re-exported (12 Mt in 2018). Natural gas has the largest share in the Belarusian energy mix (61% in 2018). Only a very small proportion (0.8%) of consumed natural gas is produced (5,948 KJ in 2018), as opposed to imported (785,185 KJ in 2018). Except where otherwise noted, the statistics in this section are from the IEA (2019); Table 5 lists some key energy indicators for Belarus.

Table 5 - Key energy indicators for Belarus - 2000, 2018.

	2000	2018	Δ FROM 2017
ENERGY PRODUCTION (MTOE)	3.54	4.15	↑0.18
TOTAL PRIMARY ENERGY SUPPLY (MTOE)	24.72	26.96	↑1.42
ELECTRICITY FINAL CONSUMPTION (TWH)	29.9	35.16	↑0.83
TOTAL CO_2 EMISSIONS (MT)	52.12	57.09	↑3.07
SHARE OF RENEWABLES IN ENERGY MIX (%)	4	6	↓0.2

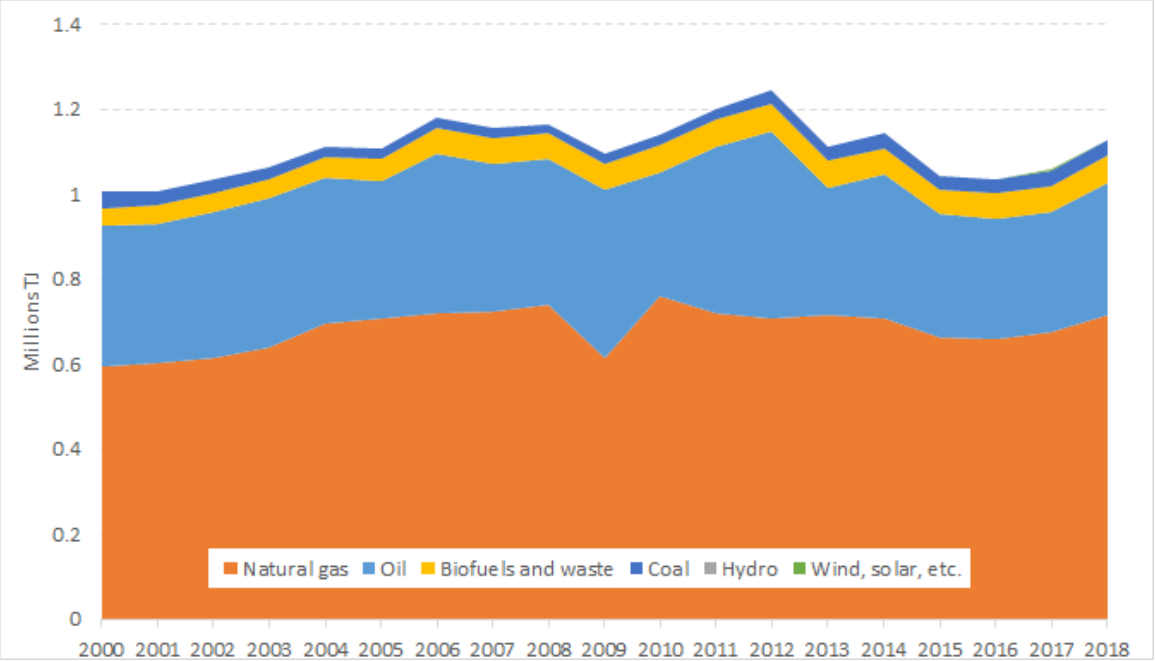
Source: IEA, 2019

Energy Generation

As can be seen in Figure 6, the energy mix in Belarus has been consistently dominated by the combustion of natural gas and oil (91% in 2018), with renewable energy a very small component. In 2018, 5.9% of the total primary energy supply was from renewable sources. Not all renewable energy is clean (using a non-polluting fuel), and biofuels/waste is a fairly consistent 99% of the renewable energy generated. Indeed, solar/wind energy was not introduced in Belarus until 2012, and still only accounts for 0.1% of the energy mix.

In 2008, the Security Council of Belarus adopted the "On Development of Nuclear Energy in the Republic of Belarus" Resolution. The country has two nuclear power plants, each with nameplate capacity of 1,110 MW. BELARUSIAN-1 started generating energy commercially in June of 2021, while BELARUSIAN-2 is still under construction.

Figure 6 - Total energy supply by source for Belarus, 1990-2018.



Source: IEA, 2019

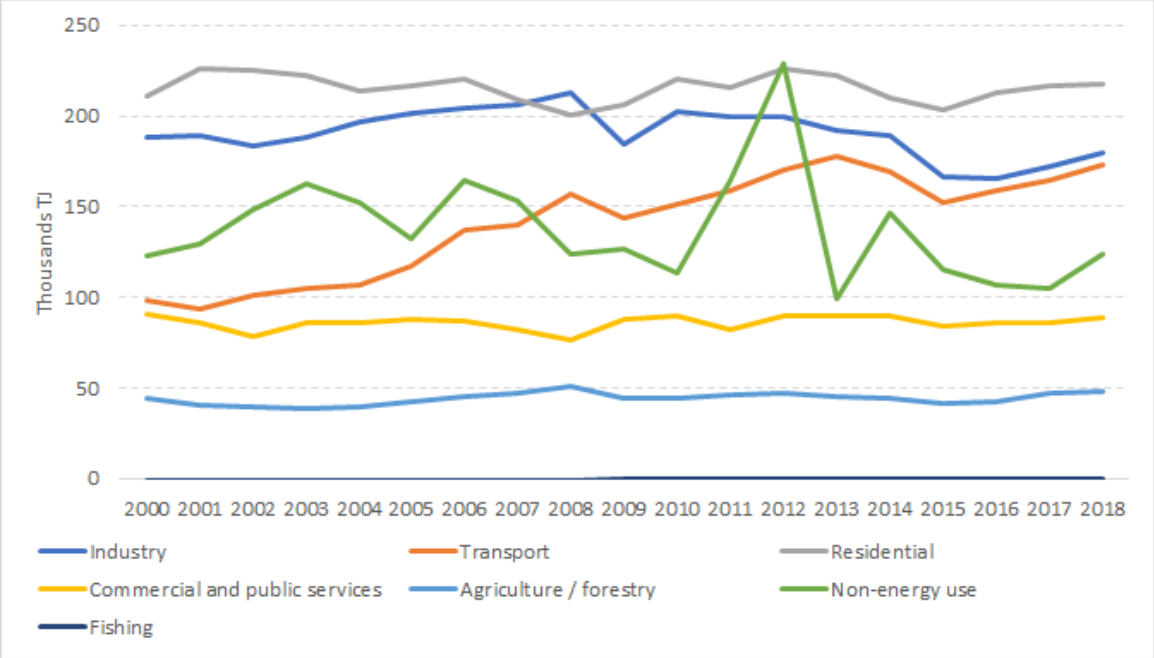
Generation of electricity is similarly dependent on fossil fuels, with only 1.8% of electricity generated from renewable energy; hydropower, wind, and solar photovoltaic (PV) technologies account for 1.3% of the electricity mix.

Energy Consumption

Nearly 80% of the total final consumption of energy is from oil (30.4%), heat (26%) – CHP / autoproducers, and gas (22.1%). With the exception of a 55% spike in oil consumption in 2012, total final consumption of energy has been quite consistent. This spike in oil consumption was entirely used for non-energy uses[1], which nearly doubled in the same year, as can be seen in Figure 7. While energy consumption increased by approximately 10% since 2000, the relative shares by sector have remained relatively consistent, except for transport, which has increased by more than 75%. The majority of final consumption is for residential and industrial use. According to the Government of Belarus, the industrial sector accounted for 26% of 2019 GDP - primarily agricultural, automotive, and electrical equipment manufacturing, followed by chemicals (Republic of Belarus, 2018).

[1]Predominantly (oven coke derived from petroleum; used for food, beverage, and tobacco production). Source IEA (2019).

Figure 7 - Total final consumption by sector for Belarus, 1990-2018.



Source: IEA, 2019

Economic Interlinkages of the Energy Sector

Belarus has recently begun integrating circular economy concepts into its energy transition plans. The draft National Strategy for the Sustainable Development of the Republic of Belarus for the period ending 2035 was developed in 2018 (Republic of Belarus, 2018) details issues related to the efficient use of resources – predominantly waste management and the production of goods from reused materials. Waste management is especially important, as the growth of waste volumes continues to outstrip the availability of land that can be used for landfills. The government's strategy for managing waste expects that almost half of secondary raw materials by 2035 will come from municipal solid waste. In order to reduce the volume of waste plastics, Belarus issued the presidential decree entitled "On a phased reduction in the use of polymer packaging", which came into effect in early 2020. The Capacity Building for Strategic Planning and Management of Regional Structural Transformations in Belarus in the Context of the Circular Economy (2019-2020) project, implemented with the help of Germany, targets developing the circular economy in the Brest Oblast. At the same time, the National Statistical Committee of the Republic of Belarus (Belstat) is deploying accounting and monitoring programmes to support the robust circular economy as it develops, driving the green economic growth. Belstat, the Ministry of Housing and Utility Services, and the Ministry of Natural Resources and Environmental Protection are collaborating to improve the statistical reporting of waste and secondary raw materials, with a particular focus on e-waste.

In Belarus, all aspects of the renewable energy sector are regulated by the Law on Renewable Energy Sources, Decree on the Use of Renewable Sources of Energy, and Resolution on Setting and Allocating Quotas for the Construction of Renewable Energy Facilities. These regulations cover the construction and modernization of renewable power plants and electricity generation and consumption. According to the 2016-2020 Scientific and Technical Programme for Power Engineering and Energy Efficiency, renewable energy R&D priorities are focused on the combustion of industrial biogas and municipal waste. While renewable energy generation is important, the country's sustainable energy plans put much more emphasis on reducing the energy load by increasing energy efficiency and system reliability.

Challenges and Opportunities for Women in the Energy Sector

Women in Belarus have high living standards when compared internationally. As per the 2020 Global Gender Gap Index, Belarus is ranked high: 29th out of 153 countries. In the Economic Participation and Opportunity subindex the country is ranked even higher, at the 5th place (WEF, 2019). The country's literacy level is high, and primary and secondary education are compulsory; however, there is a significant gender gap in tertiary education. While men have a higher tendency to matriculate to vocational schools, more womenj enrol in universities, but do not further their career to achieve higher positions. In 2018, 95%of women and 80% of men completed their tertiary education[2]. As shown in Table 6, women tend to graduate from university having studied social work, teaching, humanities and other subjects, followed by STEM subjects.

Table 6 – Graduates from higher education by field in Belarus, 2017.

Field of Education	Women (%)	Men (%)
Security Services	18.5	81.5
Engineering and Technology	28.2	71.8
Agriculture and Forestry	36.8	63.2
Architecture and Construction	38.3	61.7
Teacher Education, Vocational Education	50.8	49.2
Natural Sciences	52.4	47.6
Physical Training, Tourism and Hospitality	57.9	42.1
Communications, Law, Economics, Management, Business Admin.	69.8	30.2
Arts and Design	70.1	29.9
Health	74.2	25.8
Humanities	77.5	22.5
Environmental Sciences	79.7	20.3
Catering, Personal Services	79.8	20.2
Teacher Education	80.3	19.7
Social Protection	90.3	9.7

Source: Kremer, 2019

Good Practices for Gender Equality

Legislation in Belarus does not discriminate against women in any way, and the Labour Code explicitly forbids discrimination based on race, gender, language, or religion. However, there is a significant gender pay gap observed across all economic sectors - almost 25% in 2017 (Kremer, 2019). The gap is highest in the mining and manufacturing sector, which are mostly male-dominated occupations, and lowest in agriculture and other female-dominated sectors such as education, healthcare, and social work. It is important to consider that the state offers support to women by providing maternity leave for three years, and mothers of minor children are legally entitled to work flexible or part-time schedules. Without-cause dismissal of a pregnant woman is penalized by the law (Kremer, 2019).

As mentioned earlier, according to the Scientific and Technical Programme for Power Engineering and Energy Efficiency and National Strategy for the Sustainable Development, Belarus's sustainable energy transition plans prioritise:

- increasing energy efficiency and system reliability
- combustion of industrial biogas and municipal waste
- circularity of waste materials

[2] In 2016-17, 95% of women and 80% of men ofcompleted their tertiary education.

The latter two areas of development are relatively new in Belarus, not relying on established industries but instead diversifying to develop a sustainable and green economy. As these sectors are new several opportunities to encourage the participation of women can be promoted. For example, advanced waste management and the implementation of a circular economy can provide significant opportunities for women. With their extensive academic qualifications, especially in business administration and education, women can contribute to the sustainable energy transition in Belarus and the development of a trained workforce for the new sector.

Recommendations

- Despite the substantial encouragement given to women to obtain a college education, traditional views on the role of women are still common in Belarusian society. It is also possible that the male members of society tend to underestimate the role of women in the labour market. These perceptions act to limit the contribution women can make in the COVID-19 economic recovery and should be addressed.
- There are significant gaps in wages between genders; narrowing the wage gap could encourage higher participation of women in the energy sector, which can help drive economic growth with the energy transition.

Ukraine

Energy and Electricity

Ukraine's energy sector has historically relied upon oil, gas, and coal imports from the Russian Federation. However, this situation has changed dramatically over the course of the past two decades. Oil imports peaked in 2003, and gas imports peaked a year later; coal imports have risen steadily since 2000 (IEA, 2019). Ukraine is also a significant importer of refined oil products – primarily from Belarus. Table 7 details a few key indicators for Ukraine; the data throughout this section are from the IEA, 2019) except where otherwise indicated. Since 2000, the total energy demand in the country dropped by approximately 30% from 133.8 MTOE to 93.5 MTOE, largely due to structural economic changes, economic crises, and military conflict in 2014 that left a significant portion of the industrial sector in temporarily occupied territories (east and Crimea)[3].

Table 7 - Key energy indicators for Ukraine - 2000, 2018.

	2000	2018	Δ FROM 2017
ENERGY PRODUCTION (MTOE)	76.44	60.88	↑2.02
TOTAL PRIMARY ENERGY SUPPLY (MTOE)	133.81	93.49	↑4.03
ELECTRICITY FINAL CONSUMPTION (TWH)	136.63	136.79	↑2.72
TOTAL CO_2 EMISSIONS (MT)	295.12	181.83	↑10.5
SHARE OF RENEWABLES IN ENERGY MIX (%)	16	28	↓0.9

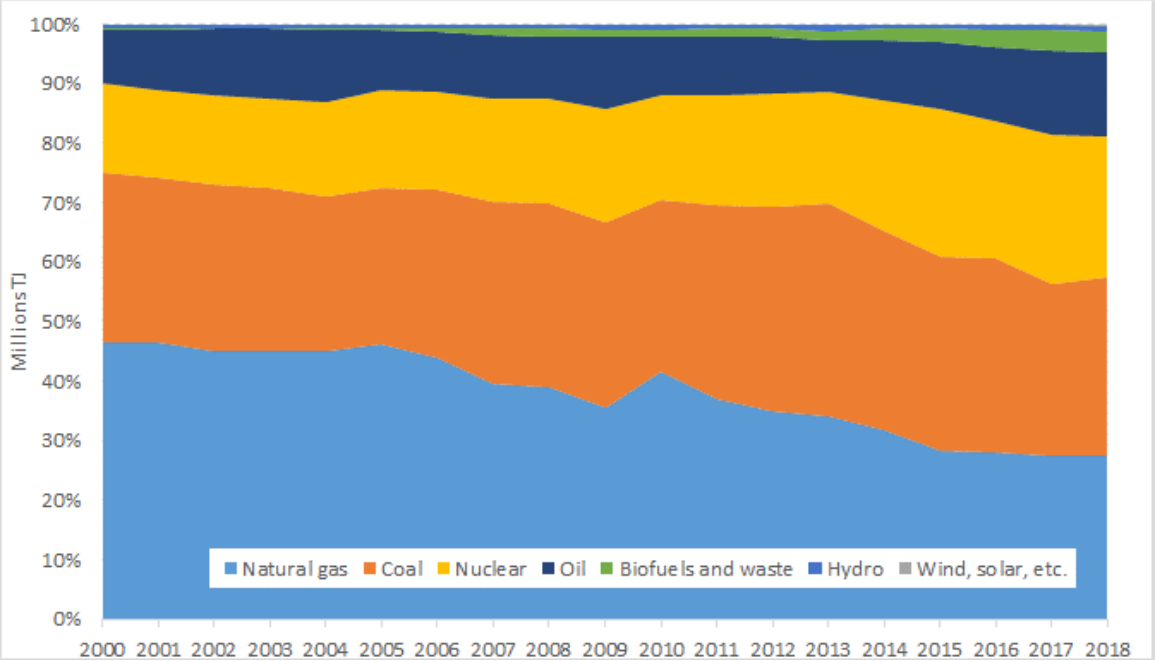
Source: IEA, 2019

Energy Generation

As shown in Figure 8, Ukraine's energy demands are met primarily by coal (30% in 2018), natural gas (27.5% in 2018), and nuclear power (23.7% in 2018). The remainder of the nation's energy is generated by oil, biofuels/waste, and hydropower, with an insignificant amount of wind and solar PV (0.2% in 2018). Similar patterns can be observed in the electricity generation mix, which is predominantly nuclear, and coal-fired, followed by gas-fired and hydropower plants.

Figure 8 - Total energy supply by source in Ukraine, 2000-2018.

[3] https://www.un.org/press/en/2021/sc14434.doc.htm



Source: IEA, 2019.

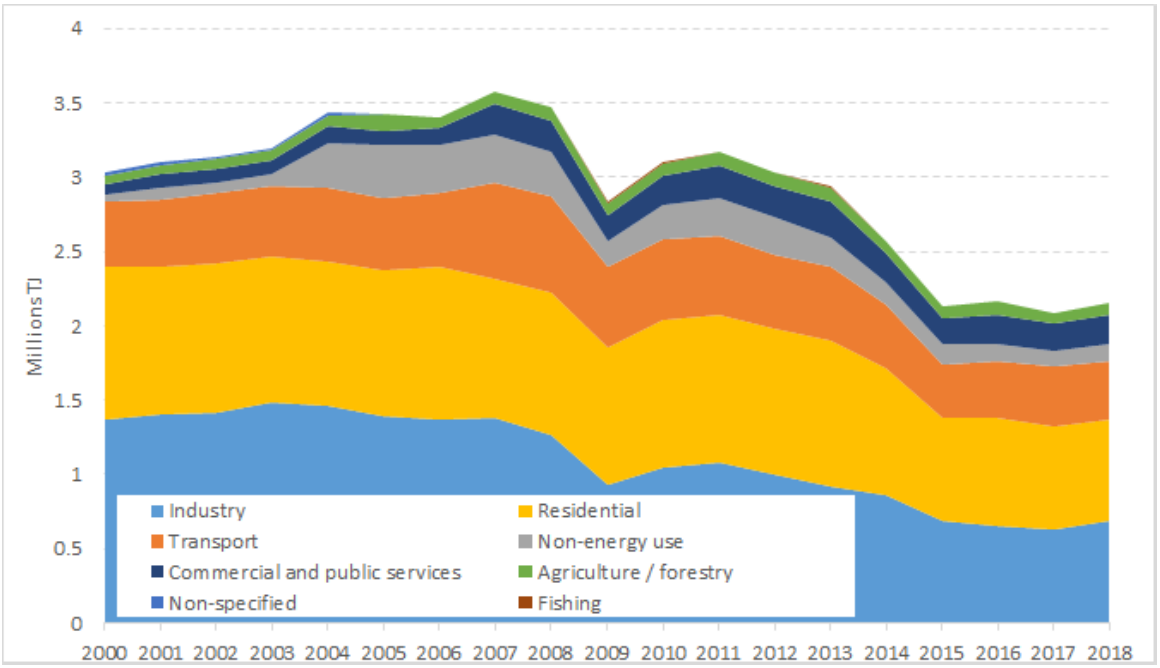
As demand and gas imports decreased, natural gas lost a significant share of the energy mix (from 46.4% in 2000 to 27.5% in 2018). Most of the shortfall was met by an increase in nuclear energy and oil combustion. Considering the other green renewable energy technologies in Ukraine's energy mix, hydropower has stayed relatively flat, while wind and solar PV only started to grow since the introduction of a feed-in-tariff in 2008. A 2008 ammendment to the 1997 Electric Power Industry Law, gave renewable energy producers the right to sell energy generated through renewable sources back to the state[4] .

Energy Consumption

Similar to the other countries analysed in this report, most of Ukraine's energy is consumed by the residential, industrial, and transport sectors. Until 2006, industrial demand accounted for up to 46% of the total consumption, having started declining in 2003. As of 2018, industrial and residential consumption are both approximately 32%, followed by transport (18.4%). These trends can be seen in Figure 9.

Figure 9 - Total final consumption by sector in Ukraine, 2000-2018.

[4] https://sk.ua/publications/green-tariff-in-ukraine/



Source: IEA 2019

Economic Interlinkages of the Energy Sector

Ukraine is simultaneously one of the largest producers of hydrocarbons in Eastern Europe and one of the least energy-efficient countries in the world (IEA, 2019). Despite increasing energy efficiency in recent years, Ukraine continues to consume nearly three times the OECD average (per unit of GDP). The Government of Ukraine has proposed a "Green Deal" (IEA, 2019) initiative, aimed at achieving their published Green Energy Transition Target 2050. The initiative commits Ukraine to an energy transition pathway based on actively developing energy efficiency measures and phasing out fossil fuel-based energy in favour of renewable energy sources. However, contrary to the long-term goal of 2050, the government continues to invest public funds in developing nuclear and gas combustion energy projects. Considering the decreasing costs of solar and wind power and the advancements being made in energy storage technologies, Ukraine could transition its energy system quite cost effectively. Increasing reliance on natural gasposes substantial risksconsidering that Ukraine currently imports approximately half (393,516 of 695,163 TJ - 57% - in 2018) of its final gas requirements(IEA, 2019). Investments in gas-fired capacity will result in higher electricity costs and bolster the entrenched position of fossil fuels in the energy mix leading to carbon lock-in. While dispatchable natural gas peaking units are often used to compensate for the intermittency of solar and wind power, greener technologies, such as battery energy storage system (BESS), smart transmission and distribution grids, and distributed energy generation, can meet this need (Rybachuk & Krynytskyi, 2020).

The Government of Ukraine has recently endorsed the Environmental Security and Climate Change Adaptation Strategy of Ukraine until 2030, key roadmap to assess the impact of climate change on society, the economy, and the environment. It alsoadapts sectoral and local policies and makes better use of climate data. Furthermore, the upcoming NDC Roadmap and Financial Strategy will guide the country's economic and social transformation across all sectors, population groups, and regions. Implementation of these key strategic frameworks is central to shifting the Ukrainian economy to more sustainable and resilient growth prospects.

There are further challenges in Ukraine related to electricity system infrastructure. Government expenditures to maintain and upgrade the power grids are insufficient, and digitalization technologies

such as smart meters and smart grid monitoring devices are absent. While Ukraine has higher feed-in tariffs to promote the adoption of renewable energy generation, the higher prices that are paid redirect public funds away from key energy transition reforms (Prokip, 2021), and there have been considerable challenges in maintaining the payments in recent years.

After signing the Association Agreement with the European Union in 2014, Ukraine created policy targets across several sectors, including the energy sector. Several initiatives and measures have been developed such as deregulating wholesale and retail gas market pricing, raising tariffs, reducing cross-sector electricity subsidies, and phasing out coal subsidies while promoting energy efficiency measures. In 2017, the Cabinet Ministers of Ukraine adopted the Energy Strategy of Ukraine (ESU 2035), which identifies six objectives for transforming the energy sector along with policy goals and a timeline which is divided into three phases: 2017-2020, 2021-2025, and 2026-2035. Ukraine's poor track record for energy efficiency has been improving, perhaps partially due to governmental measures designed to strengthen the position of energy efficiency in the county's energy transition. The following broad objectives have been identified (OECD, 2020):

- building an energy-efficient society
- ensuring energy independence and the reliability and sustainability of the fuel and energy complex
- strengthening market development
- enhancing the sector's investment attractiveness
- promoting network integration
- establishing a "Modern Management System"

The Ukraine government has developed a strategic objective to enhance grid flexibility and enable synchronization with the European grid in 2023. This initiative is the most important transformational objective for the power sector[5].

Coal Just Transition

According to recent data from the Centre for Research on Energy and Clean Air, emissions[6] from Ukrainian coal power plants were associated with an estimated 5,000 deaths in 2019, an increase over more than 50% from 3,300 in 2018; the most affected regions in Ukraine were Donetsk, Kyiv, Dnipropetrovsk and Lviv. The social costs related to the associated healthcare, reduced economic productivity and welfare losses amounted to an estimated present value of €8.4 billion in 2019, of which €3.2 billion in Ukraine and €5.1 billion in other countries.

The Government has recently adopted Just Transition concepts in the Ukraine's coal regions with a 2030 target, it is estimated that 850,000 people live in affected local communities (including 110,000 children). The goal is to ensure that these communities and the 38,000 people directly employed in coal mines are treated in a socially responsible manner, and benefit from increased diversification of the local economy, and improved infrastructure.

COP 26 Developments

[5] https://documents1.worldbank.org/curated/en/856841615833701901/pdf/Concept-Project-Information-Document-PID-Improving-Power-Sector-Resilience-and-Competitiveness-in-Preparation-for-Integration-with-the-European-Power-Grid-P176114.pdf

[6] https://en.ecoaction.org.ua/wp-content/uploads/2021/09/Ukraine-coal-health-impacts_eng.pdf

At COP26, Ukraine joined the Powering Past Coal Alliance[7], confirming its intention to phase out coal in power generation and set a course for the transition to renewables energy.

Along with 100 other countries, Ukraine has also joined the Global Methane Pledge Initiative. The Initiative's goal is to reduce global methane emissions by 30% by 2030 from the 2020 level. For Ukraine, this means setting and working to achieve mitigation targets for methane emissions in all relevant economic sectors.

To launch climate initiatives, Ukraine needs to have a framework for the regulation of industrial activities, as required by the Directive 2010/75/EU on Industrial Emissions. Its implementation is Ukraine's homework according to the Association Agreement since 2017.Without it, implementing Ukraine's declarations on decarbonization and contribution to the goals of the Paris Agreement is impossible.

Challenges and Opportunities for Women in the Energy Sector

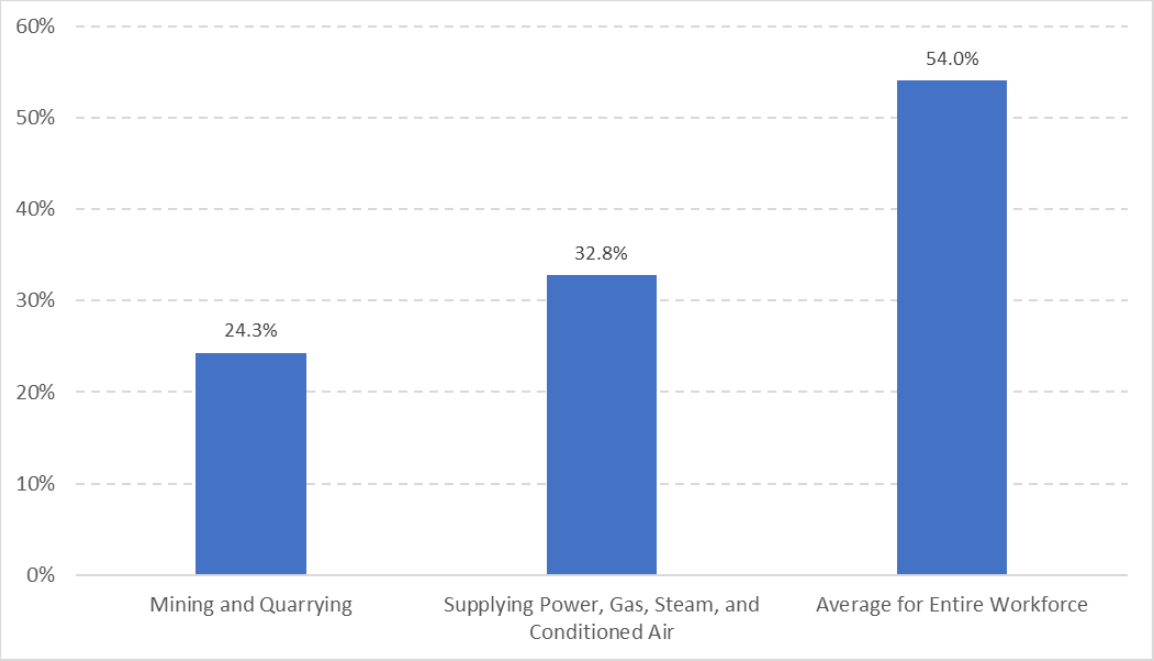
According to research conducted by the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine (Kushnarenko & Slipenko, 2019) supported by the Heinrich Böll Foundation, the share of women in the energy sector workforce is gradually growing, though women still constitute only about a quarter of all the sectoral workforce. Women's shares of employment are shown in Figure 10, fewer women work in more established subsectors, such as upstream oil and gas production. This study identified several potential barriers to women's employment in the energy sector, including:

- protective restrictions preventing women from working in certain professions with dangerous work conditions.
- lower proportion of women holding STEM degrees; 20-25% women work in Ukraine's energy sector
- work environments not amenable to employees with family commitments (lack of remote employment opportunities, remote location of work sites, rigid schedules, etc.)
- lack of corporate goals to preferentially hire more women
- traditional ideas regarding the gender roles in society

In 2017, Ukraine lifted a prior ban preventing women from being employed in 458 "dangerous to health" jobs. However, Ukraine has not yet completed the procedure of denunciation of the Convention concerning the Employment of Women on Underground Work in Mines of all Kinds (Underground Work (Women) Convention No.45). In 2018, there was an attempt to denounce this convention, but this attempt was unsuccessful, and the next chance to repeal it will not occur until 2028, by when it is expected that most mines will be closed. Despite this prohibition, Ukrainian women do work in mines, but they rarely have relevant information in their employment records, depriving them of benefits and allowances. Due to the informal employment of women in the mines, they do not receive adequate income and social protection, although they are exposed to the same risks as men.

[7] https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/110421-cop26-ukraine-aims-for-2035-coal-phaseout-as-more-european-nations-join-alliance

Figure 10 – Share of employment of women in Ukraine.



Source: Kushnarenko & Slipenko, 2019

Good Practices for Gender Equality

According to the Global Gender Gap Report 2020 (WEF, 2020), Ukraine is ranked 59th out of 153 countries. The observed gender disparities suggest gender stereotypes about women in the workplace may remain. While women benefit from the paid maternity leave offered by the State, only 3% of fathers have the chance to do so. In a recent UNFPA Ukraine (2020) survey, nearly a quarter of respondents claim to have experienced domestic violence; approximately 80% of these were women.

In early 2021, the United Nations Population Fund (UNFPA) in Ukraine launched a three-year project (UNDP, 2020), in collaboration (providing funding) with the Embassy of Sweden in Ukraine and the Office of the Deputy Prime Minister for European and Euro-Atlantic Integration of Ukraine, to eliminate gender stereotypes and reduce violence against women.

The United Nations Development Programme (UNDP) in Ukraine mainstreams gender equality as a cross-cutting issue in such development areas as democratic governance, energy and the environment, inclusive development, recovery and peacebuilding. In the crisis-affected areas of the Donetsk and Luhansk oblasts, the UNDP, together with UN sister agencies and development partners, has established a network of shelters and day centers for survivors of domestic violence, providing psychological and advisory support to the survivors of gender based violence (GBV)and raising awareness of their rights. The UNDP also works with law enforcement entities and the justice sector to develop their capacity for dealing effectively with domestic violence. In addition, the UNDP has assessed gender-related challenges in climate policy – including energy, waste management, transport, and other sectors – and provided recommendations to address them, which were incorporated in Ukraine's updated Nationally Determined Contribution to the Paris Agreement.

The Centre for Corporate Social Responsibility (CSR Ukraine) and the USAID Energy Security Project has been mapping professions in the energy sector to use as the basis for an informational booklet targeted at schoolchildren. The intent is to develop awareness around the variety of energy professions available, courses to develop the requisite skills, career paths, and prospects for the

industry. In addition to practical advice from leading Ukrainian firms, the booklet will feature vignettes of energy sector specialists' jobs (DTEK, 2020).

The Ukraine Common Country Analysis[8] (CCA) identifies closing the gap in women's economic and political participation, eliminating sexual and gender-based violence (GBV) against women and girls, violence against children, and discriminatory gender stereotypes as key SDG accelerators.

In accordance with the ITU report on "Digitally Empowered Generation Equality: Women, Girls and ICT in the Context of COVID-19 in Selected Western Balkan and Eastern Partnership countries[9]" , technical education is the foundation of Ukraine's IT ecosystem. Every year, over 150,000 students graduate, among which 40,000 obtain degrees in technological studies. This includes, approximately 15,000IT specialists. Although the education system in Ukraine stays strong in mathematics and sciences, fundamental reform is needed in Ukrainian universities, since the current curricula and structure of universities and training institutes is tied to the requirements of the old economy, rather than the future economy. Weak business and management education has also been identified as a barrier to innovation and entrepreneurship, along the lack of job opportunities for university graduates. This has leadto many highly skilled Ukrainians working in other countries for international companies.

Recommendations

- Government should develop incentive based programmes to encourage more women to study STEM topics. Opportunities for corporate placements after course completion can be an attractive proposition for students.
- To the extent possible, companies should endeavour to implement programmes to promote better work-life balance; these could include flexible schedules and telecommuting options.
- The government should introduce leadership and mentorship programmes for women in the energy sector to promote gender balance in top decision-making roles. These could promote examples of women who built their careers in the sector and could be a useful avenue to encourage women to pursue opportunities in senior management.
- The government should develop awareness and advocacy campaigns, with the goal to identify entrenched gender stereotypes which may be behind gender-based division of professions or workplace discrimination.

[8] https://ukraine.un.org/en/126017-ukraine-common-country-analysis
[9] https://www.itu.int/dms_pub/itu-d/opb/phcb/D-PHCB-EQUAL.01-2021-PDF-E.pdf

United Kingdom

Energy and Electricity

The United Kingdom has bold sustainable energy transition goals, along with the means and ambition to achieve them; energy technology and innovation are at the heart of the country's decarbonisation policy. The United Kingdom's decarbonisation goals are to reduce baseline GHG emissions by at least 68% by 2030 and to achieve a net-zero energy system by 2050. The statistics in the rest of this section, starting from the key indicators in Table 8 are all from the IEA (2019).

Table 8 - Key energy indicators for the United Kingdom - 2000, 2018.

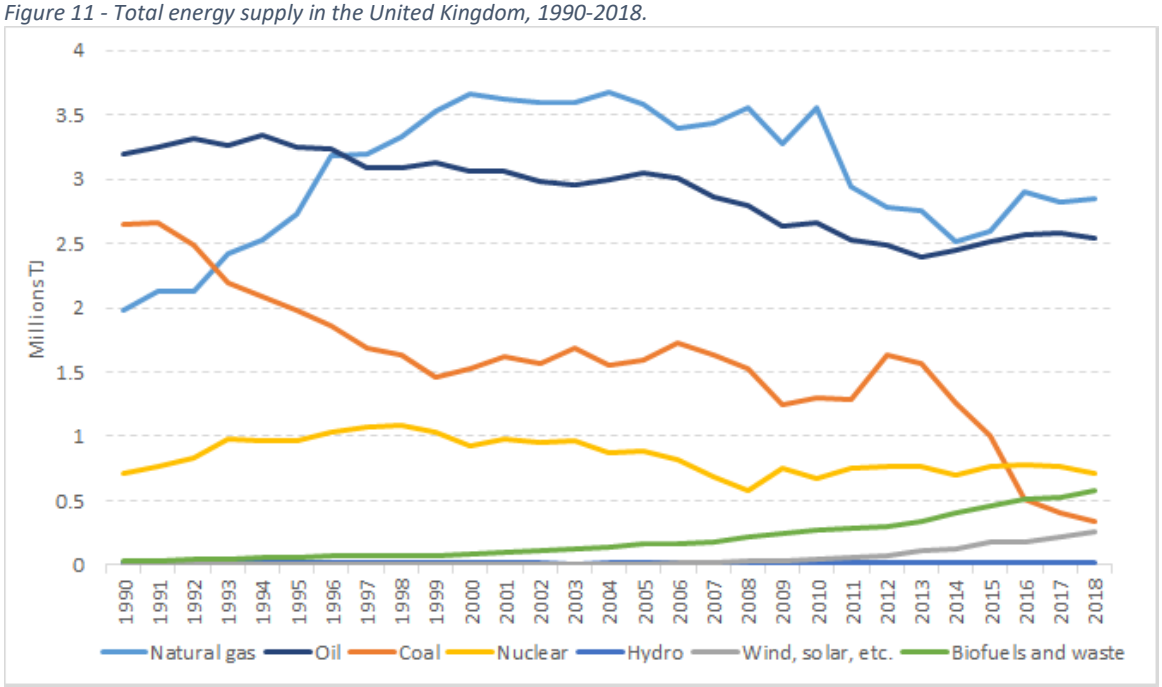
	2000	2018	Δ FROM 2017
ENERGY PRODUCTION (MTOE)	272.5	123.03	↑2.99
TOTAL PRIMARY ENERGY SUPPLY (MTOE)	222.99	175.21	↓0.93
ELECTRICITY FINAL CONSUMPTION (TWH)	360.1	325.93	↓0.66
TOTAL CO_2 EMISSIONS (MT)	520.56	352.36	↓7.58
SHARE OF RENEWABLES IN ENERGY MIX (%)	11	21	↑0.7

Source: IEA (2019)

Energy Generation

For the most part, the energy mix in the United Kingdom has stayed relatively constant since 2000. As of 2018, natural gas (39%) and oil (35%) are still the major fuel sources, accounting for almost three quarters of the energy. Wind and solar PV have grown steadily but generate less than 4% of energy.

Figure 11 - Total energy supply in the United Kingdom, 1990-2018.



Source: IEA (2019)

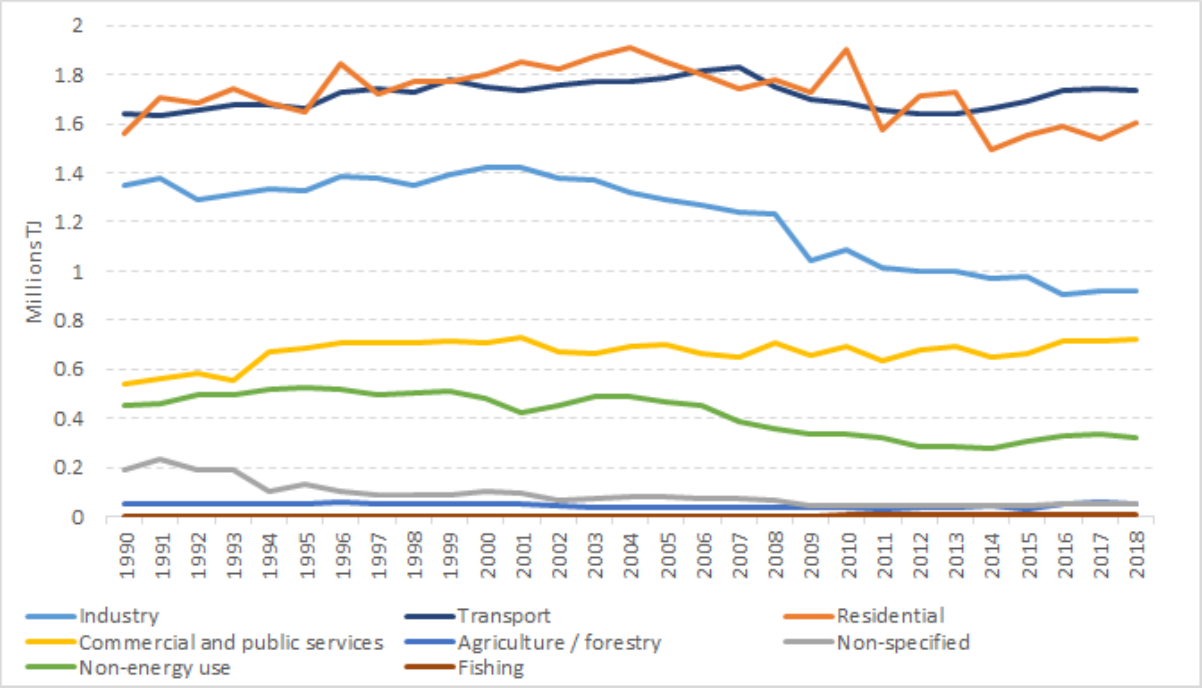
Ostensibly, a shining example of sustainable transition is the decline of energy generated by coal – from 31% in 1990 down to 3.4% in 2019 (slightly less than wind and solar PV). However, the shining example becomes somewhat tarnished when we realize that a substantial portion of that reduction was picked up by biofuels/waste, which has steadily climbed up to 8% of the energy mix in 2018. A better example would have been if more of coal's share went to cleaner, non-polluting renewable energy sources. These trends are displayed in Figure 11. The United Kingdom's current mix of electricity generation technologies is dominated by natural gas (41% in 2018), wind (20% in 2018), and nuclear power (17% in 2018). The rapid growth in wind power – from 0.7% in 2005 – is of special note,

but far short of the incredibly fast divestment of coal power from the electricity generation mix, following a similar trend as the share of coal in the country's total energy supply. From 1990, coal combustion dropped gradually, then peaked again in 2012 before declining more rapidly. As recent as 2015, nearly a quarter of electricity was generated by burning coal; in just four years, this dropped by an order of magnitude to 2.4% in 2019.

Energy Consumption

The United Kingdom's economy is founded on service-oriented businesses. This is reflected in the total final consumption data. In both Belarus and the Ukraine, in which industry is the dominant contributor to GDP, either the largest or second-largest proportion of energy was consumed by industry. In the UK, nearly a third of energy consumption is for transport (32.1% in 2018), followed by residential use (29.7% in 2018). Industrial and commercial and public services consumptions are a distant 3rd and 4th, at 16.9% and 13.4% in 2018, respectively. Since 2000, energy consumption for transport has been relatively consistent; residential and industrial consumption declined slightly, and commercial use saw a slight uptick; see Figure 12.

Figure 12 – Total final consumption by sector in the United Kingdom, 1990 – 2018.



Source: IEA,2019

Economic Interlinkages of the Energy Sector

The United Kingdom has formalized its commitment to an 80% reduction of GHG emissions from 1990 levels by legislating the net-zero 2050 target. Meeting this target will require an economy-wide transition, focused on the energy sector. This is not just about technological change, but largely a behavioural and social change, requiring a consumer-led transition. In support of the UK's net-zero target, Ofgem – the independent regulatory authority – has introduced the performance-based *Revenue = Incentives + Innovation + Output* (RIIO) model for energy generation and transmission operators. RIIO helps guide energy system investments to promote innovation at fair prices for consumers. To further encourage companies to invest and innovate, Ofgem is developing a regulatory framework, outlining the decarbonisation pathway for gas distribution and electricity transmission networks. This command-and-control policy instrument has already seen innovative practices and strategies adopted and committed by network and distribution companies in their business plans to meet the nation's decarbonisation objectives (Ofgem, 2020).

Several governmental bodies, including the Climate Change Committee, have developed detailed plans for achieving a net-zero emission economy by 2050. Despite the substantial amount of work already underway, the energy transition is still shrouded by uncertainty around the best path to decarbonisation. There are two reasons for this uncertainty:

- The United Kingdom's energy system infrastructure is complex, extensive, and highly interconnected. It includes billions of pieces of equipment, miles of networks connecting supply and demand centres and subsystems for storing and transporting both electricity and different types of fuel (solid, liquid, gaseous). These networks extend beyond the national borders. There are many possible ways to change such a complex system, and any change is bound to have many unanticipated consequences.
- The energy system is essential for nearly every aspect of everyday life, and transition should not negatively affect reliability and affordability of energy services.

Challenges and Opportunities for Women in the Energy Sector

A report jointly published this year by Pricewater House Coopers (PwC), the UK power industry, and POWERful Women[10] (PEI, 2021), analysed the composition of the boards of the top 80 most significant UK energy employers estimated to provide more than 150,000 jobs in the industry. These are some of the study's findings:

- 24% of board members across the sector are women
- 14% of executive directors are women
- 28% of companies (22) have no women on their board
- only 18 of the top 80 UK energy companies have female executive directors
- 31% of companies (25) have met the 2020 target of 33% for having women as board members while 15 companies met the goal to have 30% women in executive director roles by 2030

Table 9 reports the distribution of education and skill groups by gender (WEF, 2020).

Table 9 – Education and skills by gender in the UK, 2018.

Education and Skills	Women (%)	Men (%)
Services	0.06	0.1
PhD Graduates	0.82	1.19
Agriculture, Forestry, Fisheries & Veterinary	1.11	0.8
Information & Communication Technologies	1.23	6.82
Engineering, Manufacturing & Construction	3.75	16.35
Education	12.27	5.22
Natural Science, Mathematics & Statistics	12.55	14.91
Social Sciences, Journalism & Information	12.97	10.44
Arts & Humanities	17	13.18
STEM	17.53	38.08
Health & Welfare	17.7	7.73
Vocational Training	18.11	20.47
Business Administration & Law	20.69	23.85

Source: World Economic Forum, 2019

There is a relatively small proportion of women with STEM skills; this is likely a significant driver of the gender disparity observed in the aforementioned report, as there are fewer women with relevant

[10] POWERful Women is an initiative that promotes the professional growth and leadership development of women across the energy sector in the UK.

technical skills in the workforce. However, there is still significant opportunity for women to participate in the energy sector indirectly and through entrepreneurial activities. As can be seen in Table 9, a sizeable proportion of women have education and skills in business administration and law. These are interesting times for the energy industry, driven by the need for innovation, and there remains substantial potential for women to participate in many ways across all subsectors of energy.

Good Practices for Gender Equality

In 2019, Ofgem (Church, 2019) launched an initiative, calling all energy sector employers to promote diversity, eliminate the gender pay gap, and promote a culture of inclusivity within the energy sector. Several large employers, have taken this initiative very seriously. In the post-COVID-19 era, the trade association Energy UK, regulator Ofgem, and employer-led organization Energy & Utility Skills have announced a partnership with the British Broadcasting Corporation's "50:50 The Equality Project" initiative (Mavrokefalidis, 2021) to bridge the gender inequality gap. The country's energy industry is going through a transition to achieve net-zero emissions, but the industry's success depends on attracting diverse talent with all the skills, ideas, and expertise required to meet the challenge. As a part of this initiative, Energy UK developed informational materials documenting initiatives and activities undertaken in the energy sector and used them in outreach programmes working with schools and colleges to encourage girls to study STEM subject areas. In addition to its work through the Equality and Diversity Forum, Energy UK has also introduced a ban on all-male panels at sponsored events and a strong policy around participation in other events where there is a lack of gender balance (Energy UK, 2019).

In 2018, another initiative was launched to boost the number of women in middle and senior management in the country's energy industry. The Energy Leaders' Coalition is comprised of eight of the leading chief executives from the energy sector – of which only two are women. The coalition has made a public declaration to improve gender diversity in their companies and in the sector as a whole (Ross, 2018).

Recommendations

- Improve access to education and women's participation in STEM subjects to enable them to access technologies and get jobs. Create incentives to promote education and job security through apprenticeship programmes.
- Improve data collection to understand the barriers women face and the reasons behind their education and employment choices.
- Create financial incentives to promote women-led SMEs in the energy sector, either directly or through ancillary services.
- Promote mentorship platforms for women facilitating mentorship activities to preferentially encourage women professionals and subject matter experts from the energy sector to support connections among the female workforce through networking.

Uzbekistan

Energy and Electricity

With extensive gas reserves, Uzbekistan's energy sector is relatively self-sufficient. While the country is a net importer of both coal and oil, it exports gas that is not used for domestic consumption and is a net exporter of electricity. The country's extensive energy sector infrastructure is rapidly aging and poorly maintained. Table 10 lists a few key energy system indicators for Uzbekistan. Throughout the remainder of this section, all statistics are from IEA (2019), unless otherwise stated.

Table 10 – Key energy indicators for Uzbekistan – 2000, 2018.

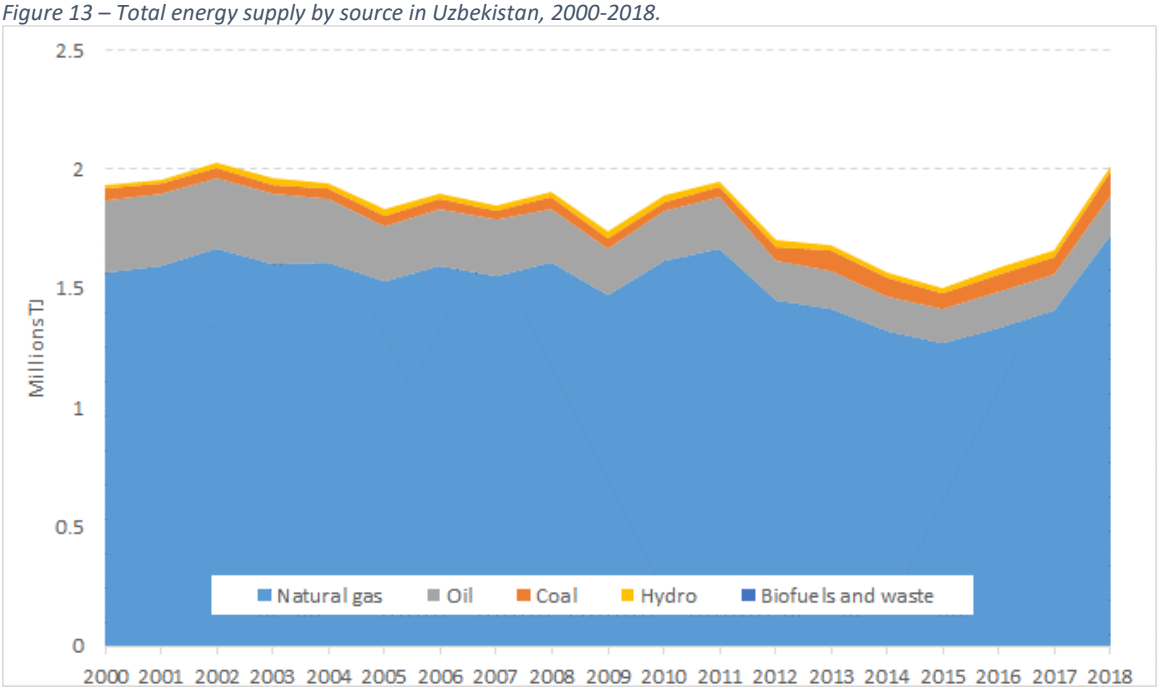
	2000	2018	Δ FROM 2017
ENERGY PRODUCTION (MTOE)	54.9	55.2	↑3.99
TOTAL PRIMARY ENERGY SUPPLY (MTOE)	50.9	46.39	↑2.65
ELECTRICITY FINAL CONSUMPTION (TWH)	43.81	57.68	↑6.83
TOTAL CO_2 EMISSIONS (MT)	120.21	107.96	↑0.89
SHARE OF RENEWABLES IN ENERGY MIX (%)	0.6	1.0	↓0.06

Source: IEA, 2019

Energy Generation

As of 2017, Uzbekistan held 1.84 trillion m^3 of proven gas reserves – 19th highest in the world (Worldometer, 2017). At the current rate of consumption, these gas reserves could last the country more than 40 years. It should come as no surprise, then, that gas has the largest share in the energy mix, and that Uzbekistan is wavering in its commitment to invest in renewable energy sources. As of 2018, 85.6% of the country's total energy demand was met by natural gas combustion technologies; see Figure 13. Except for the insignificant 1.1% of hydropower and biofuels/waste, the rest of the county's energy is generated from fossil fuels (oil = 8.3%, coal = 5.1%). Oil's share in the energy mix has come down from 15.7% in 2000, as energy demand itself has decreased. In some ways, the electricity mix narrative is similar.

Figure 13 – Total energy supply by source in Uzbekistan, 2000-2018.



Source: IEA, 2019

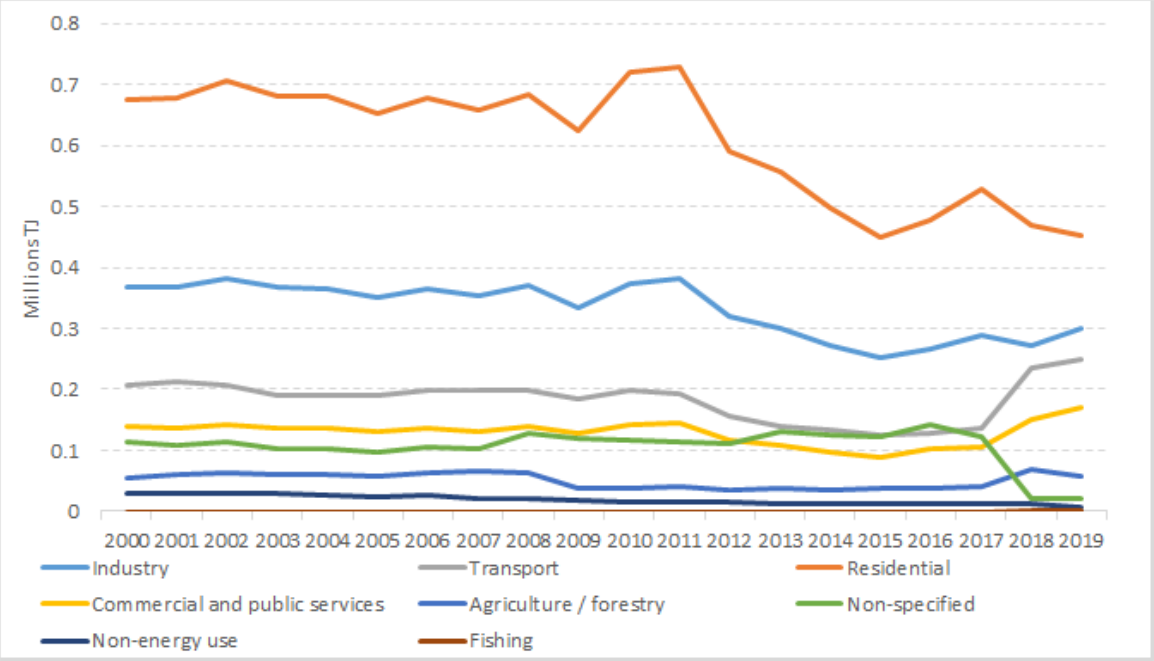
Approximately 86.5% of electricity was generated from natural gas in 2018, followed by hydropower at 9.4%, then coal and oil. Since 2000, total energy generated has increased by more than a third, from approximately 46,800 GWh to 62,900 GWh. At the same time, the share of natural gas increased by

approximately 10%. The share of coal has been relatively constant, while oil has declined. There is no consistent trend in hydropower; the annual amount varies with precipitation. The share of hydropower has been as low as 7.5% (3,528 GWh in 2000) and as high as 18.7% (8,927 GWh in 2005).

Energy Consumption

As can be seen in Figure 14, most of the energy generated in Uzbekistan was consumed for residential (38.2%), industrial (22.1%), and transport (19.1%) use in 2018. Commercial and public services is a relatively distant 4th at 12.3%. These four consumption sectors all saw a peak in 2010/2011 and have continued to decline since then, with two exceptions. In 2018, the transport and commercial and public services experienced a substantial uptick in energy consumption. The energy consumed by commercial and public services increased by 43% (from 105,878 TJ to 150,942 TJ), while transport usage nearly doubled from 137,315 TJ to 234,821 TJ.

Figure 14 - Total final consumption by sector in Uzbekistan, 2000-2018.



Source: IEA, 2019

Economic Interlinkages of the Energy Sector

While Uzbekistan is making consistent progress in developing an integrated fuel and energy industry, there are severe financial, infrastructure, and sectoral challenges. Coal imports increased nearly five-fold between 2013 and 2014, and has continued to increase since then, though at a slower rate. Oil imports have been high since 2007 (IEA, 2019). The financial losses mean reduced public revenues which could help fund the energy system transition. While the carbon emissions (per unit of GDP) in Uzbekistan has been declining steadily since 2000, it is still very high – at 1.1 kg CO_2 / per 2015 USD in 2018 (IEA, 2019). This is nearly twice the global average, and five times higher than the average among European Union member states. Reducing such a high emissions rate has taken high priority at the Ministry of Energy of Uzbekistan. In June 2021, the ministry announced a $380 million project to support private investment in the renewable sector (1,500 MW of renewable energy) and promote wider decarbonisation efforts as part of the country's clean energy transition. The investment project is approved by the World Bank and financed at very low interest rates. The investments will help enhance the performance of the national transmission and distribution networks, reduce transmission losses, and provide reliable energy supply. These are very important points, as Uzbekistan's electricity transmission and distribution network infrastructure is outdated and poorly maintained, resulting in

substantial transmission losses. The average technical losses can be as high as 2.7% in the main networks and more than 12% loss in distribution (IEA, 2019).

Presidential Decree UP-5544 (LEX.UZ, 2018) of September 2018 adopted the Strategy for Innovative Development of the Republic of Uzbekistan (2019-2021) and its implementation roadmap. Under the aegis of this strategy, mechanisms to integrate education, scientific research, and entrepreneurship are being developed to enhance the nation's scientific potential and R&D effectiveness. The intent is to facilitate the spread of research results, experimental design, and technological innovation, initially focused on the development of low-carbon energy sources. A World Bank (2021) review indicated that, as a result of this Strategy, 2021 gross expenditures in R&D are expected to quadruple from 0.2% of GDP to 0.8%. The World Bank review also highlights that Uzbekistan is aiming to foster innovation as a driver of economic growth and plans to join the top 50 countries in the Global Innovation Index by 2030. This ambition has acquired even greater importance since the start of the COVID-19 pandemic.

However, non-polluting renewable energy - a critical component in any sustainable energy plan - still fills a minor role in the country's total energy supply mix, and diversification of energy sources is practically non-existent. In addition to the combustion of coal for electricity generation, solid coal fuel is used heavily for heat in communal and residential buildings. There are a number of factors hindering the development of renewable energy sources in Uzbekistan. Several are listed here (IEA 2019).

- In Uzbekistan, electricity is still heavily subsidized; in 2018, the average price was 0.024 $/kWh (IEA, 2019); this is lower than the prices in Kazakhstan, Turkmenistan, the Russian Federation, and China. Such strong subsidies make the relative cost of renewable energy prohibitively expensive and discourage investments. However, as electricity is subsidized for consumers, a similar subsidy can be given to electricity producers that use renewable energy sources. This could help in adding more renewable energy sources in the supply mix, and lead to reduced reliance on fossil fuels.
- Legal frameworks supporting financial and economic mechanisms to stimulate the development of renewable energy generation are inadequate or completely absent.
- The rapid pace of renewable energy technology innovation has made it difficult for Uzbekistan to justify investments in the technology, fearing technological obsolescence. This barrier is magnified by the fact that the country has no renewable technology manufacturing capabilities, which results in higher purchase, installation, and maintenance costs.
- Public awareness of cleaner and greener forms of energy is lacking.

Despite being rich in hydrocarbon reserves, Uzbekistan is embarking on a plan to reduce GHG emissions, with a target of carbon neutrality by 2050. The European Bank for Reconstruction and Development (EBRD) has provided Uzbekistan with technical and financial support in developing its roadmap to achieve this target. Projects planned will be focusing on:

- construction of utility-scale renewable energy power plants
- modernization of the electricity transmission and distribution system
- decommissioning/conversion of outdated fossil fuel-based power plants

One of the EBRD's directives is to focus efforts on gender equality and inclusion. As part of this directive, the EBRD is cooperating with Uzbekistan to develop a roadmap to implement the (recently adopted) law on protection of women and gender equality. The EBRD is also providing guidance regarding the practical implementation of gender equality principles in the energy sector. These activities align with the country's green economy transition and Strategy for the Promotion of Gender Equality (UNDPa, 2020).

Challenges and Opportunities for Women in the Energy Sector

According to the Uzbekistan State Committee on Statistics (World Bank, 2021), approximately 54% of women – compared to 78% of men - participated in the labour market in 2017. Of these, only 39% of women and 62% of men worked in formal employment. In 2020, the Deputy Prime Minister and the Chairperson of the Women's Committee, Elmira Basitkhanova, reported that the number of girls in higher education had increased, and that the country has the highest literacy rate for women in the world at 99.98%. However, only 35% of women with secondary education are employed and 68% of women with higher education are employed; this shows that women with higher degrees should consider participating further in social, economic, and political activities. Regardless of gender, few people have college degrees in Uzbekistan; among people aged 25+, 20% of men and 13% of women hold a university degree (ADB, 2020). Increasing the number of women who complete higher education is key to enhancing their prospects for employment. Doing so will help them earn more for their families and contribute more to the country's economic growth. With such a relatively low proportion of half the population in the workforce, increasing women's employment – especially in the energy sector – can have a transformative impact on the post-COVID-19 recovery and the energy transition. With these goals in mind, the government of Uzbekistan announced an anti-crisis fund to mitigate the negative impact of the pandemic in June 2020, a package of measures to reduce poverty among women (Tulyakov, 2020). These measures include plans for:

- expanding women's employment and entrepreneurship
- preferential access to social assistance, healthcare, housing, and preschool services
- professional retraining and higher education

There are many opportunities for women in forestry management, indirectly contributing to the energy sector through ancillary services. One example could be R&D of forest-friendly approaches and technologies for the management of timber and non-timber resources. In addition to creating jobs and economic growth, these opportunities can benefit the environment and protect the limited forest cover (FAO, 2020). Sustainable forestry is linked with area development, basic (water, energy, roads) infrastructure development, and the provision of social services. In 2017, Uzbekistan's State Committee on Forestry developed a ground-breaking long-term budgeted Corporate Gender Strategy; among other outcomes, the strategy has established a gender coordinator position in each forestry firm.

The more ambitious second generation of Uzbekistatn's NDC states that the nation's high population growth rate and industrial development (construction, textiles, automotives, agriculture) require further development of the energy sector. In addition, further aridization of the climate will require additional energy consumption for cooling. Despite the parital reduction of GHG emissions due to the rapid development of renewable energy, total GHG emissions will likely increase, although insignificantly[11]. In light of this, another relevant Ukranian initiative, supported by UNDP, is the Resolution of the Cabinet of Ministries of the Republic of Uzbekistan, approving the National Program on the Complete Phase Out of Ozone-depleting Substances in Uzbekistan (#126, dd 09.03.2021). This initiative includes gender mainstreaming in the refrigeration and air-conditioning (RAC) sector with the involvement of several ministries and state agencies. Considering that about 20% of global energy generation is consumed for refrigeration, air conditioning, and heat pumps, and the limited representation of women in this sector, the national program may trigger the involvement and employment of women in the RAC sector in other countries.

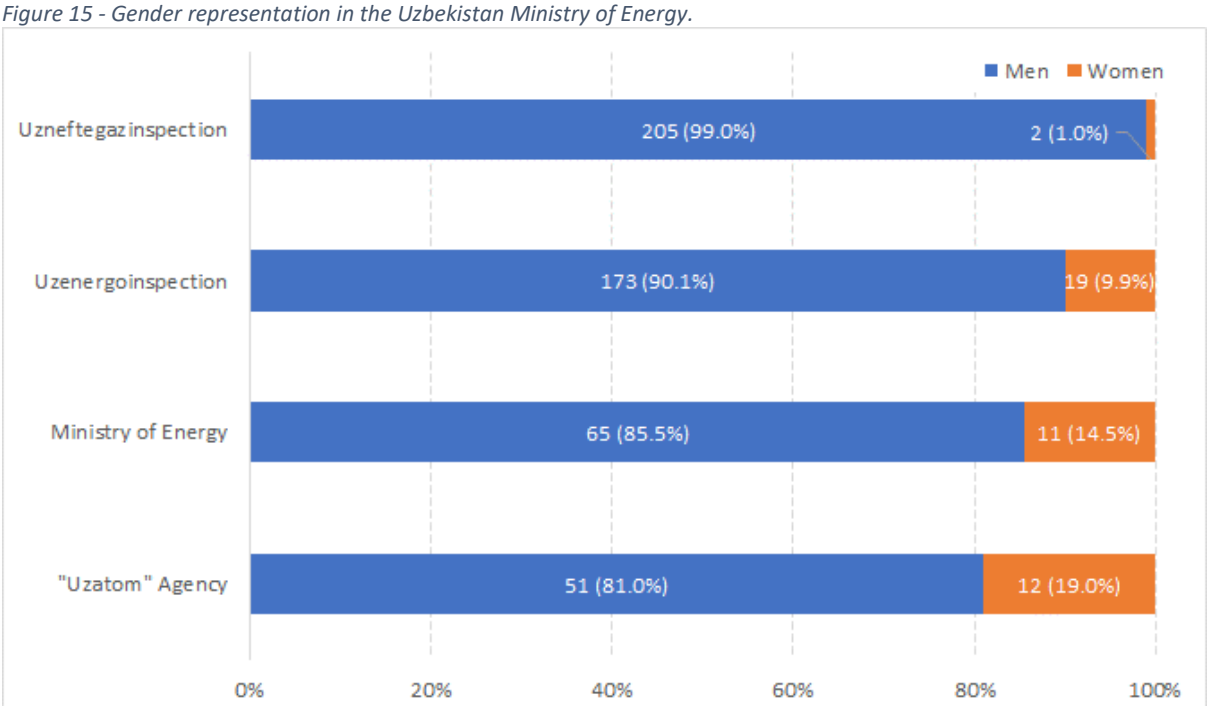
[11] https://www4.unfccc.int/sites/ndcstaging/Pages/Party.aspx?party=UZB&prototype=1

In energy and related sectors, developing the circular economy could provide many opportunities for women. In addition to solid domestic waste, Uzbekistan's mining, oil and gas production, coal, and chemical industries produce significant volumes of industrial waste. Both domestic and industrial waste generally ends up in landfills, dumps, and sludge storage facilities. Much of this waste could potentially be recycled or reused. Another key area for entrepreneurial and employment opportunities for women is that of R&D and technological innovation to reduce the country's high energy intensity.

Good Practices for Gender Equality

As mentioned in Chapter 1 of this report there are many potential benefits to having women participate in climate change-related policymaking. Uzbekistan's Ministry of Energy (including subsidiaries) is comprised of 538 staff members, of which nearly 92% are men. Figure 15 shows the distribution of genders in each of the subsidiaries. The shares of women range from 19% in the Nuclear Development Agency (Uzatom) to approximately 1% (ADB, 2020) in the Petroleum Products and Gas Inspectorate (Uzneftegazinspection). There is clearly much work to be done to bring greater gender balance to the Ministry of Energy.

Figure 15 - Gender representation in the Uzbekistan Ministry of Energy.



Source: Ministry of Energy of the Republic of Uzbekistan

Recommendations

- The Ministry of Energy and energy companies should determine and communicate gender diversity and equality targets as part of their human resources policies.
- Data collection, monitoring, evaluation, and publication on women participation in energy sector should be undertaken to help develop policies to promote gender equality.
- The Ministry of Employment and Labor Realtions should consider developing and conducting gender mainstreaming courses to enhance awareness of gender-equality issues and concepts, especially for the Ministry of Energy and energy sector companies.
- The energy sector and universities should collaborate on promoting programmes for internships, apprenticeships, and other types of on-the-job vocational training for female students.

- The government should develop policies to strengthen the ties between gender equality, energy targets, and national poverty reduction strategies.

Chapter 7 Drivers of Change: Women Participation Towards a Sustainable Energy Transition and Green Post-COVID-19 Recovery

Lessons learned from the Pandemic Specific to Women's Roles

People should have access to information about new employment opportunities if they lose their job. In particular, information regarding possible upskilling learning opportunities, is invaluable. This knowledge can help people use their time to learn new skills during a lockdown or similar circumstances. In addition to the clear economic benefits, this can help an individual psychologically by creating a positive learning environment and giving them hope of new employment when things return to normal. Relevant education and training programmes that can boost the economy should be made available on the internet. These programmes could focus on promoting skill development for women, which can be useful in creating opportunities targeted at growing areas of the economy, and in non-traditional sectors (such as energy).

Policy Formulation to Promote Climate Change Efforts and Build a Resilient Economy

Data collected by the IEA (2020a) on renewable energy performance during the COVID-19 pandemic shows that energy generation from renewable energy outperformed fossil fuel energy generation. In addition to the benefits of using low-carbon sources, there is evidence that the renewable energy sector is resilient, as it continued to contribute towards the functioning of economies and society. As discussed earlier in Chapter 3, the development of national/local markets and supply chains to regain self-sufficiency, energy security, and socioeconomic well-being. However, it is noted that investments in low-carbon energy sector are declining due to the economic slowdown. Public spending should continue to be aimed at renewable energy to ensure the continuation of new and existing projects, while creating innovation hubs, new employment opportunities, and developing local supply chains – all of which will contribute to the economic recovery.

It is well documented that the healthcare, retail, Information and Communications Technology (ICT), and energy sectors played a vital role in helping economies transition towards a "new normal" during the strict lockdown measures. It is imperative for the energy sector to similarly redefine its contributions to the economy and build capacity through investing in developing a skilled workforce and driving technological innovation for a low-carbon and sustainable transition.

Gender Equality in the Business and Work Environment

This study has discussed extensively the need for gender diversity in the energy sector. Transitioning towards a low-carbon and energy-efficient system will increasingly benefit women around the world. There are multiple benefits of engaging with women in the context of energy:

- women can access technology and renewable sources of energy to change household consumption patterns
- energy transition strategies will impact both men and women; the decisions to adopt one approach or another will have a direct impact on which resources women and men are willing to use, whether as entrepreneurs or consumers
- there are several other areas of energy where women can contribute due to their diverse skills and knowledge

The policy brief on women's leadership published by the United Nations (C3E, 2017) notes that the participation of women improves political decision-making process as women work across party lines to promote gender equality issues. The global energy transition is leading towards an innovative future, offering an opportunity to transcend the current economic structure towards a green and

sustainable economy. Equal gender participation in this endeavour can create future opportunities for technological advancement in the energy sector.

Role of Financial Policies and Banking Operations

Financial institutions can play a pivotal role in promoting investments in the energy sector, by implementing complementary fiscal policies and supporting regulatory environments, in ways that increase business and investor confidence in the transition. Successful implementations of projects in the energy sector can truly lend confidence to businesses to invest in green jobs, but it will likely need greater coordination and engagement with wider public policy. A good example is the increasing availability of green finance through green bonds and other similar instruments, which are encouraging long-term investments in low-carbon technologies. The banks and financial institutions can benefit from diversifying their investment portfolios, and it will help them show that they are creating green jobs.

Creating Business Networks

Evidence from the national case studies in Chapter 6 emphasizes the importance of accessing information and networks that can facilitate women's participation in the energy sector. This entails strengthening labour market information systems and career guidance services - perhaps through public employment offices. Having access to mentors and role models who can advocate equality of opportunity could help women rise above the so-called "glass ceiling" and increase the representation of women in positions of leadership.

Education, Training, and Skill Development

While there are many prerequisites, a fundamental requirement for transitioning the global energy system to sustainability is a skilled labour workforce. Further, many of the skills used in the energy sector currently will not be useful in a green economy, so an effective green transition will rely on the development of newer skillsets. Whether this need is filled through developing newer skill sets for performing existing jobs, or introducing new jobs entirely, investments in education and training programmes will be needed. As the economy changes structurally, demand for some occupations will decrease, and others will go away entirely. However, many of the existing skillsets may be applicable in other contexts, enabling workers to transition to new, greener occupations (WGEO, in press). For example, as some types of energy operations are similar, the fossil fuel industry has many jobs from which it should be relatively easy for employees to transition into cleaner energy jobs.

Conclusions and Recommendations

This study analyses the impact of the energy transition on women in a post COVID-19 socioeconomic recovery. The study is multi-faceted, assessing:

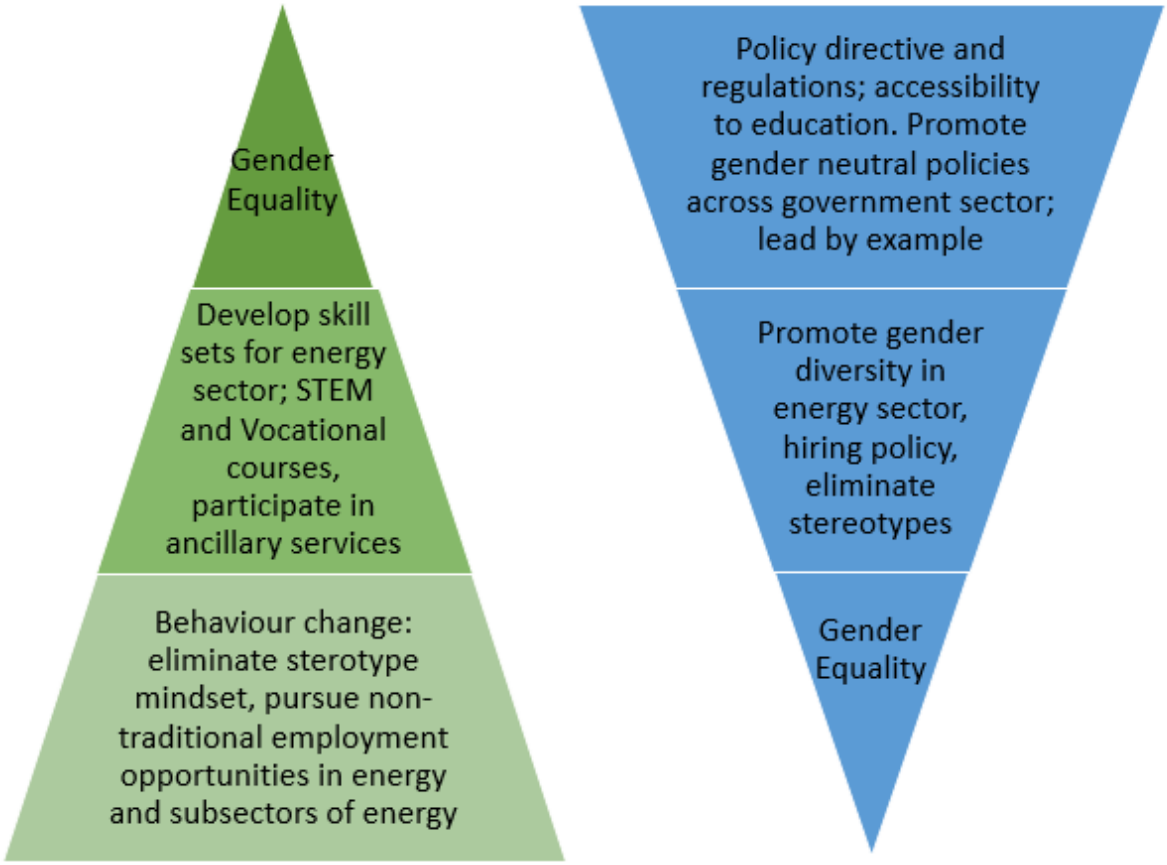
- the impact of the energy transition on gender equality and women's empowerment
- developments in the energy sector: trends, developments, and innovation
- the impact of the COVID-19 pandemic on the energy sector, economy, and social wellbeing, and its impact on women

Based on these assessments, the study identifies the opportunities and challenges facing women's participation in the economy – specifically in the energy sector – and promotes their participation to ensure a successful transition to a sustainable energy system and green economy post-COVID-19. The overall findings from the research and analysis of the national case studies indicate that there are three primary challenges limiting women's participation in the energy sector; these are:

- Contextual obstacles – women's own biases are holding them back from realizing their full potential. The career choices women make suggests that women tend to perceive energy careers as highly technical and requiring physical strength. Very little effort has been made by the society and the energy industry to eliminate such false perceptions and promote more gender diversity. Even considering energy sector roles that do require a high degree of technical knowledge, there seems to be no reason why more women could not fill those roles.
- Economic Obstacles – vary by the type of economy, but limited access to finance and training to enter the formal labour market can be a hindrance for women's participation. In emerging economies and developing countries, the primary barrier is financing and training. It should also be noted that a high proportion of people in developing countries are employed in informal work. This is particularly true for women and may be part of the reason that access to finance and training to enter the formal labour market is the greatest obstacle. These differences should be systematically analysed to most effectively guide efforts to create more energy sector jobs for women.
- Soft Obstacles – lack of information regarding employment opportunities acts as a barrier to women's employment in energy sector. Limited access to mentors and role models, and low representation of women in senior roles, can strengthen the perception that it is a male-dominated sector, thus discouraging women to consider various opportunities.

The five national case studies revealed the stark reality of gender inequality in the energy sector. Most countries have policies and initiatives to address the observed disparities, but implementation is predominantly voluntary. This study proposes a two-way complementary approach, shown in Figure 16, to tackle the challenge of gender diversity. The bottom-up triangle (green) shows the need for action by women and society to bridge the gap of gender inequality in the energy sector. The top-down triangle (blue) shows the approach for the government and policymakers, who need to develop policy tools to encourage women's participation in the energy sector.

Figure 16 - Two-way complementary approach to solving the challenge of gender diversity.



Equality of opportunity is an especially important characteristic of the improved "human well-being and social equity" expected of a sustainable economy. Broad considerations of equity also include relative wages, working hours, the work environment, and basic needs (clean water, food, shelter). Of particular importance is the availability of skilled labour who must be equipped to meet the challenges of the transition and the dynamics of changing production and consumption patterns. In part, the challenge of skilled labour availability can be resolved by a combination of pivoting on existing skillsets towards newer skills and developing entirely new jobs. Substantial investments in education and training programmes will be needed to support existing and new workforce participants. Governments, industries, and society should understand these considerations to ensure gender equality is addressed by providing access to relevant training and education, upgrading jobs and wages based on skills and ability, and encouraging women's participation.

The transition of the global energy system is leading us towards an innovative future, offering an opportunity to transcend the current global economy in favour of a more sustainable one. Equal gender participation in this endeavour can help society leap to a future of technological advancement in the energy sector. It is disappointing to note that the participation of women continues to be low across the spectrum of the energy sector, from policymaking to the labour workforce.

Recommendations

For Policymakers

Recommendation a: **Adoption of a low-carbon energy pathway**: This will drive countries towards a structural economic shift by driving technological innovation, creating jobs, and developing opportunities to build a greener and sustainable economy.

Recommendation b: **Invest in technological development**: The development of national policy instruments across economies - including public investments, phased elimination of fossil fuel subsidies, market mechanisms, and regulatory frameworks - is imperative, and goes hand-in-hand with the development and implementation of technological solutions.

Recommendation c: **Promote change in demand-side**: Awareness-raising on energy efficiency and automation technologies can help decrease power demand; developing regulations and guidance can support changes in consumption patterns.

Recommendation d: **Challenge social and cultural perception**: Empower women by helping them develop skills to build confidence to address cultural norms that may discourage them from participating in sectors like energy.

Recommendation e: **Information and data collection**: There is a need for collection, monitoring, evaluation, and publication of data regarding the participation of women in the energy sector. Analysing such data can help in promoting policies and monitoring trends in the gender gap.

Recommendation f: **Ensure national energy security**: Transitioning towards sustainable energy can create direct and indirect job opportunities in the energy sector and develop opportunities for building new supply chains. This transition can create opportunities for investment, entrepreneurial activities, and the development of a skilled workforce. There may also be significant potential in building local supply chains.

Recommendation g: **Non-discrimination in property rights and access to finance**: Ensure there is no gender-based discrimination in property rights and access to finance.

Recommendation h: **Networking and mentoring**: Promote mentorship platforms to preferentially encourage women professionals and subject matter experts from the energy sector to support connections among the female workforce through networking.

Recommendation i: **Capacity development**: Provide opportunities for women to access training and education programmes that improve entrepreneurship and technical skills; this will increase their opportunities for participation in the energy sector and its subsectors.

Recommendation j: **Green economic recovery**: Financial investments in the energy sector, supporting innovation, green growth, and sustainable development, can create multiple opportunities for women to participate in "build back better" and promote low-carbon solutions during the socioeconomic recovery from the COVID-19 pandemic.

For Industries

Recommendation k: **Capacity building through upskilling the current workforce**: Provide access to training to improve current skillsets; this can help in career development and future opportunities.

Recommendation l: **Review gender diversity gaps**: Assess human resources policies to review the gender gap and analyse best practices adopted by other industries and organizations.

Recommendation m: **Promote networking and mentoring**: Promote networking group platforms for women within the organization and across industry. A mentorship program can be beneficial for new entrants.

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